UNITED NATIONS
ECONOMIC AND SOCIAL COUNCIL

Distr.: Limited
E/ECA-SA/ICSOE.XXVIII/2022/6
October 2022

ECONOMIC COMMISSION FOR AFRICA
SUB REGIONAL OFFICE FOR SOUTHERN AFRICA

Twenty-Eighth Meeting of the Intergovernmental Committee of Senior Officials and Experts of Southern Africa

26-27 October 2022
Hybrid: Maputo, Mozambique and Virtual

Study Report on:

Greening Industrialization in Southern Africa through Digitalization, Infrastructure Development and Regional Integration: Leveraging AfCFTA Implementation

Greening Industrialization in Southern Africa through digitalization, infrastructure development and regional integration: leveraging AfCFTA implementation

Draft Report

Submitted to Inclusive Industrialization Section, ECA Subregional Office for Southern Africa

18 October 2022

Table of Contents

List of Tables

List of Figures

Executive Summary

The report analyzed the current state of green industrialization, digitalization and infrastructure development in Southern Africa. It identified gaps in the current industrial and development policies and frameworks and potential sectors and value chains that could anchor green industrialization. The analyses relied on secondary data compiled through a comprehensive desk research of publicly available national, regional and continental materials. The report focuses on the Southern African member states of Angola, Botswana, Eswatini, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe. The key findings and policy recommendations of the study are presented below.

Summary of key findings

The state of green industrialization, digitalization, infrastructure development

Energy: Recurrent load shedding and power outages, shocks in oil and gas markets, inefficient energy supply and consumption patterns are some of the key challenges facing the region. Disruptions in the energy supply impact all economic sectors adversely. Furthermore, the impacts are more severe for vulnerable populations such as women and youth who engage in informal business activities that depend on the main electricity grid and cannot afford alternative sources that might be expensive, such as generators. Energy resources across the remain are largely under-exploited. This contributes to energy supply challenges in the region. Some of the underlying factors contributing to this observation are limited financial capacity, constraining policy and a regulatory environment that fails to attract adequate private financing sources to address the energy infrastructure gap.

ICT and Digital Infrastructure: ICT and digital infrastructure sectors are growing across member states at different paces. This has facilitated the increasing penetration of ICT and digital technologies that contribute to improving economic growth and job creation by strengthening connections between goods, markets, people, and jobs. However, access to ICT and digital technologies and services varies across countries in the region. Some of the challenges that need to be addressed include improving accessibility ensuring wide coverage of the infrastructure, affordability, especially among women and youth and the capacity to benefit from the innovations effectively in the micro, small and medium enterprises.

Transport and logistics: The poor state of transport infrastructure (such as road infrastructure) and other factors, such as non-tariff barriers and weak logistics, adversely affect the transportation of goods and services across the region. High-trade costs adversely impact the development of regional value chains, and the effect is more severe for backward participation than forward participation. This trend reinforces the commodity-based, extractive industry patterns of trade currently dominating the region and undermining value chain development within and across countries of the region. Causes of high trade costs include poor transport infrastructure, non-tariff barriers and weak trade-related services, like trade finance, payments, and logistics.

The role of technology, innovation, digitalization, and infrastructure in the process of greening industrialization policies and practice

Technology and innovation: Developments in technology and innovations such as robotics, additive manufacturing, data analysis and systems, digital platforms and digital supply chains are shaping production and distribution activities and services within and across value chains. New technologies and innovations are being applied to embed sustainable and

environmentally friendly approaches to manufacturing, integrate resource efficiency and implement sustainable ways of disposing waste. These are important innovations to improve the competitiveness and the participation of stakeholders in regional and international value chains. New technologies and modern production processes and innovations can allow for less resource-intensive use of inputs (decoupling) to ensure that manufacturing growth does not have negative environmental impacts.

Digitalization: The expansion of digitalization, such as applications ranging from robotics, big data, 3D printing, and the Internet of Things, have transformative impacts on the economy, society and the planet. Digital technologies and innovations are improving the efficiency of production, logistics, customs and finances, enhancing cross-border trade and creating new opportunities for small and informal producers. The increased use and adoption of digital technologies can empower the poor (including youth and women) with access to information, job opportunities and services improving the inclusiveness of economic growth and development.

Infrastructure: Regional infrastructure facilitates the establishment of large competitive markets by providing lower-cost energy for all economic sectors (such as industry, agriculture, mining and communications). However, the infrastructure deficit (such as in energy, transport, ICT and digital infrastructure) holds back the region's potential to grow and transform into an industrialized region. In addition to the high costs of doing business and less competitiveness, the infrastructure deficit costs the region in terms of reduced potential output each year. Addressing the region's infrastructure gap is critical for green industrialization, economic growth and sustainable development. The costs of investing in required infrastructure in the region are beyond the capacities of governments. Therefore, Public Private Partnerships are required to contribute to financing investments in infrastructure in the region.

The industrialization policies and frameworks

Continental and Regional Policy Frameworks: Regional Economic Communities (SADC and COMESA) have various documents that embed elements of green industrialization. These include the revised Regional Indicative Development Strategy (RISDP), the Industrialization Strategy and Road Map, the Regional Infrastructure Development Master Plan and other sector-specific protocols, COMESA Medium Term Strategic Framework, 2021-2025. Also, the 2017 COMESA Industrial Policy and Industrialization Strategy (2017-2026). For example, the SADC Green Economy Strategy and Action Plan identify priority green growth/ industrialization opportunities across priority sections in the region. Also, the COMESA Industrialization Strategy (2017-2026) aim to promote investments in green technologies to ensure environmental preservation, climate change adaptation and mitigation.

National Industrial and Industrialization Policy Frameworks: Green industrialization presents opportunities for countries to leapfrog from traditional carbon-intensive methods of industrial growth to cleaner, more sustainable patterns that are more competitive. The review of country-level policy frameworks showed that industrial policies do not explicitly elaborate on green industrialization. Mauritius and South Africa are the two countries that have a national policy or plan that articulates green industrialization. Green economy plans, where available, highlighted either green industrialization/ green jobs or green economy as a strategic focus for the country. Furthermore, climate change policies and nationally determined contributions to UNFCCC also show that green industrialization/ green economy/ green jobs are part of efforts to reduce greenhouse emissions. Overall, the reviewed documents highlight the strategic focus on sustainable development, especially those developed after 2015.

The review showed the limited domestication of the continental and regional policy frameworks on green industrialization. For example, SADC has a clear green industrialization strategy; however, the national industrial policies of the member states do not articulate how they plan to implement the regional priorities. The implementation of regional agreements is delayed as member states ratify them at different times (some taking years) based on different processes. This is also worsened by the lack of capacity to unpack regional statutes and limited appreciation of their role in shaping domestic priorities. Another challenge is although climate change documents elaborate efforts to promote sustainable practices, often green industrialization is not articulated in terms of concrete priorities and actions. The strong commitment, in some cases, is not followed through to implementation due to weak institutions or an unfavorable political environment. One of the challenges has been the lack of resources and weak institutional environments to drive the implementation of the initiatives. Innovative financial instruments (such as public-private partnerships, blended finance etc.) are required to ensure national and regional green industrialization initiatives are implemented to yield expected socio-economic and environmental goals.

Selected cases of green industrialization experiences in Southern Africa

Eco-Industrial Parks Programme: The National Cleaner Production Centre, South Africa's Eco-Industrial Parks Programme demonstrates a practical example of efforts to facilitate the transition of industries to a green economy and/or green industrialization. The East London Industrial Development Zone – South Africa is an example of the international best practice of the EIP approach. It is part of the government's Special Economic Zones Programme aimed at developing, operating and maintaining modern purpose-built infrastructure and attracting strategic investments. Also, the ELIDZ is one of three EIP parks capacitated by the NCPC-SA through various RECP interventions. The thriving businesses in the ELIDZ range from renewable energy, agro-processing, aquaculture, automotive, ICT and electronics and general manufacturing. The companies have grown in competitiveness to participate in regional and global value chains.

Some of the lessons learned contributing to the success of the ELIDZ include:

(a) Fostering the exchange of synergies (industrial symbiosis) by facilitating companies to gain competitive advantage through the physical exchange of materials, energy, water and by-products that reduce/eliminate resource waste and environmental impacts of their activities.
(b) Enhancing inclusive and sustainable development by embracing community collaboration.
(c) Ensuring a conducive business environment that can attract global investments in green technological innovations and applications to drive green industrialization.
(d) Building global competitiveness for local companies encouraging them to enter regional and global value chains. This helps create new markets for small businesses that generally would face challenges accessing such opportunities.
(e) Strict entry criteria in EIP zones are critical to driving green industrial growth and development in the target regions. By only targeting 'clean industries', the ELIDZ has facilitated the development of the renewable energy sector as an alternative to fossil fuel energy.

Industrial Energy Efficiency (IEE) Project: Established in 2010, the National Cleaner Production Centre, South Africa (NCPC-SA)'s international award-winning Industrial Energy Efficiency (IEE) Project is the largest energy efficiency initiative in South Africa. The IEE Project is a multistakeholder initiative supporting increased and sustained energy efficiency in

industrial and selected commercial sectors such as agro-processing, chemicals and liquid fuels; metals processing and engineering; automotives; and mining. The IEE Project promotes the adoption of Energy Management Systems (EnMS), Energy Systems Optimization (ESO), and the Energy Management Standard ISO 50001 Series. In October 2020, the IEE Project was awarded the highest international accolade for an energy program by the global Association of Energy Engineers (AEE): the International Energy Project of the Year.

Some of the lessons learned contributing to the success of the ELIDZ include:

(a) Partnerships play an essential role in delivering green industrialization projects. The IIE Project was implemented with financial support from the Global Environment Facility (GEF) with co-funding from the South African Department of Trade and Industry (the dti).
(b) Effective energy management practices can contribute to cost savings and competitiveness improvement: The IEE project helped companies (such as Toyota South Africa) reduce production costs and improve their competitiveness by promoting industrial energy efficiency and energy management systems.
(c) The reduced costs and improved productivity and competitiveness from adopting industrial energy efficiency and management systems are key to the sustainability of the IEE project principles.
(d) IEE principles can significantly cut national energy use and contribute to improve energy security and to national carbon dioxide emissions reduction targets.
(e) Skills and capacity building help sustain the implementation of green industrialization activities: The IEE Project developed relevant skills in the industry as a core component of the support. Also, the IEE Project ensured and promoted an improved gender balance within the energy efficiency industry in South Africa.

The Southern Corridor Development initiative: Tsau //Khaeb National Park (Hyphen SCDI) Project: The Namibian government's strategic focus is to achieve large-scale, low-cost renewable energy development and design models for sustainably maximizing fiscal revenue and local development in renewable energy investments and green ammonia production. The government conceived the Southern Corridor Development Initiative (SCDI) as the country's first-gigawatt-scale fully vertically integrated green hydrogen project.

Some of the lessons learned contributing to the success of the ELIDZ include:

(a) The Namibia green hydrogen project offers potential local, national, regional and global socio-economic and environmental benefits. These include the supply of secure and low-cost renewable energy, supply chain and infrastructure development, reduced emissions, boost to GDP and jobs, and improved access to electricity and clean water, for example, the project will:
    a. Provide a renewable energy capacity of 5GW by 2030 (2GW to be commissioned in January 2027) and other downstream products, including green ammonia and methanol that can be produced in Namibia and exported globally at lower prices cost than local production.
    b. Create about 15 000 full-time jobs during the four-year construction period, and 90% of these will be Namibians. In addition, more than 100 000 domestic jobs are expected to be created from opportunities spurred by the green hydrogen project.
    c. Ensure 20% youth participation, and Hyphen has already started skills development and bursary programs.

Priority sectors to jump-start green industrialization in Southern Africa

The priority regional sectors to jump-start green industrialization in the region include agriculture and agro-processing, energy, manufacturing, waste, transport and infrastructure. These were selected based on the review of regional and country-level policy frameworks and other publications and informed by the focus of this report. Opportunities in these sectors include integrating sustainable production and consumption practices, improving resource use efficiency to reduce resource footprint, and increasing sector productivity.

Agriculture and agro-processing: The agriculture sector is characterized by limited value addition, and most products are exported in raw form or semi-processed. Also, there is increasing pressure on agroecosystems from the ever-growing global demand for food, feed, fiber and clean energy. The increasing demand, together with current and projected changes in climate, requires an urgent transition to resource-efficient and high-productivity food production and processing systems.

Energy sector: Investing in the energy sector is central to green industrialization. The transition to less-energy-intensive industries, cleaner technologies and fuels and the implementation of energy efficiency policies will contribute to economic growth while significantly helping reduce the carbon intensity of the GDP in the region. Extensive investments in green infrastructure and management practices and skills upgrades are critical for the transition to resource and energy-efficient outcomes.

Manufacturing: The challenge is many countries in the region are exploiting natural resources and exporting them in their raw form with limited value addition. Despite vast natural resources, countries in the region have inadequate infrastructure that constrains the development of national industries and intra-regional trade. Improvements in the value addition of natural resources within member states will create opportunities for increased incomes and new jobs. For example, improving resource efficiency such as energy, water and other raw materials in the manufacturing sector is critical to sustainable use of the limited resources to meet growing demand in the region.

Waste: Sustainable waste management and disposal are essential in the transition to green industrialization. The reduce, recycle, reduce (3R approach) presents a guiding principle for all actors in the waste management chain. Green investments in waste management, such as recycling plants or waste-to-energy technologies, contribute towards the transition to more sustainable waste management systems.

Transport and infrastructure: The development of regional transport corridors in the region helps improve efficiency in the transportation of goods and services within and across countries. This is important for enhancing intra-regional trade and facilitating regional integration. There are opportunities to diversify transport modes and increase the use of clean energy sources in transport networks. Mainstreaming digital and other green technologies in the transport sector would also help improve efficiency and reduce costs and environmental impacts. Such developments improve the competitiveness of regional goods and services in global value chains.

Potential regional value chains to propel green industrialization

Agro-processing of main agricultural products: The agro-processing industry mainly consists of grain milling, vegetable oil, fruits and vegetable processing, dairy, beverages, nuts, forestry and plantation products, fish and fishery products. Promoting value addition and application of sustainable production and processing of these commodities presents potential

opportunities for green industrialization. For example, digital technologies can also improve value chain efficiency across markets within and across countries. The growth of the agro-processing sector in the above value chains has the potential to increase incomes and creates jobs. Also, this improves integrated manufacturing and sectoral linkages while diversifying the manufacturing base and product differentiation.

Renewable energy value chains: The member states boast abundant untapped energy resources such as hydro power, hydrocarbons, nuclear minerals and renewable energy (solar, wind, geothermal) that are available and affordable when processed. Tapping on these energy resources, especially clean sources, is critical to address the energy challenges impacting the region's manufacturing sector. An example of the renewable energy regional value chain is the Namibian green hydrogen project, the Southern Corridor Development Initiative (SCDI). The SCDI will export green energy into the regional power pool (SAPP), which will be critical in supporting regional industrialization efforts.

Green fertilizer (such as ammonia) value chain: Renewable energy production, such as green hydrogen, produces downstream products, including green ammonia and methanol. The experiences from Namibia show how investments in green energy (hydrogen in this case) strengthen linkages with other sectors through clean energy and downstream products. The increased share of green ammonia used in food production in the region will also help improve the competitiveness of the region’s agricultural products in global markets.

Recommendations

To accelerate green industrialization in Southern Africa, Member States should:

- Maintain and/or upgrade the existing energy generation capacity and promote/facilitate investments in new clean energy infrastructure to ensure an undisrupted supply to all regional citizens and stakeholders. The investment includes expanding the share of clean energy sources in the energy generation mix currently dominated by coal.
- Mobilize public and private sector funding and address policy and regulatory constraints to create an enabling environment that attracts adequate private financing sources to address the energy infrastructure gap.
- Promote investments that grow the share of modern renewables in the generation energy mix. This contributes to national targets towards reducing emissions while contributing to socio-economic goals.
- Strengthen the implementation of the regional energy sector programs to save on electricity production costs through power interconnectors that integrate the region’s power market through Power Pools. This is important to improve access to energy to support manufacturing and trade activities.
- Ensure support for the effective functioning of the Southern African Power Pool to deepen deepening regional integration efforts. For example, member states should provide a conducive regulatory environment that facilitates trading in power between surplus and deficit countries and attract increased investments in new energy generation capacity, including modern renewable energy sources.
- Create enabling operational environments that attract public and private sector investments in growing the ICT and digital infrastructure sectors, including investment in developing entrepreneurial skills, targeting youth and women to help them engage in business activities in the growing digital economy;
- Support upscaling various digital technologies and internet of things-based technologies already being applied in the region and other parts of the continent and world to help improve productivity and incomes while addressing environmental goals.

- Invest in ensuring effective regulation that enables digital infrastructure expansion and makes connectivity affordable, reliable and universal. There is need for policy measures that address barriers to entry, such as restrictive licensing and exclusivity rights and promote competition on a level playing field, such as asymmetric regulation of dominant operators, infrastructure sharing and antitrust enforcement;
- Design and implement public-private partnerships to address the energy, ICT and transport infrastructure gaps;
- Develop regulatory and legal frameworks to stimulate digital innovations and incentivize the private sector and other partners to contribute to investing in an inclusive and dynamic digital economy. Some of the required investments include growing the digital infrastructure, developing digital skills and entrepreneurship (including among women and youth), digital platforms and digital financial services;
- Increase investments to maintain existing infrastructure and integrate climate resilience and green technologies into new infrastructure, including enhancing investment in connective infrastructure in the strategic industrial clusters to facilitate the development of regional value chains and foster private sector participation in green industrialization and the export of value-added products in the broader African market under the AfCFTA;
- Articulate green industrialization in their national industrial policies, including consolidating green industrialization priorities across all national documents and develop concrete action plans for green industrialization as well as allocate and mobilize resources for implementation;
- Design and implement strategic and focused policies that support increased domestic and foreign investments in green technologies and innovations. For example, increased investments in green technologies and modern production processes can allow for less resource-intensive use of inputs (decoupling) to ensure that the growth in manufacturing does not having negative environmental impacts.
- Develop effective institutions, capacity, favourable policy environment and mobilize resources (public and private) to operationalize regional and national green industrialization actions, including creating a transparent and predictable policy environment to incentivise private sector investments in green industrialization initiatives and priority value chains through fiscal incentives and other such mechanisms;
- Promote investments in improved and climate-resilient infrastructure to facilitate intra- and inter-regional and international trade, reduce the cost of doing business for private sector in the manufacturing and other sectors.
- Promote investments in connective infrastructure in the strategic industrial clusters in the region to help develop the regional value chain and foster private sector participation in green industrialization.
- Scaleup the implementation of green industrialization experiences that have demonstrated positive socio-economic and environmental benefits and share experiences across the region.
- Promote investments in sustainable production and consumption in agricultural value chains to reduce the natural resource footprint and increase the sector's productivity. This should include climate-smart, resource-efficient and high-productivity food production and processing systems;
- Strengthen regional production to support backward participation in value chains and enhance private sector investments to create productive jobs;

- Design and implement sound waste management policies and strategies to promote sustainable development outcomes and support the creation of new sustainable industries;
- Ensure a conducive environment that attracts investments in needed infrastructure and capabilities to scale the green industrialisation case studies such as in energy efficiency and renewable energy;
- Strengthen the domestic and regional regulatory framework concerning Investor State Dispute Settlement (ISDS) provisions which may increasingly come into conflict with environmental, mining rights, tax policies and, indeed, green industrialization priorities of member states;
- Develop a clear and transparent regulatory framework is necessary to foster effective PPPs that help deliver the infrastructure gap requirements in the region.

To deepen green industrialization, the private sector should:

- Continue to proactively invest in technologies to enhance productive and distributive efficiency and facilitate green industrialization, including through investments in clean energy, digital technologies and attendant infrastructure;
- Share experiences in the application and use of green industrialization technologies, especially how these technologies reduce costs and enhance product competitiveness;
- Seek opportunities to collaborate on the development and deployment of innovations which support green manufacturing processes.
- Embrace opportunities to engage in regional and global value chains with green manufacturing focus or linkages, which would assist in driving increased efficiency and competitiveness of MSMEs in the green economy.
- Invest in improving resource efficiency such as energy, water and other raw materials in the manufacturing sector to facilitate sustainable use of the limited resources to meet growing demand in the region.

To facilitate the sharing of experiences and accelerate the adoption of green industrialization, regional economic communities should:

- Strengthen regional frameworks on the same, set standards for adoption;
- Provide a platform for the member states and the private sector to share experiences periodically.
- Configure regional industrialization frameworks to favour green industrialization and the use of clean energy and energy efficiency.
- Institute standardization, quality assurance and quality management systems that meet international standards, including environmental regulations to facilitate intra-regional trade through AfCFTA.

To promote green industrialisation, development partners should:

- Support the development of green industrialization policy frameworks at regional and national levels.
- Support domestication, alignment and harmonization of green industrialisation policy frameworks.
- Provide a platform for the member states and the private sector to share experiences periodically.

Acronyms

AfDB	African Development Bank
AEE	Association of Energy Engineers
AfCFTA	African Continental Free Trade Area
AUC	African Union Commission
COMESA	Common Market for Eastern and Southern Africa
ECA	Economic Commission for Africa
EIPS	Eco-Industrial Park
ELIDZ	East London Industrial Development Zone
GDP	Gross Domestic Product
ICSOE	Intergovernmental Meeting of Senior Officials and Experts
ICT	Information and Communications Technology
IEE	Industrial Energy Efficiency
IoT	Internet of Things
ITU	International Telecommunication Union
LCOH	Levelized Cost of Hydrogen
NCPC-SA	National Cleaner Production Centre, South Africa
OECD	Organization for Economic Co-operation and Development
PIDA	Program for Infrastructure Development in Africa
RECP	Resource-Efficient and Cleaner Production
SADC	Southern African Development Community
SAPP CC	Southern African Power Pool Coordination Centre
SCDI	Southern Corridor Development Initiative
SDG	Sustainable Development Goals
SEZ	Special Economic Zones
SMEs	Small to Medium Enterprise
SRO-SA	Sub-Regional Office for Southern Africa
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization

1. Introduction

1.1 Background

The Southern African region has high commodity dependence and a low degree of industrialization, inconsistent with structural transformation and sustainable economic development to reduce poverty and increase equity in the region significantly. Most countries in the region, have been unable to sustain manufacturing value added beyond 15% of GDP (World Bank, 2020), noting that structural transformation requires sustained value-added levels circa 25% of GDP, based on evidence of newly industrialized economies of East Asia[1]. For example, between 2016 and 2020, only Eswatini (29%) and Lesotho (16%) had an average manufacturing value added above 15%, while Malawi, Mauritius, Namibia, South Africa and Zimbabwe (ranged between 11 and 13%) and Angola, Botswana and Zambia reported between 6 and 7% manufacturing value added (World Bank, 2022). The high levels of poverty[2] and inequality[3] indicate that economic growth[4] and development have not been inclusive. Furthermore, the limited economic diversification and a narrow export basket mostly comprised of semi-processed commodities undermine the region's resilience to economic, climatic, pandemic or war-driven shocks, impacting the economic fundamentals and worsening vulnerability and poverty. Vulnerability to economic and climate shocks compound each other, especially in developing countries, locking countries into an eco-development trap of permanent disruption, economic precarity and slow productivity growth (UNCTAD, 2021).

In the face of global climate change, increasing natural resource degradation and rising environmental pollution, member states in the region have embraced green industrialization– and are pursuing economic growth without externalizing the negative environmental costs of development (Okereke, et al., 2019). Increasing industrialization to drive economic transformation will increase the use of resources, and greening the process contributes to developing a more competitive, resource-efficient, a climate-resilient industrial sector that increases manufacturing value add and creates jobs while preserving environmental resources (ECA, 2016). However, many unanswered questions remain about the feasibility of green industrialization in Southern Africa, particularly regarding sustaining growth and the conditions under which this might best happen. Others suggest that as latecomers to industrialization, African countries have the advantage of not grappling with technology lock-in and associated path-dependencies, which often constrain change (UNEP, 2011).

The region faces an urgent challenge to accelerate green industrialization and improve the diversification of its economies to mitigate the impact of climate change and take full advantage of the opportunities of digitalization. Climate change is advancing fast while the global community is lagging in implementing the mitigation and adaptation measures necessary to attenuate the phenomenon's economic, social, and environmental costs. Extreme weather events have already started damaging the hard-needed infrastructure that the region needs to accelerate structural transformation, economic diversification, and industrialization. The lack of interconnectedness of the region's infrastructure is well documented, whether ports,

[1] Between 1950, 1980 and 2005, East and South-East Asia economies MVA as % of GDP on average was 10%, 22% and 24% respectively, with a 6% growth rate over the period. These rates include fast industrializing East Asia economies which at their peak were registering rates of 24 -36% (Chang & Zach, 2019).

[2] Between 2014 and 2019, the poverty headcount ratio at $3.65 a day (2017 PPP) (% of population) ranged from 40% to 89% in the focus countries except in Mauritius which was about 2% (World Bank, 2022).

[3] Between 2014 and 2019, the poverty gap at $3.65 a day (2017 PPP) (%) ranged from 25% to 51% in the focus countries and only Botswana (14%), Namibia (13%) and South Africa (16%) had poverty gap below 20% (World Bank, 2022).

[4] Based on World Development Indicators Data, average GDP annual growth rate between 2010 and 2021 was 3% with individual countries ranging 1.3% to 5% (World Bank, 2022).

interlinked highways and feeder roads, or electrical grid systems required to power the firms driving the industrial process.

Africa's current and future industrialization drive is confronted with the issues of green industrialization, digitalization, energy access and affordability, transport logistics and regional integration (Lopes & te Velde, 2021). Supportive policies are essential to building a productive capacity that uses lower cost and clean energy. Also, digitalization can contribute to achieving environmentally and socio-economically sustainable industrialization. For example, digitalization can contribute to the achievement of SDG 9 through the reduction of emissions, enabling decoupling and significant CO_2 savings from the industry while simultaneously raising economic growth and increasing incomes, especially in low and middle-income countries (Sachs, Schmidt-Traub, Mazzucato, Messner, & Rockström, 2019; Matthess & Kunkel, 2020; Kunkel & Tyfield, 2021). Deepening regional integration provisions, investing in complementary infrastructure, building industrial capabilities, and investing in the institutions needed to promote regional trade are critical to accelerating green industrialization.

The African Development Bank estimate that Africa requires $130-170 billion per annum in infrastructure investments to power the continent's development aspirations articulated in Agenda 2063 (AfDB, 2018). Further, the region will need to grapple with the drivers of green industrialization that can support faster intra-Africa and global trade to build resilience against multiple shocks. Critically, green infrastructure investments are needed in the region to support a just transition, clean, sustainable energy to power industrialization and enhance private sector development. Given the strong correlation between energy use and economic growth, at least historically, decoupling carbon dioxide emissions from economic development presents a huge challenge for any state. But achieving this objective is even more difficult for developing countries where institutional capacity and innovation systems are weaker (Mulugetta & Urban, 2010; Wakeford, et al., 2017).

Digitalization can change established economic development processes, revealing new challenges with respect to the distribution of the welfare gains from industrialization, especially where variability in access to digital infrastructure impacts equality of opportunities, particularly evident in the rural-urban divide in developing countries. On the other hand, making industrialization and digitization environmentally sustainable is essential to simultaneously address 'sustainable industrialization' (SDG 9) and other sustainability goals like climate change mitigation (SDG 13). The political and economic systems should be considered in digitalization and green industrialization efforts to ensure that the ecological harm of industrialization is alleviated rather than worsened by aggregate macro-level growth that might reverse efficiency gains in material resources and energy (Kunkel & Tyfield, 2021).

Given the region's potential comparative advantage in agriculture, there is a need for a concerted focus on climate-smart and resilient agriculture, which supports increasing crop yields for food security and sustainable supplies of agro-processed goods for regional and global trade. At the centre of the industrialization drive is the African Continental Free Trade Area (AfCFTA) as a critical framework supporting an increased pace of continental industrialization and, in some cases, re-industrialization. The AfCFTA aims to boost intra-Africa regional trade connecting more than 1 billion people and a combined GDP of more than USD$ 3 trillion[5]. The measures to address trade and non-trade barriers and facilitate intra-Africa regional trade will help create opportunities to develop regional value chains. The growing new regional markets, complemented by improvements in the regional and national policy environment, will also help attract private sector investments and spur innovations that

[5] https://au.int/en/ti/cfta/about. Accessed 16 October 2022.

will help transform national and regional economies. Digitalization, infrastructure development, ICT, energy access and regional integration will be key in enhancing the benefits of the AfCFTA among regional member states.

1.2 Green industrialization and inclusive growth

Industrialization 'is the process during which a society or country transforms itself from a primarily agricultural society into one based on manufacturing goods and providing services' (ECA, 2016). Also, industrialization is a transformative process shaping the economic structure of countries and affecting their social and institutional fabric (UNIDO, 2020). Designing and implementing effective green industrial policies and strategies complemented by the green and resilient infrastructure can be a driving force in transforming negative trends and incentivizing stakeholders to invest in an inclusive green socio-economic transformation.

Green industrialization encompasses three closely related concepts: green economy, green growth and green jobs. Based on the United Nations Industrial Development Organization (UNIDO), green industrialization has two main dimensions (a) industries green themselves and (b) green enterprises that offer environmental goods and services. In the first dimension, industries can green themselves by reducing the environmental impacts of industrial processes (decoupling), that is, improvements in the use of materials, energy and water inputs and or a reduction in the release of pollutants concerning product outputs. The second dimension involves establishing new enterprises or expanding existing ones to deliver environmental goods and services (Luken & Clarence-Smith, 2019).

Figure 1-1 shows the three public policy goals of industrialization, green growth and inclusive growth. Traditionally these goals have been addressed in isolation with different government institutions responsible for each area of policy design, implementation and funding. However, overlapping the three goals helps identify the synergies between industrialization, green growth and inclusion and aligns the policy areas to strengthen win-win outcomes and minimize trade-offs among them (ECA, 2016). Green and inclusive industrialization present a vital pathway to combine sustainable economic growth, more inclusive incomes and an enhanced environment within a broader green economy strategy (ECA, 2016). Attaining inclusive green industrialization requires increases in economic growth and incomes together with sustained efforts to advance green transformation, social inclusiveness and management of trade-offs.

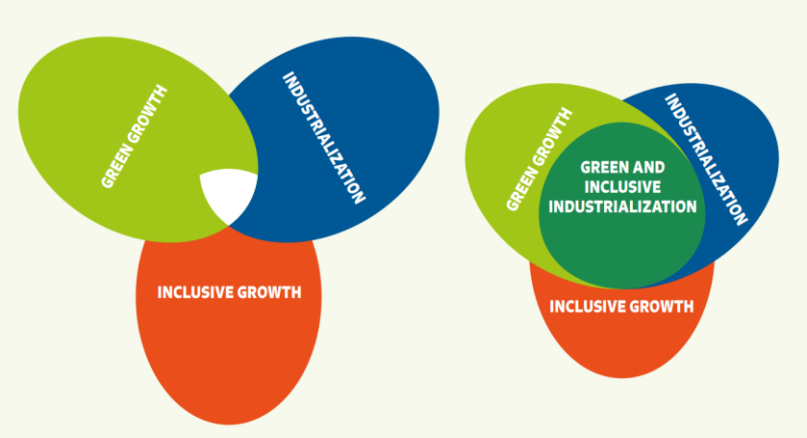

Figure 0-1: Greening industrialization and inclusive growth

Source: ECA (2016)

1.3 Objectives of the study

The study's main objective was to: (a) conduct an analysis of the current state of green industrialization, digitalization and infrastructure development (energy, ICT and digital, transport and logistics), (b) undertake a gap analysis of the current industrial policies and frameworks, and (c) identify potential sectors and value chains that could promote green industrialization. The report focuses on the Southern African member states of Angola, Botswana, Eswatini, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe. The analyses relied on secondary data compiled through a comprehensive desk research of publicly available national, regional and continental materials.

1.4 Approach and methods of the study

The empirical analyses relied on secondary data compiled through a comprehensive desk research of publicly available national, regional and continental materials.

Inception Phase: This involved inception activities, including engaging with the SRO-SA to clarify the assignment. The inception report and annotated outline were prepared and submitted to SRO-SA for review and approval.

Desktop Review Phase: The desk review included gathering relevant documents, databases and other information that addressed the objectives of the consultancy. The collected information was critically reviewed and synthesized, guided by the different sections of the annotated report outline.

Secondary Data Collection, Capturing and Analysis Phase: Informed by the comprehensive desk review, data on selected variables were gathered from identified publicly available databases. The data were captured and analyzed in Microsoft Excel to provide empirical evidence on respective sections of the report.

Draft Report Writing Phase: Based on the desktop review and analysis of secondary data above, this phase included preparing the assignment report. The phase produced the first draft report and summary of findings and recommendations submitted to SRO-SA for review and feedback before revising and preparing for the presentation of the revised version at the ICSOE.

Finalization Phase: This phase included revising the draft report and summary of findings and recommendations, integrating feedback from SRO-SA, EGM and ICSOE. The final submission consisted of the final report and summary of findings and recommendations as well as data utilized in the empirical analyses, including charts, figures and tables.

1.5 Structure of the report

This section provided the background, objectives and approach of the report. The following section discusses the state of green industrialization, digitalization, and infrastructure

development in Southern Africa. The focus is on the state of green industrialization, digitalization, and infrastructure development (energy ICTs, digital interoperability, and transport and logistics). The discussion assesses opportunities or constraints in AfCFTA implementation for Green Industrialization. Section 3 reviews the important role of trade, technology, innovation, digitalization, and infrastructure in the process of greening industrialization policies and practice. The industrialization policies and frameworks in Southern Africa are discussed in Section 4, focusing on gaps in incentives, environmental laws and regulations and other policies that promote the greening of industry in the region. Section 5 presents successful case studies of green industrialization experiences from selected countries. Section 6 assesses priority sectors by country where opportunities and competitive advantages exist to jump-start green industrialization. Section 7 section analyses potential green regional value chains which offer opportunities to propel green industrialization and facilitate intra-Africa trade under the AfCFTA. Section 8 presents conclusions and policy recommendations to accelerate green industrialization in the region.

2. The state of green industrialization, digitalization, infrastructure development in Southern Africa

2.1 Introduction

Challenges experienced in the energy sector include overcoming barriers for the grid integration of renewable energy resources, increasing the efficiency of the energy processes in the industry sector, addressing increasing energy demand (including from rebound) and security issues associated with interconnected energy generation systems (Coroamă & Mattern, 2019; Mondejar, et al., 2021). Digitalization entails that development and application of digital technologies in different realms of society. This include socio-technical changes associated with the application of digital technologies such as changing production and consumption patterns triggered by the introduction of digital technologies (Kunkel & Tyfield, 2021). Digitalization can contribute to achieve environmentally and socio-economically sustainable industrialization. For example, digitalization can contribute to achievement of SDG 9 through reduction of emissions, enabling decoupling and significant CO_2 savings from industry while simultaneously raising economic growth and increasing incomes especially in low and middle-income countries (Sachs, et al., 2019; Matthess & Kunkel, 2020; Kunkel & Tyfield, 2021). This section will focus on an empirical analysis of the state of green industrialization, digitalization, and infrastructure development, focusing on energy infrastructure, ICTs and digital infrastructure, and transport and logistics. The discussion includes a critical assessment of opportunities or constraints in AfCFTA implementation for green industrialization. Connections and interlinkages between the different sub-sections are also discussed.

2.2 Energy

The demand for energy in the region continues to grow, driven by rising population, urbanization, and growing economic activity that demands more energy. The energy challenges experienced in the region include recurrent load shedding and power outages, shocks in oil and gas markets, inefficient energy supply and consumption patterns, limited power generation capacity and lack of interconnectivity of power grids. Like the rest of the continent, the region suffers from under-exploitation of energy resources due to limited financing capacity, constraining policy and a regulatory environment that fails to attract adequate private financing sources to address the energy infrastructure gap (AfDB & AUC, 2013b). These challenges significantly affect economic activities and constrain the potential growth of the manufacturing sector. As a result, the region is experiencing high opportunity costs in terms of lost output when businesses and households experience sustained periods without electricity and no alternative energy sources. Alternatively, they incur extra charges if they use other sources like generators.

Access to electricity in the focus countries remains a challenge across the region. Figure 2-1 below shows that only 5 of the 11 focus countries (Botswana, Eswatini, Mauritius, South Africa and Zimbabwe) have at least 50% of their population with access to electricity by 2020. Countries with decent access to electricity, such as South Africa, have been experiencing unreliable power supplies recently. Lack of access to electricity severely affects all sectors of the economy, impacting economic activities for individuals and businesses. For example,

access to electricity is critical to foster the growth of the internet economy by supporting electronic devices and IT infrastructure. Electricity allows users to power their devices such as smartphones, tablets and telecom operators to run their IT infrastructure, including main distribution frames, base stations and internet exchange points. Furthermore, data center operators require access to reliable electricity to provide data storage and processing services (Google & IFC, 2020).

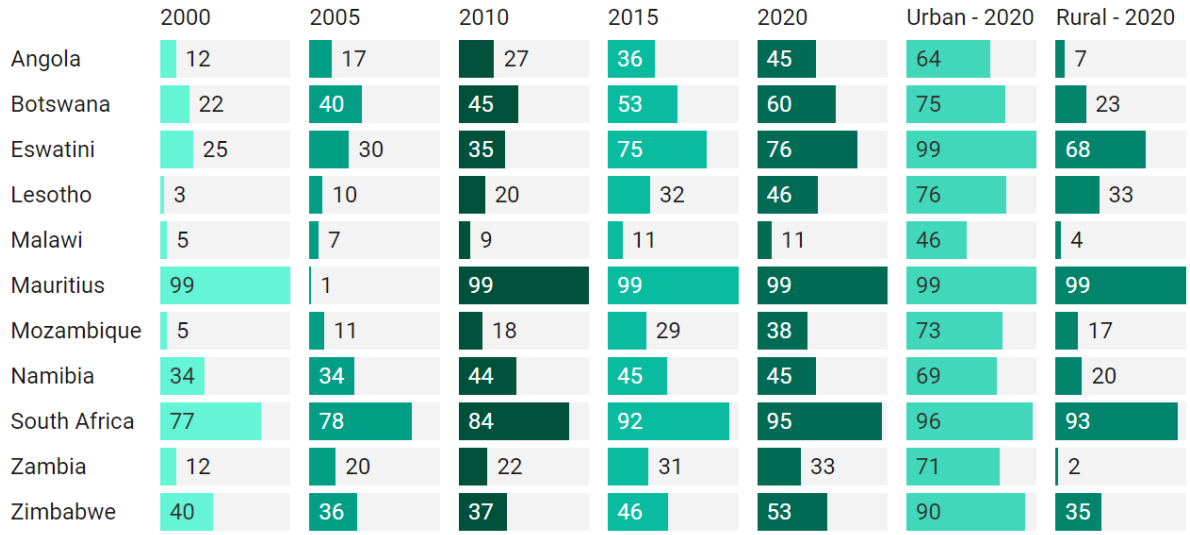

Figure 2-1: Proportion of the population with access to electricity (%)

Source: Own construction based on date from IEA (2021)

Figure 2-2 further demonstrates the interlinkages between energy, ICT and digital infrastructure. The illustration shows the importance of interlinkages in driving the digital economy and green industrialization in the region.

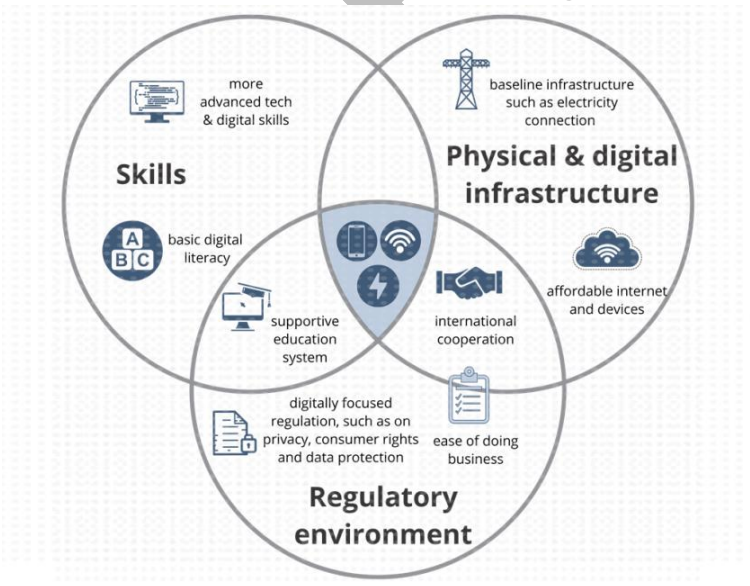

Figure 2-2: Interlinkages between energy, ICT and digital infrastructure

Source: Tralac (2022a)

Unreliable access to electricity significantly affects access to the internet, digital connectivity and costs of doing business for individuals and businesses, especially small and medium-sized enterprises (SMEs) that cannot afford alternative sources of electricity such as electric generators, solar systems etc. Figure 2-3 shows the percentage of the population with access to electricity and the percentage of people using the internet in 2010 and 2020. The results show that countries with low access to electricity in the region also have low access to the internet and vice versa. This highlights the importance of investments in energy and ICT infrastructure complemented with relevant supporting investments such as skills development and improvements in the regulatory environment.

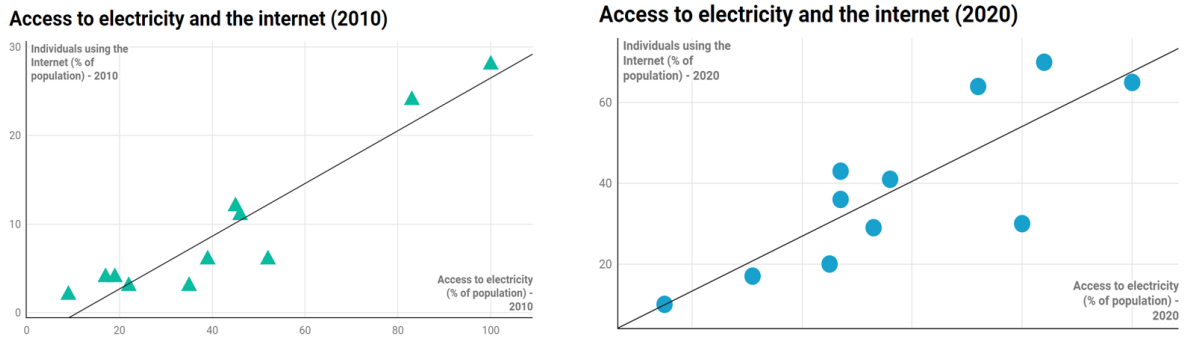

Figure 2-3: Access to electricity and the internet

Source: Own construction based on WDI data, World Bank (2022)

An analysis of the share of modern renewables in total final energy consumption showed that only Eswatini and Malawi had at least a 40% share (Figure 2-4). The growing demand for clean energy sources can help attract increased investments to mainstream modern renewable energy sources in their energy mix. There are increasing opportunities for increased investments in renewable energy to drive green industrialization. The SADC region has experienced growing investments in renewable and non-renewable energy forms contributing to the surplus electricity generation capacity (mainly from cola, wind and hydro) registered since 2017 after a decade of power deficits which began in 2007 (SADC, 2019).

Examples of initiatives from member states include the South African Renewable Independent Power Producer Programme that was designed to add clean energy onto the national electricity system through private sector investment in biomass, solar, wind and small hydro among others[6]. Over 6 000MW generation capacity was allocated to private sector investors. Another example is the Renewable Energy for Sustainable Development in Zambia aimed at developing local and readily available renewable energy resources such as biomass, solar, and mini-hydro[7]. The examples given are not exhaustive and member states have different clean energy initiatives that they are implementing. An enabling environment is critical to attracting investments in modern renewable energy sources from the public and private sectors. Increasing the share of modern renewables in the generation energy mix helps contribute to national targets towards reducing emissions while contributing to socio-economic goals.

[6] https://www.gov.za/about-government/government-programmes/renewable-independent-power-producer-programme. Accessed 15 October 2022.
[7] https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-renewable-energy-for-sustainable-development-in-zambia. Accessed 15 October 2022.

	1990	1995	2000	2005	2010	2015	2019
Angola	2.68	2.81	2.92	3.83	4.31	4.64	8.83
Botswana	0.62	1.43	0.04	0.01	0	0.04	0.09
Eswatini	36.9	29.42	32.94	39.84	47.96	51.58	40.73
Lesotho	0	0	2.35	2.59	3.93	5.58	6.46
Malawi	31.88	34.98	36.55	41.23	43.38	45.22	42.07
Mauritius	40.65	36.84	19.48	16.78	11.92	10.84	8.49
Mozambique	11.38	11.84	2.99	11.27	19.79	17.18	14.92
Namibia		15.27	16.25	19.99	18.45	19.69	20.24
South Africa	3.11	3.34	3.49	3.61	4.35	4.91	5.64
Zambia	22.55	23.01	22.28	23.65	22.8	23.5	22.84
Zimbabwe	8.53	7.35	9.27	11	10.55	9.39	8.94

Figure 2-4: Share of modern renewables in total final energy consumption (%)

Source: Own construction based on date from IEA (2021)

The Southern African Power Pool (SAPP) is a platform for trading in power among the focus countries of this study. Trade under SAPP contributes to enhancing regional integration efforts through enhanced energy access in deficit countries and facilitating surplus countries to sell energy across the region through the interconnectors. Figure 2-5 shows the SAPP SADC Grid map showing existing lines and substations. The initiative contributes to deepening regional integration efforts and accelerating the development of regional power interconnectors to enable member states in the SADC region to share and benefit from increased generation capacity across borders. This is critical to address ongoing power shortages that adversely affect the industry and all economic sectors across the region (SADC, 2019).

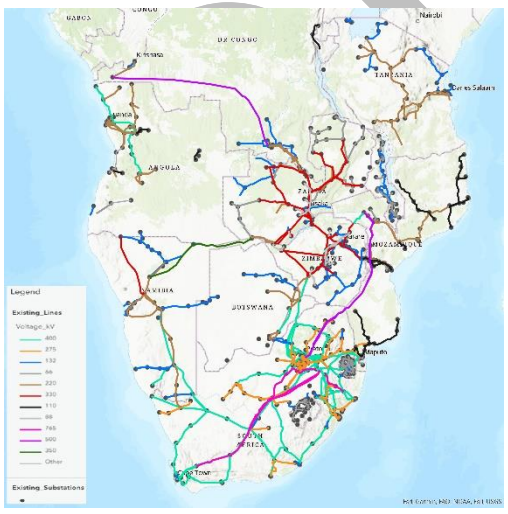

Figure 2-5: SAPP SADC Grid Map

Source: SAPP[8]

[8] https://www.sapp.co.zw/. Accessed 9 October 2022

The SAPP demand and supply status (for the focus countries) as in March 2021 is presented in Figure 2-6. The installed capacity of the SAPP (for the focus countries excluding Mauritius) as of March 2021 was 76,470MW with an operating capacity of 61, 047 MW and demand and reserve of 52 148 MW resulting in 8,898 MW excess capacity. The reported excess was partly due to reduced electricity demand triggered by the COVID-19 pandemic that led to drastic reductions in industrial and commercial businesses and suspension of a large portion of service sector related activities despite growing household electricity demand in the same period (SAPP, 2021).

	Installed Generation Capacity (MW)	Operating Capacity (MW)	Current Peak Demand (MW)	Peak Demand Plus Reserves	Capacity Excess/ Shortfall (MW)
Angola	5,878	4,877	2,209	2,687	2,190
Botswana	892	322	587	675	-353
Eswatini	71	65	226	259	-194
Lesotho	74	70	150	173	-103
Malawi	506	330	351	380	-50
Mozambique	2,796	2,642	1,948	2,240	402
Namibia	624	390	695	695	-306
South Africa	60,326	48,215	35,005	40,256	7,959
Zambia	2,891	2,736	2,510	2,887	-151
Zimbabwe	2,412	1,400	1,724	1,896	-496
Total	76,470	61,047	45,405	52,148	8,898

Figure 2-6: SAPP Demand and Supply situation as in March 2021

Source: Own construction based on data from SAPP (2021)[9]

Figure 2-7 shows the installed capacity contributions by generation technology for the SAPP in March 2021. The installed capacity energy generation mix is mainly thermal (coal) (59%) followed by hydro-power (24%). Other energy sources include Solar PV and Distillate at 4% and nuclear and wind contributing 3%. The current mix shows that there are opportunities to expand the contribution of clean energy sources in the region.

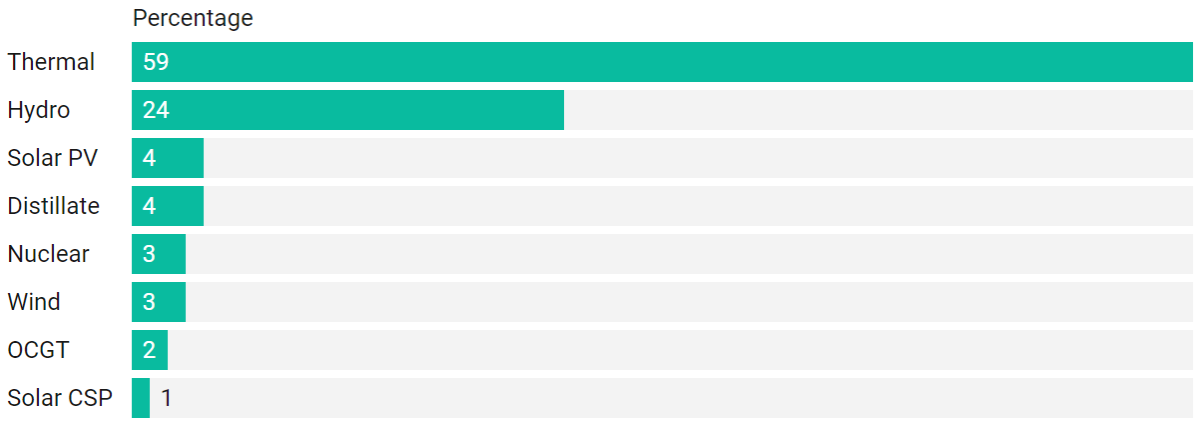

Figure 2-7: SAPP installed generation mix as in March 2021

Source: Own construction based on data from SAPP (2021)

[9] Exclude data from DRC and Tanzania

The history of new generation capacity between 2010 and 2020 showed that the SAPP was 8,168 MW below the planned capacity of 30,092MW by 2020 (Figure 2-8). This contributes to regional electricity challenges and a number of focus countries (such as South Africa, Zimbabwe) have been experiencing electricity challenges in recent years. Addressing the new generation capacity offers ways for member states to expand the contribution of clean energy sources in the regional pool. Also, consistent infrastructure maintenance is required to avoid supply disruptions. The energy supply disruptions adversely affect all economic sectors and constrain efforts to drive green industrialization.

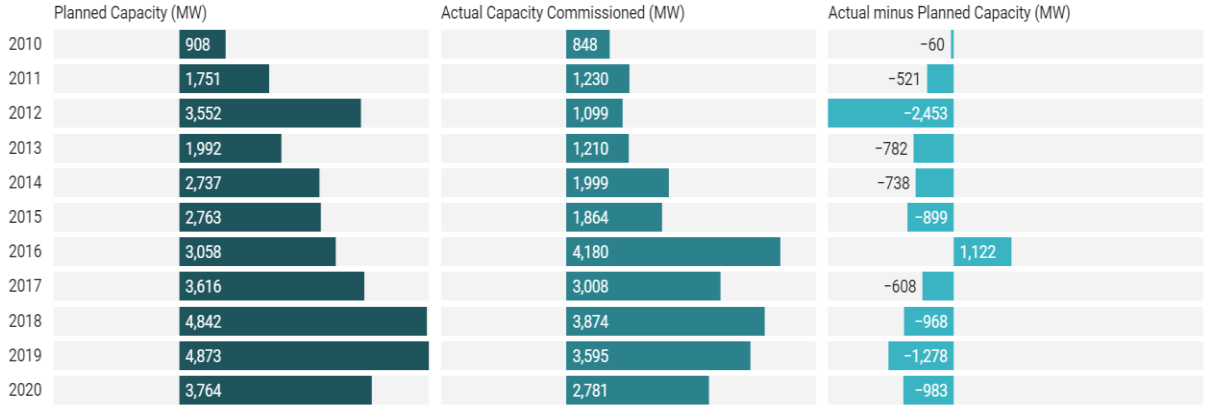

Figure 2-8: Planned vs actual generation capacity commissioned by SAPP since 2010

Source: Own construction based on data from SAPP (2021)

2.3 ICT and Digital Infrastructure

ICT and digital infrastructure encompass the network services needed for individuals, businesses and governments to get online and connect with local and global digital services connecting to the global digital economy. Furthermore, ICT and digital infrastructure include connectivity (based on highspeed internet and internet exchange points), the internet of things (computers, mobile devices, sensors, geospatial instruments, voice-activated devices, machine-to-machine communications, vehicle-to-vehicle communications) and data repositories (data centers and clouds) (Calderon & Cantu, 2021). Similar to other studies such as (Calderon & Cantu, 2021) and International Telecommunication Union (ITU), to discuss the status of ICT and digital infrastructure in the region, the report used the following indicator categories: network coverage, ICT access at home, mobile and fixed broadband subscriptions, mobile and fixed telephone subscriptions and mobile ownership, and internet services (the percentage of internet users in the population).

Infrastructure and access

Broadband penetration helps improve economic growth and job creation by strengthening connections between goods, markets, people, and jobs (AfDB & AUC, 2013c). The population covered by a mobile cellular network shows that all countries reported at least 85% cellular network coverage except Eswatini (55%) (Figure 2-9). Also, the results for 4G (ultra-broadband internet access) showed that 7 of the 11 focus countries (Botswana, Eswatini, Lesotho, Malawi, Mauritius, South Africa and Zambia) reported at least 50% coverage. The focus countries show high coverage rates of 3G (the first to enable video calls and faster data

transfer), similar to mobile cellular network coverage. The wide mobile cellular and 3G coverage open opportunities for improved access to digital innovations (such as digital financial platforms) across the country, including reaching the economically disadvantaged, such as youth and women in remote areas.

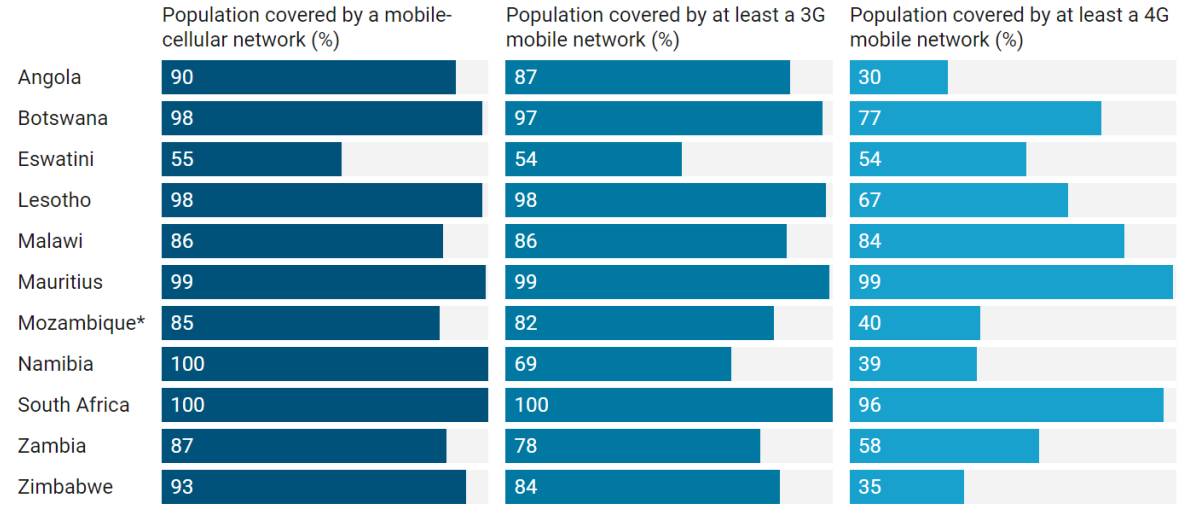

Figure 2-9: Network coverage (2020)

Source: Own construction based on date from ITU

Household internet use remains low in the region, with only three countries (Botswana, Mauritius and South Africa) reporting internet access above 50% in 2020 (Figure 2-10). Internet access is also reported for urban and rural areas. Ownership of a computer at home is less than 50% in all the countries. The main challenge to internet access is affordability, with entry-level and second-hand devices costing between $35 to $40, equivalent to up to 80% of monthly wages in some countries in the continent (Google & IFC, 2020). Despite efforts by governments to reduce the cost of data in the recent past, affordability remains a challenge for many low-income people in the region. The Internet of Things (IoT) connects physical components over the internet. The development of smart systems connected to the internet of things can generate unique opportunities to strategically address challenges associated with the SDGs to attain an equitable, environmentally sustainable and healthy society (Mondejar, et al., 2021).

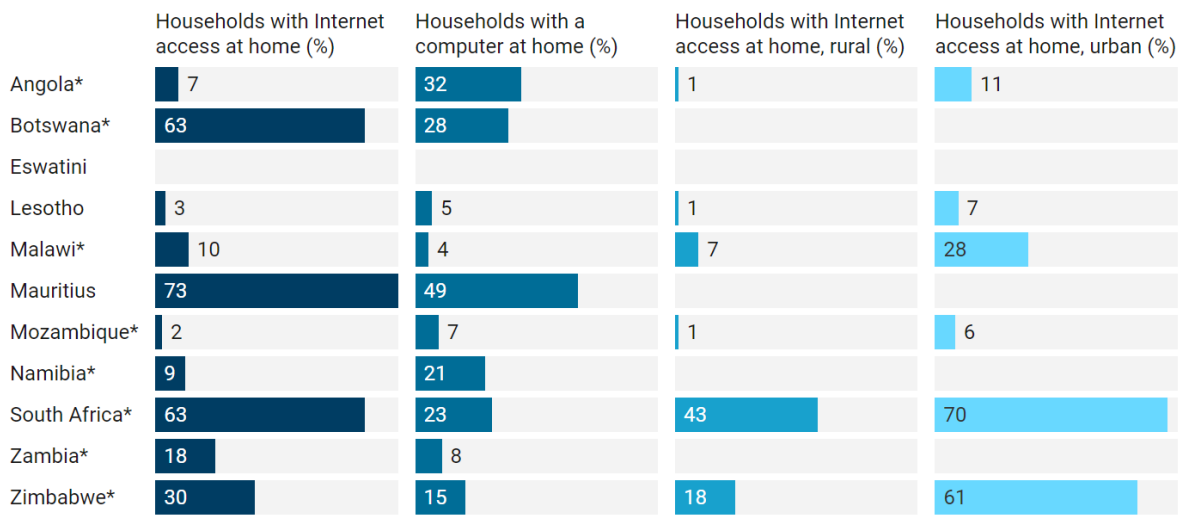

Figure 2-10: ICT access at home (2020)

Source: Own construction based on date from ITU | **Note:** Gaps indicate no data available

To discuss the penetration of mobile services (number of connections per capita), Figures 2-11 and 2-12 present mobile and fixed (broadband and telephone) subscriptions per 100 inhabitants and international bandwidth per internet user. Figure 2-13 shows mobile phone ownership as a percentage of the population in each focus country. The penetration of mobile services (number of connections per capita) indicates high mobile broadband and telephone subscriptions and very low numbers for fixed broadband and telephone subscriptions. Botswana (95%), Mauritius (98%) and South Africa (111%) reported high levels of mobile broadband penetration per 100 inhabitants among the focus countries (Figure 2-11). Angola (20%), Eswatini (18%) and Mozambique (18%) had the lowest mobile broadband subscriptions per 100 inhabitants. Six of the eleven focus countries have a rate of mobile penetration that exceeds 100 percent (that is, more than one connection per person). The highest rate of penetration is registered by South Africa (162) and Mauritius (150) (Figure 2-13).

The extensive spread of mobile broadband indicates the increasing mobile network services needed for individuals, businesses and governments to get online and connect with local and global digital services connecting to the global digital economy. This also means entrepreneurial youth and women across the region can start new digital businesses or apply digital technologies to improve their businesses, for example, improved access to regional and global markets.

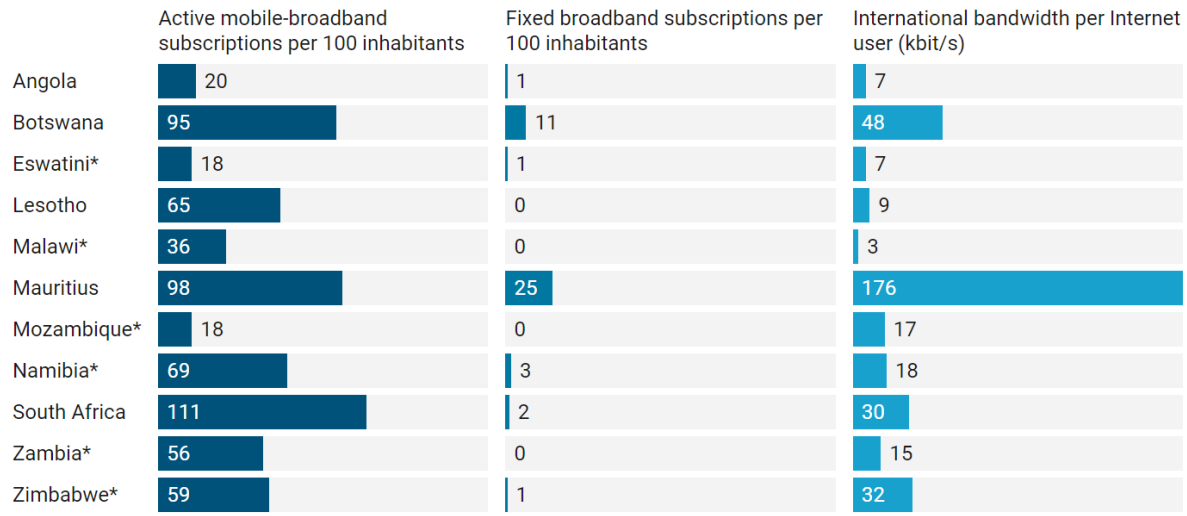

Figure 2-11: Mobile and fixed broadband subscriptions (2020)

Source: Own construction based on date from ITU

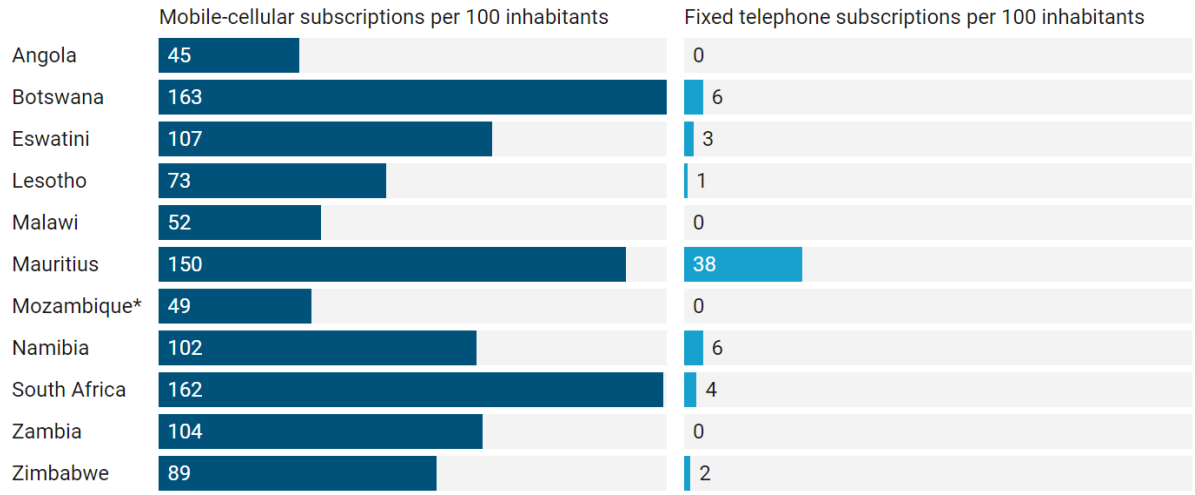

Figure 2-12: Mobile and fixed telephone subscriptions (2020)

Source: Own construction based on date from ITU

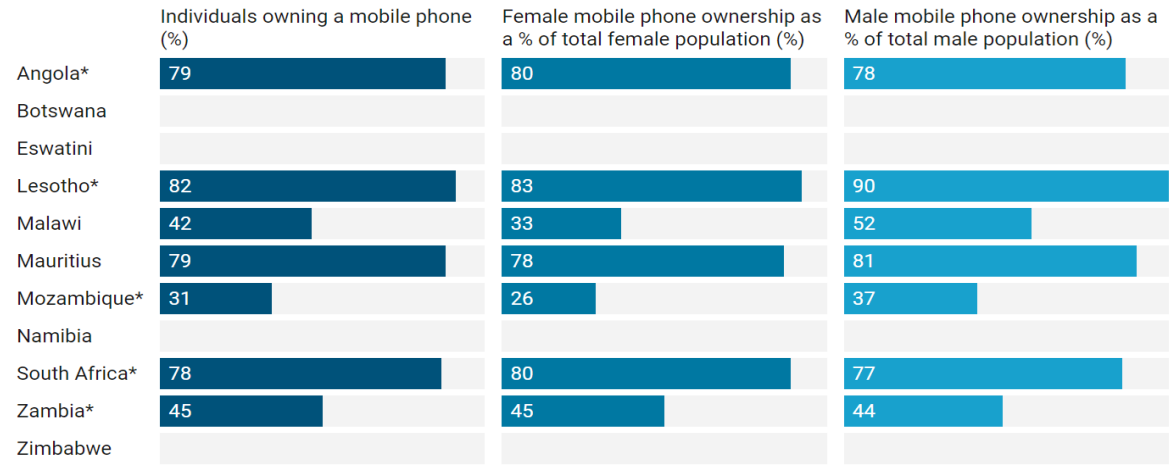

Figure 2-13: Mobile phone ownership (2020)

Source: Own construction based on date from ITU | **Note:** Gaps indicate no data available

Internet use

Household internet use remains low in the region, with only three countries (Botswana, Mauritius and South Africa) reporting internet access above 50% in 2020 (Figure 2-14). The Internet of Things (IoT) connects physical components over the internet. The development of smart systems connected to the internet of things can generate unique opportunities to strategically address challenges associated with the SDGs to attain an equitable, environmentally sustainable and healthy society (Mondejar, et al., 2021). Increased connectivity presents opportunities for businesses and communities to leapfrog with new technologies creating new pathways for economic development. For example, a 10% increase in mobile internet penetration increases GDP per capita by 2.5% in Africa compared to 2% globally (ITU, 2019). Also, a 10% increase in digitization, the conversion of information into a digital medium, increases GDP per capita by 1.9% in Africa (Katz & Callorda, 2018). Also, improved internet connectivity is also important to facilitate market access within and across countries, strengthening regional integration efforts.

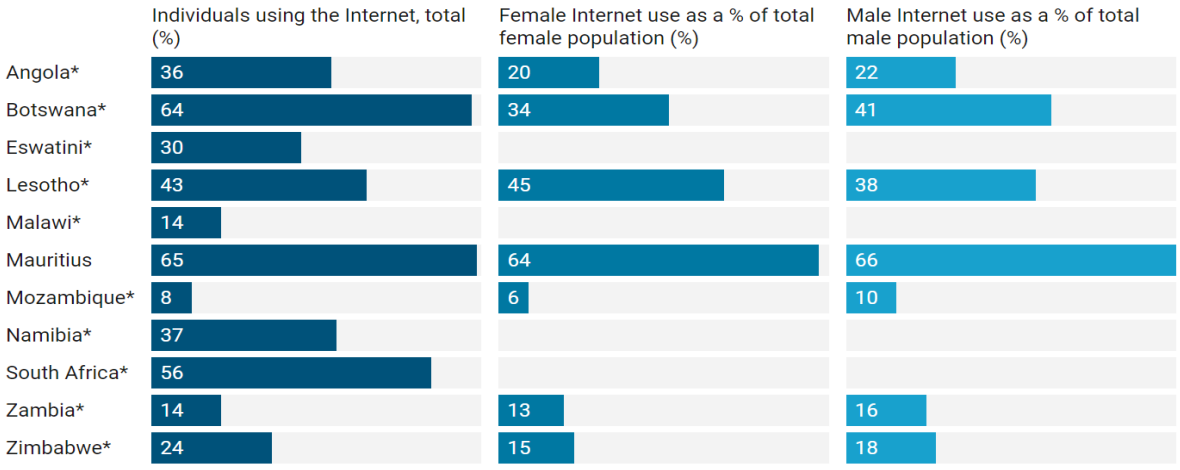

Figure 2-14: Percentage of population using the internet (2020)

Source: Own construction based on date from ITU | **Note:** Gaps indicate no data available

Digital infrastructure is central to the internet economy around the world and in the Southern Africa region. Investments in digital infrastructure are essential to ensure a competitive regional digital economy for Southern African countries. The increase in investments in subsea and terrestrial fiber-optic infrastructure has contributed to the rapid growth in international internet capacity leading to greater availability and lower price for high-speed transmission capacity (Google & IFC, 2020). All focus countries are connected directly or through terrestrial fiber systems (Figure 2-15). The international internet bandwidth for Africa increased by a factor of 10 in the past decade to 12 terabits per second (Tbps), but this is still less than half that of China (36 Tbps), indicating significant room for further growth (Google & IFC, 2020).

Large technology companies such as Google and Facebook are improving connectivity across the continent by expanding their undersea cable networks. For example, Google's new submarine cable (Equiano) is expected to be completed in 2022, connecting Portugal and South Africa and bringing unprecedented bandwidth to the region (Google & IFC, 2020). The ambitious country digital strategies, private sector investments, and a continent-wide effort to reach universal access by 2030 continue to drive digital activity, presenting opportunities for digitalization to contribute to green industrialization in the region. Examples include the application of digitalization in energy efficiency, improving transport and logistics services and financial services across the region. These examples are discussed in detail under in Section 3.

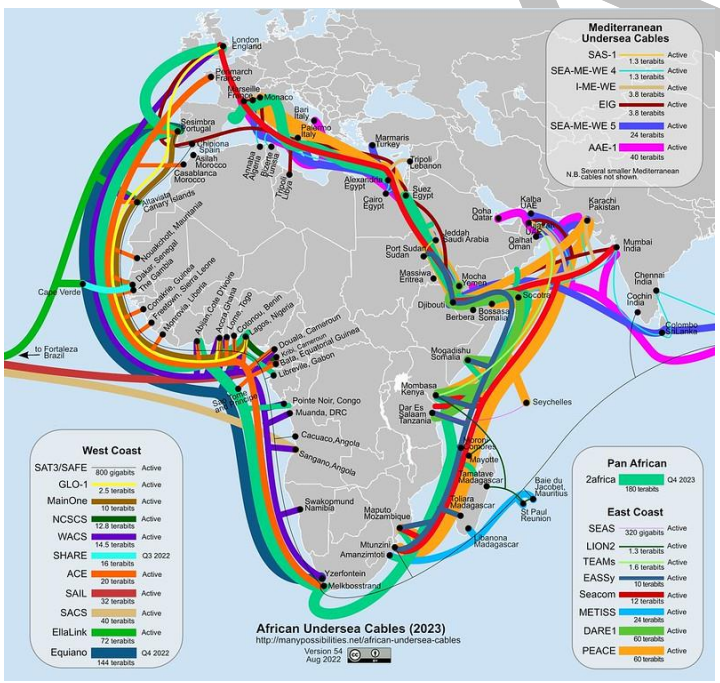

Figure 2-15: The African undersea cables

Source: "African Undersea Cables," map version 54, ManyPossibilities.net, August 2022 ,https://manypossibilities.net/african-undersea-cables/

2.4 Transport and logistics

Figure 2-16 presents international trade costs for the focus countries measured by the average cost of trade within the continent/ with all countries as a percentage of merchandise value of manufactured/primary goods. The average cost of trade for the focus countries is high when considered as a percentage of the merchandise value of primary goods (Figure 2-16). Causes of high trade costs include poor transport infrastructure, non-tariff barriers and weak trade-related services, like trade finance, payments, and logistics (AUC & OECD, 2022). High intra-Africa trade costs affect the development of regional production networks as they compound each time products cross borders. Logistics costs in Africa are estimated to be four times higher than the World average (Plane, 2021). High-trade costs adversely impact the development of regional value chains, and the effect is more severe for backward participation than forward participation (Antràs & De Gortari, 2020). This trend reinforces the commodity-based, extractive industry patterns of trade currently dominating the region and undermining value chain development within and across countries of the region.

Country	Average cost of trade within continent as % of merchandise value, manufactured goods, 2019	Average cost of trade with all countries as % of merchandise value, manufactured goods, 2019	Average cost of trade within continent as % of merchandise value, primary goods, 2019	Average cost of trade with all countries as % of merchandise value, primary goods, 2019
Angola	170	151	266	435
Malawi	147	259	156	261
Mauritius	132	152	215	262
South Africa	84	100	124	154
Zimbabwe	76	262	96	299
Eswatini	66	121	106	148
Namibia	63	143	109	248
Mozambique	62	117	110	247
Botswana	58	138	97	317
Lesotho	44	136	86	137
Zambia	-	-	178	305

Figure 2-16: International trade costs

Source: Africa's Development Dynamics Key Indicators[10]

The logistics performance index[11] measured by trade and transport-related infrastructure quality remains low in the region. For the countries with data, the logistics performance index is low (less than 2.5) in Angola, Lesotho, Malawi, Zambia and Zimbabwe. There are notable decreases in the index for some countries; for example, Lesotho dropped from 2.12 in 2014 to 1.96 in 2016, and Zimbabwe shows a decline from 2014 (2.25) to 2018 (1.83) (Figure 2-17). Improvements in transport infrastructure and logistics are important to facilitate regional trade and integration. Enhancing the ease of doing business is critical for green businesses that are either starting up or existing ones that are integrating green industrial processes and applications in their operations. Not least because the cost of 'green transition' for existing businesses is not easily translated to the pricing structure for their products in the short term.

The above observations could be driven by challenges in development of new infrastructure and maintenance of existing infrastructure, especially for Zimbabwe. Despite

[10] https://www.compareyourcountry.org/africa-development-dynamics-indicators. Accessed 11 September 2022
[11] The index measures logistics professionals' perception of country's quality of trade and transport related infrastructure (e.g. ports, railroads, roads, information technology), on a rating ranging from 1 (very low) to 5 (very high) (World Bank, 2022).

South Africa showing an increase in 2012 (3.79), there was a marked decline in 2014 (3.2) before an increase in 2016 (3.78) and another decline in 2018 (3.19). The initial increases for South Africa could be explained by completed infrastructure projects developed as part of the 2010 FIFA World Cup hosted by the country. Similar for other countries, subsequent decreases could be due to challenges in maintenance of the infrastructure as well as development of new infrastructure to keep with rising demand for transport and logistics services.

Improvements in transport infrastructure and logistics remain critical to facilitate regional trade and integration. Member states in the region have also adopted reforms to improve the ease of doing business, especially for companies in the digital economy (Google & IFC, 2020). Improving the ease of doing business is critical for green businesses that are either starting up or existing ones that are integrating green industrial processes and applications in their operations.

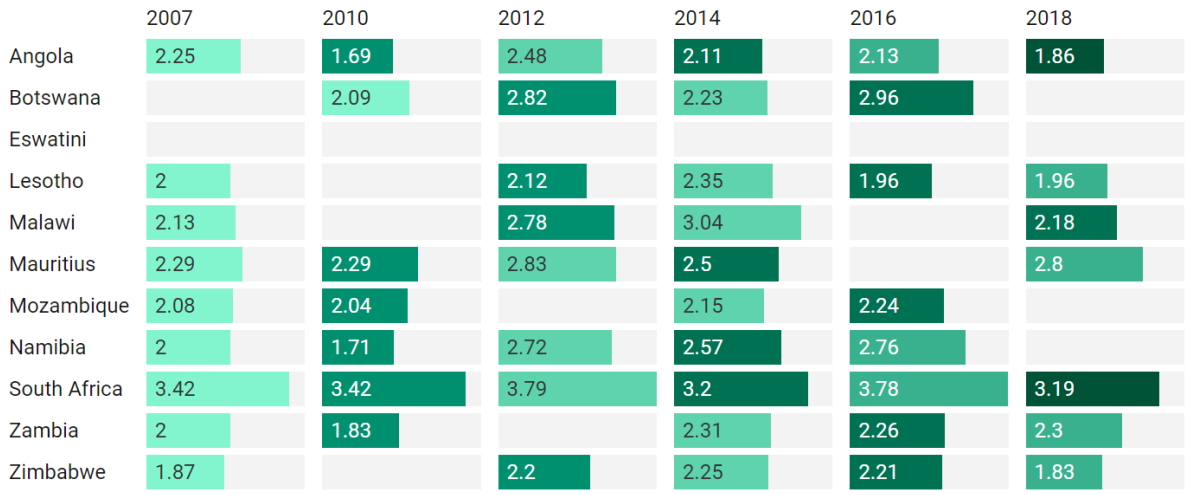

Figure 2-17: Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high)

The African Regional Integration Index (ARII) assesses the regional integration status across countries. The ARII measures the level of integration based on five indices: trade integration, productive integration, macroeconomic integration, infrastructure integration and free movement of people. Figure 2-18 shows that the overall level of integration among the focus countries (0.36) is low. This indicates that more needs to be done to boost intra-regional trade and integration under the AfCFTA. The infrastructural integration index (0.24) is the lowest among the different ARII indices. The regional infrastructural integration index includes the infrastructure development index (transport, electricity, information and communications technology; and water and sanitation), the proportion of intra-regional flights; total regional electricity trade (net) per capita; and the average cost of roaming[12]. Improving regional

[12] Other components of the ARII include: (a) Trade integration measured by the following indicators: level of customs duties on imports, share of intra-regional goods exports (% GDP), share of intra-regional goods imports (% GDP), and share of total intra-regional goods trade. (b) Productive integration includes the share of intra-regional intermediate goods exports (% total intra-regional exports goods); share of intra-regional intermediate goods imports (% total intra-regional imports goods); and merchandise trade complementarity index (total absolute value of the difference between share of imports and share of exports of a member state in an REC). (c) Financial and macroeconomic integration includes regional convertibility of national currencies and inflation rate differential (based on the harmonized consumer price

infrastructure is necessary to facilitate and open opportunities for green industrialisation and increased intra-regional trade and integration under the AfCFTA. For example, energy infrastructure helps ensure adequate electricity supply for the manufacturing sector and digital economy, and transport infrastructure facilitates the movement of goods and services across the region.

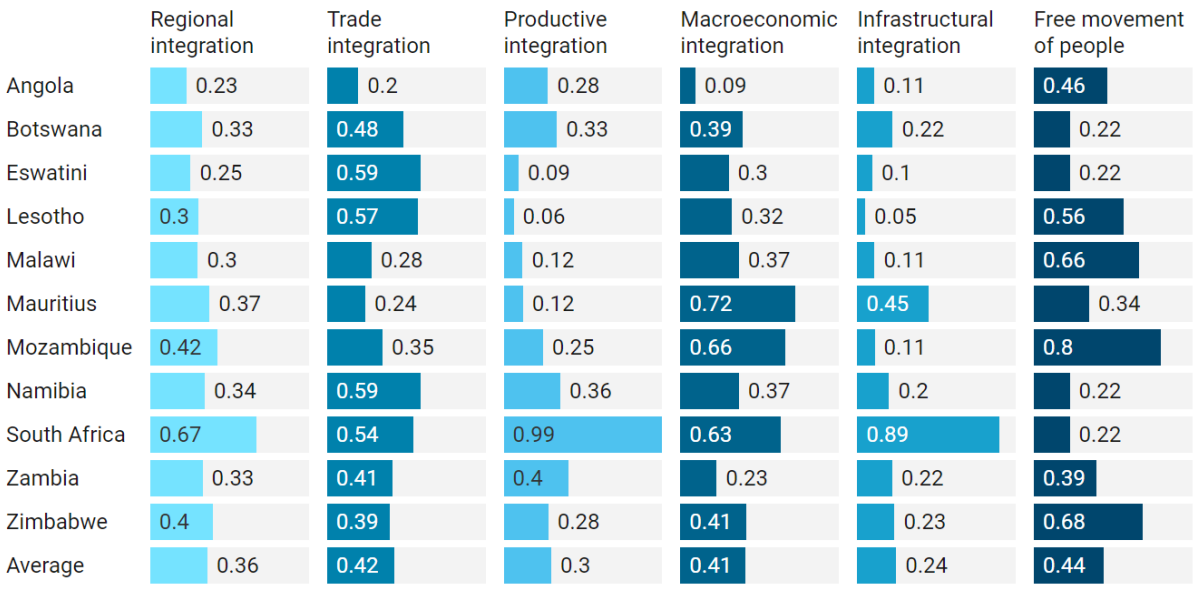

Figure 2-18: Africa Regional Integration Index for the focus countries (2019)

Source: Own construction based on data from AUC, et al., (2019)

index) (d) Free movement of people includes ratification (or not) of the REC protocol on free movement of persons; proportion of REC member countries whose nationals do not require a visa for entry; and proportion of REC member countries whose nationals are issued with a visa on arrival.

3. The role of technology, innovation, digitalization, and infrastructure in the process of greening industrialization policies and practice

3.1 Technology and innovation

Various technologies and innovations alter production and service activities within and across value chains. New opportunities to accelerate innovation and increase value-added content of production are driven by advances in increased applications of robotics, additive manufacturing, data analysis and systems, digital platforms and digital supply chains (UNIDO, 2019; UNIDO, 2020). These developments in technology and innovations are helping shape the greening of industrialization policies and practice. Of critical importance is just in time, fast manufacturing and critically reduced waste, improved consumption patterns etc.

Figure 3-1 shows the relationships between industrialization and different clusters of SDGs. Green industrialization through fostering green innovation and technological change can help address most pressing social and environmental challenges. Industrialization has a direct positive impact on all Sustainable Development Goals (SDGs) Goals associated with poverty reduction, education, jobs creation, technological and infrastructural upgrading and broader economic development and an indirect relationship with the SDGs on sustainability dimensions (UNIDO, 2020). Industrial policy instruments and institutions have been critical in successful industrialization experiences helping to develop social capability, direct market forces, spur technological and organizational innovation, create new markets and institutions and drive structural transformation (Andreoni & Anzolin, 2019; UNIDO, 2020).

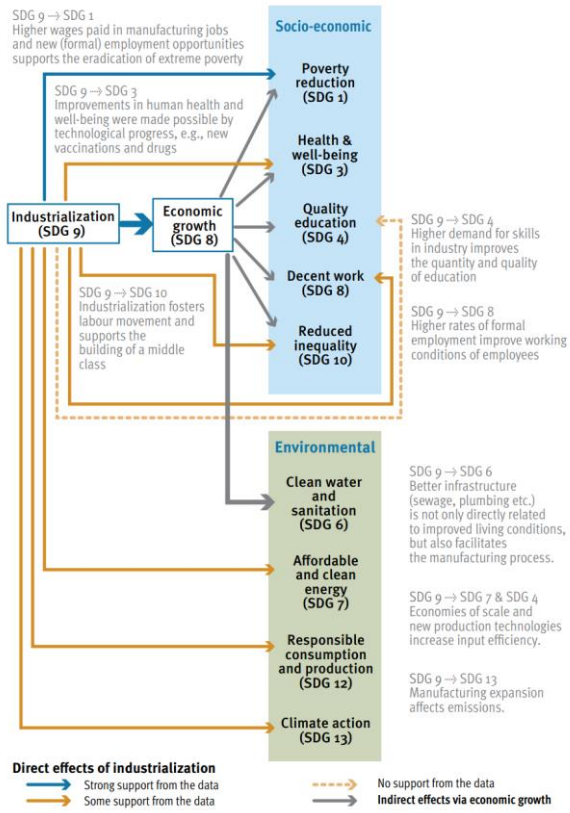

Figure 3-1: Industrialization, economic growth and the SDGs: Synthesis framework

Source: UNIDO (2020)

The growth in most southern African countries, for example, is associated with increased exploitation of non-renewable natural resources. The economic structures remain largely based on raw material extraction with limited value addition and job creation. Technology and innovation developments in manufacturing help reduce the energy intensity and material consumption inputs, a direct relationship between industrialization on clean energy and responsible consumption and production (UNIDO, 2020). Also, technologies and innovations in green industries offer opportunities for countries to drive structural transformation that results in sustainable and inclusive growth, creates jobs and safeguards the productivity of the natural resource base. Green industrialization, through fostering green innovation and technological change, can help address the most pressing social and environmental challenges (Andreoni & Chang, 2017; UNIDO, 2020). The southern Africa region can leapfrog historic environmentally damaging technologies by fostering green technologies and innovations.

Challenges experienced in the energy sector also include overcoming barriers to the grid integration of renewable energy resources, increasing the efficiency of the energy processes in the industry sector, addressing increasing energy demand (including from rebound) and security issues associated with interconnected energy generation systems (Coroamă & Mattern, 2019; Mondejar, et al., 2021). Digitalization presents a broad range of possibilities for the energy sector ranging from increased sustainability of the energy systems, improved access to electricity in remote areas and efficient energy use. All stakeholders benefit from the modernization of power systems, such as smart grid technologies that offer a solid platform for a safe, stable and sustainable transition (Mondejar, et al., 2021). Figure 3-2 presents a conceptual framework of smart grids that includes: (a) application of intelligent strategies to effectively coordinate energy flow between generation and the consumption of power, (b) coordination of diverse energy resources through encouraging maximum use of renewable energy resources, (c) integration of distributed and diverse energy storage systems, and (d) energy management policies to coordinate relationships between suppliers and consumers (Mbungu, et al., 2020; Mondejar, et al., 2021).

The opportunities for future energy systems in the region can integrate opportunities offered by microgrid and smart grid innovations to provide affordable, green and clean energy generation, as well as secure and reliable energy sources. Smart grid technologies offer the electrical system opportunities for digitized designs with diverse possibilities to coordinate several energy resources optimally, helping reduce losses during grid transmissions and increase energy efficiency. Further, the smart grid technologies are adaptive, distributed and have smart metering sensors allowing for two-way communication, providing pervasive control, self-monitoring and remote checks in a real-time and dynamic environment (Mondejar, et al., 2021).

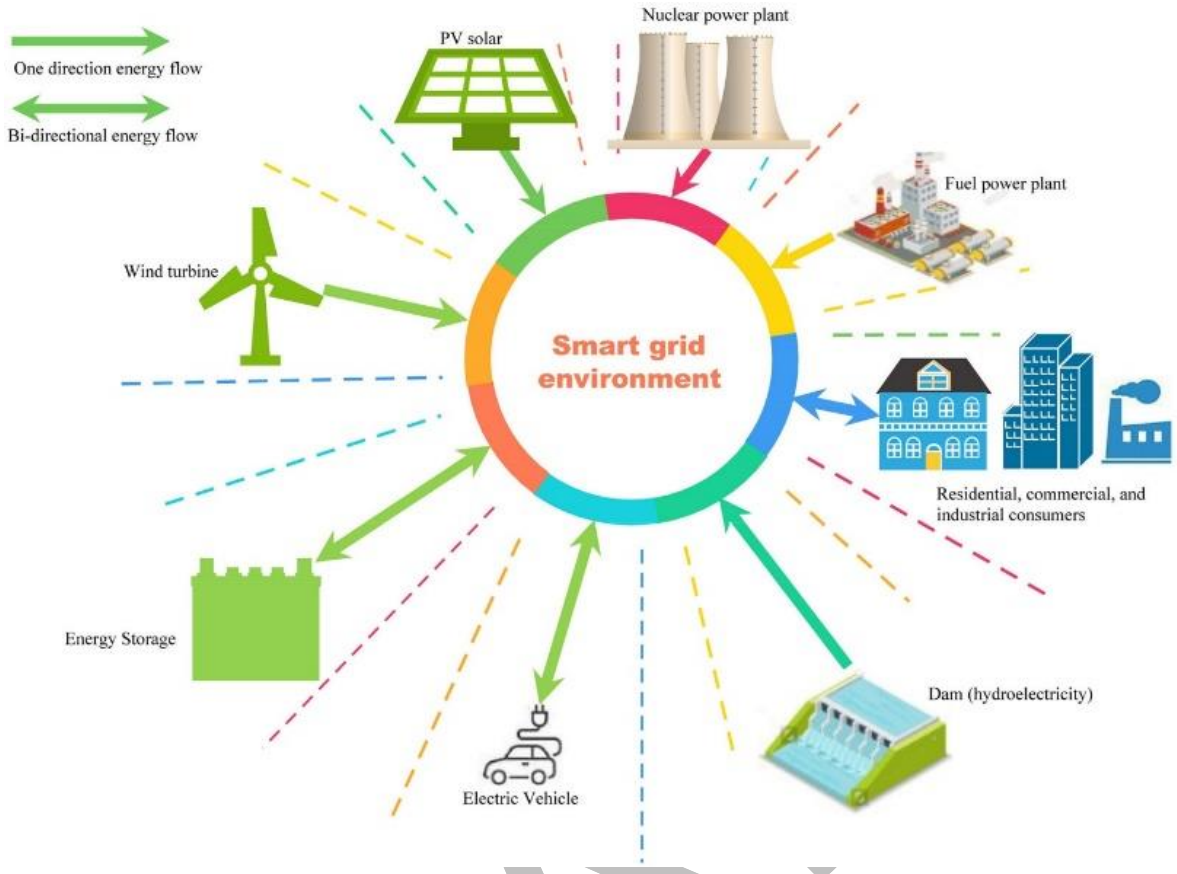

Figure 3-2: Overview of intelligent energy system

Source Mbungu et al. (2020)

Digitalization through integrating the energy internet and the internet of things (IoT) remains a priority for regional and country power systems. The IoT can help contribute to energy management and conservation (Figure 3-3). Through the IoT, stakeholders can reduce operational expenses, optimize asset maintenance, reduce energy spending, integrate green energy, minimize carbon emission, comply with regulations and predict consumption and spending (Bradu, et al., 2022; Hossein, et al., 2020).

There is also growing pressure on producers (especially multinationals) to meet environmental, social and corporate governance standards. Governments are increasingly setting legally-binding measures to ensure environmental and social considerations are integrated into corporate supply chains (AUC & OECD, 2022). Green technologies and innovations can help meet the increasing demand for goods and services produced in environmentally friendly settings from production to consumption and the end of their life cycle. Unlike developed countries, which were able to address environmental and developmental challenges in sequence, for African countries and other developing countries, there is increasing pressure to integrate environmental challenges in producing goods and services. Emerging green growth opportunities include developing environmental products and services, adopting eco-labelling, certification in manufacturing and new financing sources (AUC & OECD, 2022). Facilitating intra-regional trade through the AfCFTA would be accentuated if regional communities and member states institute standardization, quality assurance and quality management systems that meet international standards, including environmental regulations.

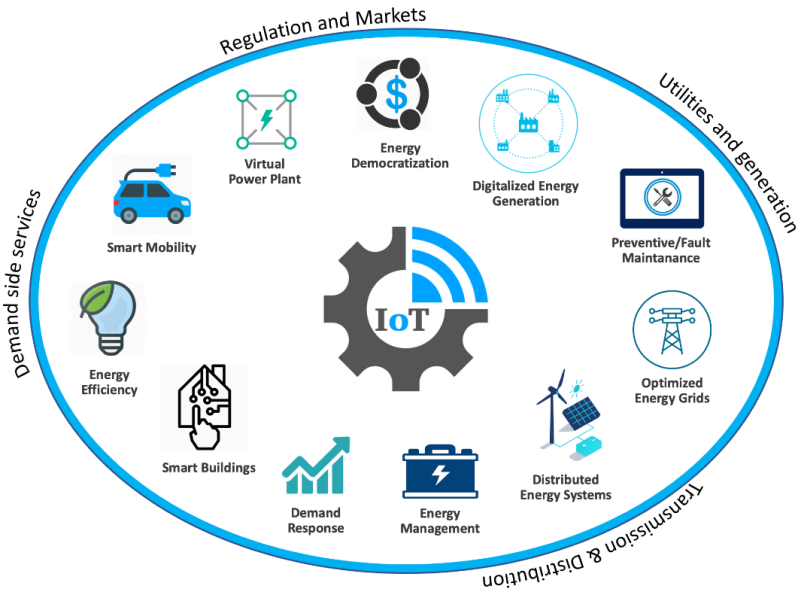

Figure 3-3: Applications of IoT in an integrated smart energy system

Source: Hossein et al., (2020)

Innovations in green manufacturing can enhance private sector participation in developing strategic national and regional value chains. This is important to grow their competitiveness and participation in global value chains creating new opportunities for structural transformation and for creation. For example, digital innovations can enhance efficiency in trade-related logistics, customs and finance and facilitate increases in intra-regional African trade.

Also, technologies and innovations embed the integration of the entire product life-cycle from raw material acquisition and manufacturing (and intermediate transformation) stages to the product's end of life (Figure 3-4). The realization of closed-loop life cycles increases traceability and monitoring of product usage, for example, through the reuse of individual product components and facilitating partnerships between companies and end-of-life stakeholders (such as recycling companies), easing the integration of remanufacturing of individual parts into the life cycle (Labrunie, 2019; Ardito, Petruzzelli, Panniello, & Garavelli, 2019).

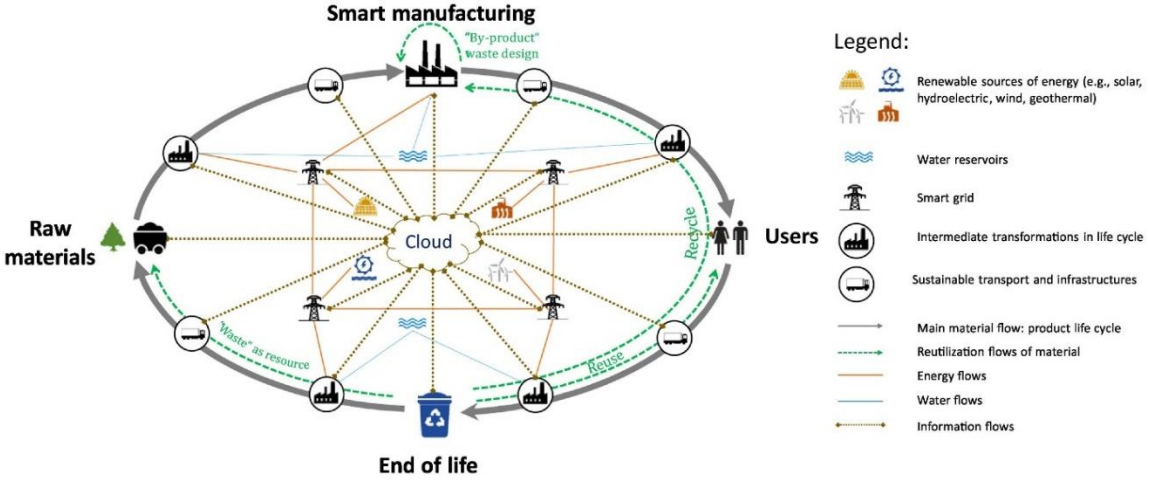

Figure 3-4: Vision of the product life cycle in 4IR integrated with material, energy, and information flows through digital technologies

Source: (Mondejar, et al., 2021)

New technological developments and innovations foster sustainable and environmentally friendly approaches to manufacturing, integrating renewable resources and recycling bio-based materials (Dogaru, 2020). Green technology innovations through the application of science to reduce human impacts on the environment can help industries find alternative and sustainable ways of disposing of waste and use more bio-based advanced materials for cheap, safe and eco-friendly products. For example, innovative green supply chain management (Figure 3-5) incorporates environmental considerations into supply chain management, product design, material sourcing and selection, manufacturing, packaging, final product delivery and end-of-life management (Bradu, et al., 2022).

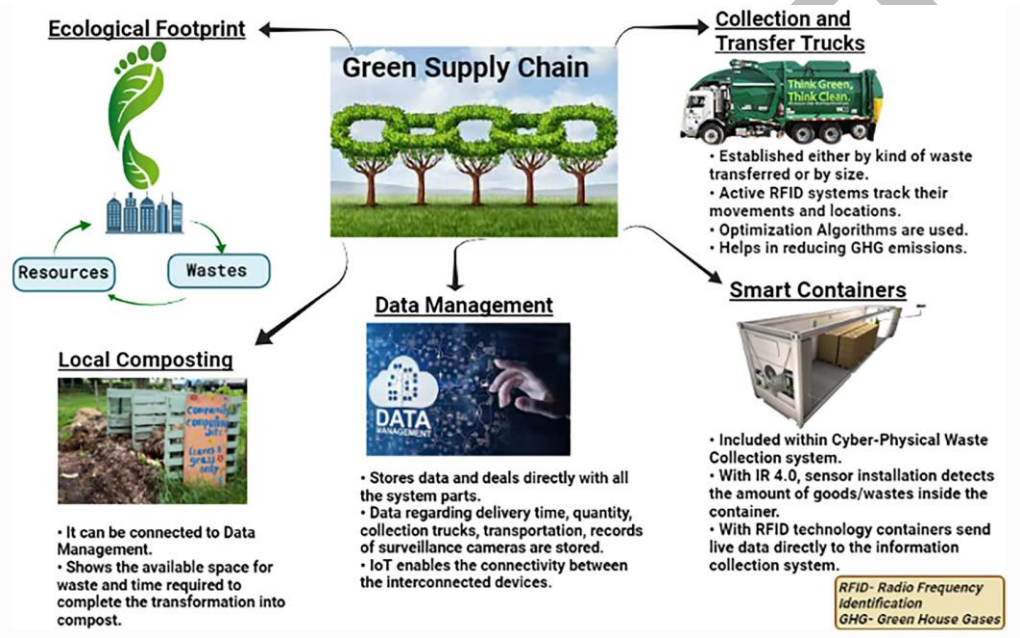

Figure 3-5: Illustration of the application of innovative green supply chain management

Source: Bradu et al., (2022)

On the negative side, despite 4IR technologies resulting in increased energy efficiency, there might be increases in primary energy consumption due to increased use of data-centers, telecommunication networks, computer equipment and constant monitoring and adaptation of production processes. Furthermore, additive manufacturing processes are currently high energy intensive, for example, in the production of starting materials used. Also, increased integration of sensors and transmission devices in new smart products and equipment increases the demand for new and critical raw materials like 'technology metals' that are usually non-recyclable (Labrunie, 2019). Further, there is uncertainty regarding the technological limitations and costs of low carbon or mitigation technologies like carbon capture and storage (UNIDO, 2020; Bullis, 2014). Sustained and conscious efforts to integrate inclusive and sustainability principles in green industrialization are required to ensure positive socio-economic and environmental benefits.

3.3 Digitalization

Digitalization refers to the integration of digital technologies and applications in everyday life. Digitalization is having transformative impacts on the economy, society and the planet through the production, use and disposal of hardware (Information and Communication Technologies equipment, data centers, data transmission networks), software, digital technologies and applications ranging from robotics, big data, 3D printing, the Internet of Things, via distributed ledger technologies like blockchain, cloud computing and emerging platforms, to Artificial Intelligence (Liu, et al., 2019; Kunkel & Tyfield, 2021; Mondejar, et al., 2021; Zeufack, et al., 2021). These present opportunities for developing and applying advanced digital technologies to boost productivity, create new jobs and drive green industrialization-led growth in the region.

Despite the traditional role of formal sector businesses (like large corporations) in shaping the economy, the internet economy presents leapfrog opportunities to address challenges faced by Africa's fast-growing informal businesses and workers (Google & IFC, 2020). The main sectors driving the African digital transformation include fintech, e-commerce, agritech, media and entertainment, health tech, food delivery, local transportation and business-to-business (B2B) e-logistics. The pandemic contributed to accelerated use and adoption of digital technologies across firms, evidenced by increased demand for good quality virtual communication methods, resilient broadband infrastructure, and greater use of online digital services and products (such as fintech platforms, e-commerce and online work platforms). The World Bank 2022 Africa Pulse report showed that manufacturing firms experienced the largest increase in the proportion of firms using digital solutions, increasing from 47% to 80%, while small firms increased from 37% to 64% (Zeufack, et al., 2021).

Digital technologies and innovations are improving the efficiency of logistics, customs and finances, enhancing cross-border trade and creating new opportunities for small and informal producers (AUC & OECD, 2022). The increased use and adoption of digital technologies can empower the poor (including youth and women) with access to information, job opportunities and services improving the inclusiveness of economic growth and development. In the long-term, innovation and implementation of new technologies will lead to increased demand for high-skilled workers in new sectors of economic activity as the demand for low-and medium-skilled workers in traditional sectors decrease (Zeufack, et al., 2021). The development of technical skills and a critical mass of high-skilled workers to scale and continue innovations and implementation and adopt new technologies to local needs and standards is important to support industrialization through digitalization. In addition to digital technologies and services creating direct jobs and contributing to national and regional GDP, digitalization has helped address the information asymmetry challenges in financial systems and the labor market increasing efficiency, certainty and security, which are all critical for economic growth and job creation (Ndung'u & Signe, 2020).

Digitalization has enhanced inclusive finance with significant impacts on economic growth through increased access to financial services that enabled the unbanked to enter formality through retail electronic payment platforms, virtual savings and credit supply platforms. For example, formal financial services through mobile phones like M-Pesa have transformed access to financial services reaching the underserved, including women (Ndung'u & Signe, 2020). Digitalization enables entrepreneurs and businesses to rethink business models that are

sustainable, impactful and connected to other economic sectors. Companies can design products and trade online, governments are shifting to online platforms to provide public services, and individuals can operate financial services and payments for investments and shopping (Ndung'u, 2018). The digital financial services ecosystem requires forward-looking and proportionate legal and regulatory frameworks (for example, to allow market entry and innovation), robust financial infrastructures (for example, national payment systems and credit reporting systems), and the development and deployment of low-cost delivery channels (agents, point of sale devices, automated teller machines, and mobile phones)' (Calderon & Cantu, 2021). Improvements in coordination and harmonization of digital policies, regulations and standards across industries and countries are critical to facilitate the scaling up of private sector innovations to grow further intra-Africa regional trade and participation in global value chains.

Digital platforms offer products and services accessible through digital channels, including computers, mobile devices and the internet. Businesses use digital platforms to provide various products and services ranging from digital mapping, social media, data analytics, digital education, digital commerce, digital health, streaming services etc. Through global connectivity, users can access global information and services regardless of geographic location, such as Google Search, Facebook or Amazon Web Services. Governments are designing and implementing regulatory and policy measures (such as robust data policy frameworks (protection and localization), competition policy, antitrust policies, labor protection etc.) that foster the development of private sector platforms and mitigate markets distortions that can be induced by platforms to the economy (Calderon & Cantu, 2021).

Figure 3-6 presents the interdependencies between (a) digital technologies, (b) government policies and (c) firm capabilities. Digital technologies in production directly affect the efficiency of manufacturing, and those in transactions and distribution have an indirect impact through government policies like trade facilitation and public infrastructure. Government policies for a digital industrial transformation include those focused on: building digital capabilities, fostering competitiveness and delivering an inclusive and accountable process. Firm capabilities include digital and other capabilities (Lopes & te Velde, 2021).

Figure 3-6: Linking digital technology, government policies and manufacturing capabilities

Source: Banga & te Velde (2018)

Digital technologies and applications are increasingly being developed and applied to enhance productivity and efficiency in various socio-economic, industry, environmental, sustainable and climate systems (Balogun, et al., 2020; Ceipek, et al., 2021; Mondejar, et al., 2021; Appio, et al., 2021). Digitalization provides access to an integrated network of unexploited big data with potential benefits for society and the environment. The development of smart systems connected to the internet of things can generate unique opportunities to strategically address challenges associated with the SDGs to attain an equitable, environmentally sustainable, healthy society.

Despite expectations for digitalization to deliver 'win-win' green/ sustainable industrialization in Global South countries and contribute to absolute decoupling of economic growth from resource use, there is limited empirical evidence on concrete mechanisms to achieve expected positive sustainability effects associated with digitalization in the industry (Beier, et al., 2020; Kunkel & Matthess, 2020). Also, digitalization is expected to impact the drivers of structural change, for example, by impacting technology (development) and facilitating service trade affecting the environmental intensity of industrialization (Matthess & Kunkel, 2020; Kunkel & Tyfield, 2021).

The environmental sustainability impacts of digitalization are direct and indirect. Digital technologies need energy and resources in their production, use and disposal (direct environmental impact), for example, manufacturing of digital technologies and mega servers related emissions and the creation of e-waste. Data processing services industry /e-commerce traffic emit huge heat emissions that then need to be cooled. The indirect environmental impact includes changes in energy and resource efficiency in manufacturing and systemic impacts on production and consumption patterns (Kunkel & Matthess, 2020). Also, more empirical research is needed to measure the net impact of positive and negative direct and indirect effects of digitalization in industry and green industrialization. This will help ensure that the rebound effects of digitalization do not outweigh the gains in resource use and efficiency.

The development and manufacturing of electronic devices deplete limited resources and generate e-waste (unwanted electronic products not working and nearing or at the end of their 'useful life') and are hardly recycled (Dhir, et al., 2021; Ahirwar & Tripathi, 2021). Green industrialization should embed a life-cycle as well as circular and access economy and develop re-cycling technologies and infrastructure to ensure negative environmental impacts do not outweigh the gains from the application of digitalization in the transition to green industrialization.

The socio-economic sustainability impacts of digitalization include changes in productivity, new business and trade opportunities. On the other hand, there are concerns about the potential of employment-intensive industries to absorb a growing labor force, given the decreasing labor-intensity due to automation and digitalization in various industries (Hallward-Driemeier & Nayyar, 2017; Hawash & Lang, 2020; Myovella, et al., 2020).

3.4 Infrastructure

Quality infrastructure with all building blocks in place: standardization, metrology, accreditation and conformity assessment; in particular, testing, certification and inspection services are critical for supporting economic transformation. Also, quality infrastructure stimulates industrial development, competitiveness, innovation, trade and efficient use of resources; and ensures food safety and protection of human health and the environment

(UNIDO, 2019). According to the International Network on Quality Infrastructure (INetQI), Quality Infrastructure is "the system comprising the organizations (public and private) together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the quality, safety and environmental soundness of goods, services and processes. Quality infrastructure is required to operate domestic markets effectively, and its international recognition is important to enable access to foreign markets. It is critical in promoting and sustaining economic development and environmental and social well-being (UNIDO, 2019).

Regional infrastructure facilitates the establishment of large competitive markets by providing lower-cost energy for all economic sectors (such as industry, agriculture, mining and communications). It also fosters regional integration by facilitating intra and inter-regional trade, and hence capitalizing on the opportunities from the AfCFTA (AfDB & AUC, 2013b). Regional infrastructure also fosters regional integration and facilitates intra and inter-regional trade, capitalizing on the AfCFTA. Increased regional integration will also help reduce transaction and operating costs for businesses, further enhancing the competitiveness of the region's goods and services.

Addressing the region's infrastructure gap is thus critical for green industrialization, economic growth and sustainable development. Investments in improved and resilient infrastructure foster intra-and inter-regional and international trade, reduce the cost of doing business and enhances the competitiveness of the region within itself and in the global economy, in addition to catalyzing economic transformation and diversification through value addition, industrialization and inclusive and sustainable growth (AfDB & AUC, 2013a).

In addition to high costs of doing business and less competitiveness, the infrastructure deficit costs the region in terms of reduced potential output each year. The infrastructure deficit holds back the region's potential to grow and transform into an industrialized region rapidly. Improved and resilient infrastructure enhances the region's competitiveness as an exporter of manufactured goods and services and as a destination for investors (AfDB & AUC, 2013a).

Facilitating investments in connective infrastructure in the strategic industrial clusters in the region can help develop the regional value chain and foster private sector participation in green industrialization. Strategic regional corridors have been identified with earmarked regional infrastructure projects. Examples include the Walvis Bay Corridor (covering five SADC countries) and the Maputo Development Corridor (Mozambique-South Africa). Development in road infrastructure linking these development corridors can significantly improve connectivity, reduce trade costs and improve the attractiveness and competitiveness of private section investments in regional value chains.

The costs of investing in required infrastructure in the region are beyond the capacities of governments. Public-private partnerships in providing regional infrastructure and services are critical to helping reduce regional production and trade costs. For example, public-private partnerships in developing regional internet infrastructure complemented with an appropriate regulatory environment can help improve connections between national and regional digital markets with global markets facilitating economies of scale, attracting private sector investments and increasing value chain competitiveness (AUC & OECD, 2022).

4. The industrialization policies and frameworks in Southern Africa

4.1 Introduction

Industrial policy frameworks, instruments and institutions have been critical in successful industrialization experiences helping to develop social capability, direct market forces, spur technological and organizational innovation, create new markets and institutions and drive structural transformation (Andreoni & Anzolin, 2019; UNIDO, 2020). Given the dynamic industrial and technological landscape, countries use various policy frameworks/instruments and institutions for different functions depending on the context. Where policies have remained unchanged, their forms have changed over time and space, for example, due to countries adapting to context and time-specific country conditions and evolving industrial and technological environments (UNIDO, 2020; Andreoni, et al., 2019). This section discusses the broader policy framework within which the transition to green industrialization is happening. Based on the review of the industrial policy frameworks, gaps in terms of incentives, environmental laws and regulations and other policies which promote the greening of industry in the region are discussed.

4.2 Continental and Regional Policy Frameworks

For SADC member states, various regional documents embed elements of green industrialization ranging from SADC protocols, policies and strategies. These include the revised Regional Indicative Development Strategy (RISDP), the Industrialization Strategy and Road Map, the Regional Infrastructure Development Master Plan and other sector-specific protocols. SADC's industrialization policy is encapsulated in the Regional Indicative Strategic Development Plan (RISDP), the SADC Industrialization Strategy and Roadmap 2015-2063, the SADC Industrialization Action Plan, the 2014 SADC Declaration on Regional Infrastructure Development, and the 2019 SADC Protocol on Industry among others. At the global and continental level the following frameworks that member states have adopted also embed elements of green industrialization: the UN Agenda for Sustainable Development Goals (Agenda 2030), 2015 Paris Agreement, African Union Agenda 2063, and 2015 Addis Ababa Action Agenda etc.

These frameworks support the development and implementation of green industrialization activities in the region. The frameworks also support member states' efforts to integrate their various development policies and strategies. For example, Agenda 2063 aspires to foster structural transformation to deepen industrialization, develop modern and productive agriculture and increase investments in science, technology and innovation. Also, Agenda 2063 commits to driving major infrastructure investments in energy, transport and information and communication technology (ICT) through the Program for Infrastructure Development in Africa (PIDA) (AUC, 2015). The SDGs are anchored on the economic, social and environmental dimensions of sustainable development and therefore provide a framework for green industrialization in the context of sustainable development (ECA, 2016). SDGs embed industrial development in the larger environmental sustainability (SDG 9).

To advance regional integration, the Southern African Development Community (SADC) focuses on sectoral cooperation, industrialization and infrastructure development. SADC has developed appropriate policy frameworks, protocols and decisions ratified and

domesticated by member states. SADC's industrialization policy is encapsulated in the Regional Indicative Strategic Development Plan (RISDP), the SADC Industrialization Strategy and Roadmap, the SADC Industrialization Action Plan and the 2014 SADC Declaration on Regional Infrastructure Development, among others. The SADC Industrialization Strategy and Roadmap 2015-2063 was developed as an inclusive long-term modernization and economic transformation scheme. The main objective is to achieve significant economic and technological transformation at national and regional levels, accelerate growth of the SADC economies, and enhance comparative and competitive advantages (SADC, 2019).

Also, the SADC Regional Green Economy Strategy and Action Plan for Sustainable Development was developed to facilitate a balanced and accelerated attainment of economic wellbeing, social equity and environmental sustainability pillars of sustainable development (SADC, 2015). The Green Economy Strategy and Action Plan identify priority green growth/ industrialisation opportunities across priority sections in the region. The SADC region prioritizes sustainable industrial development, productive competitiveness and supply-side capacity, free movement of goods and services, stability-oriented macroeconomic convergence, financial market integration and monetary cooperation, intra-regional and foreign direct investment, and deepening regional integration (SADC, 2019).

The 2014 SADC Declaration on Regional Infrastructure Development presents the regional resolve by member states to mutually cooperate 'in the rapid development of bankable projects that will foster adequate and efficient trade routes for regional and international trade and develop robust infrastructure in energy, transport, ICT, water, meteorology and tourism' (SADC, 2014). Regarding industrialization, the declaration specifies the regional commitment by member states to 'implement regional agreements and protocols to facilitate the development of infrastructure that promotes industrial development and creation of regional value chains and to achieve sustainable growth and development', including partnerships with multilateral development finance institutions such as the AfDB, the private sector and other stakeholders to secure funding for infrastructure development to attract investment and promote industrialization (SADC, 2014).

The SADC region is implementing different initiatives such as the corridor development approach towards seamless transport services, reduced transaction costs through a One-Stop-Border Post and Standardization of Policy and Guidelines (SADC, 2019). Also, there are improvements in the region's transport infrastructure for surface, air and intermodal transport to deepen integration and boost intraregional trade within southern Africa. These improvements are mainly through the Regional Infrastructure Development Master Plan (RIDMP), the Protocol on Transport, Communication and Meteorology of 1996 and other complementary programs (SADC, 2019). The RIDMP was adopted by SADC Heads of State and Government in August 2012, a 15-year blueprint that will guide the implementation of cross-border infrastructure projects until 2027. To deepen regional integration efforts, the RIDMP is aligned with the Program for Infrastructure Development in Africa (PIDA) and the COMESA-EAC-SADC InterRegional Infrastructure Master Plan.

The focus countries (except South Africa and Botswana) are also members of the Common Market for Eastern and Southern Africa (COMESA), and its policy framework was also reviewed. Industrialization is a strategic pillar in the COMESA Medium Term Strategic Framework, 2021-2025. Also, the 2017 COMESA Industrial Policy and Industrialization Strategy (2017-2026) provides a regional framework for the industrial sector in member states. The COMESA Industrial Policy and Industrialization Strategy have a vision for a globally competitive environmental-friendly, diversified industrial sector. The COMESA

Industrialization Strategy (2017-2026) highlights one of the policy interventions as 'promoting investment in green technologies to ensure environmental preservation' as part of the priorities to achieve the regional vision. Based on the review of current policies and strategies, COMESA doesn't have a specific green industrialization/ green growth policy that articulates priorities for green growth and specific intervention areas.

The COMESA Industrialization Strategy (2017-2026) aim to promote investments in green technologies to ensure environmental preservation, climate change adaptation and mitigation. In addition to challenges of inefficient use of natural resources such as land, energy, water etc., climate change induces new standards for the industry. This includes goals to reduce greenhouse gas emissions that require significant investments in appropriate technologies and the design of industry production and processing methods (COMESA, 2017). These developments affect the competitiveness of the industry sector, and green industrialization presents opportunities for member states to meet socio-economic and environmental objectives simultaneously. For example, improvements in resource use efficiency (such as energy efficiency) and other cleaner production initiatives can help improve the competitiveness of regional value chains in global markets while addressing environmental resource challenges.

The COMESA Industrialization Strategy (2017-2026) also promotes value addition and sustainable regional value chains by strengthening value addition and sustainable value chains at national and regional levels to transform economies and create jobs. There is limited value addition in many focus countries, and most products are exported in raw form, particularly in agriculture and mining (COMESA, 2017). The challenge is compounded by poor market linkages and low vertical and horizontal integration in the manufacturing industries. Strengthening value addition in regional value chains by enhancing productive capacities, for example, through green technologies and innovations, entrepreneurship, production linkages and industry clusters, can strengthen their competitiveness in regional and global markets. The strengthening of value addition at national and regional levels presents opportunities to enhance integrated manufacturing and sectoral linkages in value chains. The AfCFTA, through the removal of trade and non-trade barriers, facilitate the movement of inputs and processed goods in the region and to global markets.

4.3 National Industrial and Industrialization Policy Frameworks

Green industrialization presents opportunities for countries to leapfrog from traditional carbon-intensive methods of industrial growth to cleaner, more sustainable patterns that are more competitive (Lopes & te Velde, 2021). Also, green industrialization fosters the need to 'harmonize the requirements of productivity-enhancing structural change with environmental objectives and to align to national interests with the protection of global commons' (Altenburg & Assmann, 2017). The realization of green industrialization requires strong leadership commitment and a national green growth vision and strategy (Lopes & te Velde, 2021). Member states must increase efforts to drive their economies towards a green growth path driven by green industrialization.

To understand the country-level policy frameworks supporting green industrialization, the industrial policies were reviewed to understand the extent to which they integrated green industrialization. Based on the finding that most of them did not specifically include green industrialization, the review looked at aspects of green growth, green economy, and green jobs. The review was extended to national development plans that provide an overarching country framework for all policies. The report also considered the countries' green economy/ green

growth policies/plans/strategies that were available. Furthermore, the review noted that national climate change policies, plans and communications to the UNFCCC might include aspects of the transition to green growth/ industrialization.

The review of country-level policy frameworks showed that industrial policies do not explicitly elaborate on green industrialization (Tables 4-1 and 4-2). Mauritius and South Africa are the two countries that have a national policy or plan that articulates green industrialisation. Green economy plans, where available, highlighted either green industrialization/ green jobs or green economy as a strategic focus for the country. Furthermore, climate change policies and nationally determined contributions to UNFCCC also show that green industrialization/ green economy/ green jobs are part of efforts to reduce greenhouse emissions. A review of national development plans also showed that Namibia, South Africa and Zambia clearly articulated green industrialization in their overarching framework. Overall, the reviewed documents highlight the strategic focus on sustainable development, especially those developed after 2015. The review does not claim to be exhaustive of all sectoral policy developments that impact aspects of green industrialization but provide a better understanding of how countries embrace green industrial development in their policy framework.

Table 4-1: Consideration of green industrialization in industrial policies and green economy plans

Country	Industrial Policy		Green Economy Policy/Plan/Strategy	
	Year	Consideration of green industrialization	Year	Consideration of green industrialization
Angola	2021	No		Yes*
Botswana	2014	No		
Eswatini	2015	No	2016	Yes*
Lesotho	2007	No	2021	Yes*
Malawi	2016	No		
Mauritius	2020	Yes	2015 and 2021	Yes
Mozambique	2016	No	2016	Yes
Namibia	2012	No	2012	Yes
South Africa	2018	Yes	2021	Yes
Zambia	2018	No	2022	Yes
Zimbabwe	2019	Yes*		

*Green industrialization mentioned but not articulated in detail | Gaps indicate no information was found

Source: Own assessment based on various country policies and strategies

Table 4-2: Consideration of green industrialization in NDPs and climate change policies

Country	National Development Plan		National Climate Change Policy/Plan/Strategy		Nationally Determined Contributions	
	Year	Consideration of green industrialization	Year	Consideration of green industrialization	Year	Consideration of green industrialization
Angola			2021	No	2021	No
Botswana	2017	No	2018	Yes*	-	No
Eswatini	2019	No			2021	Yes*
Lesotho					2017	Yes*
Malawi	2017	No	2016	Yes*	2021	Yes*
Mauritius	2021	Yes	2012	Yes	2021	Yes
Mozambique	2014		2021	Yes	2021	Yes

Country	National Development Plan		National Climate Change Policy/Plan/Strategy		Nationally Determined Contributions	
	Year	Consideration of green industrialization	Year	Consideration of green industrialization	Year	Consideration of green industrialization
Namibia	2021	Yes			2021	Yes
South Africa	2013	Yes			2021	Yes
Zambia	2022	Yes	2016	No	2021	No
Zimbabwe	2020	No	2017	No	2021	Yes

*Green industrialization mentioned but not articulated in detail | Gaps indicate no information was found

Source: Own assessment based on various country policies and strategies

4.4 Gaps and lessons from regional and country policy frameworks

National and regional policy frameworks are necessary to ensure a conducive environment to enhance private sector investments and competitiveness in regional and global value chains. Supportive, transparent and predictable policy environment helps attract new and existing private sector firms to invest in strategic value chains nationally and regionally (AUC & OECD, 2022).

Another challenge is the domestication of agreed policies and legal frameworks, roadmaps for implementation, enforcement and follow-up mechanisms, administrative issues, capacity issues, statistics and information sharing and budgetary constraints (SADC, 2019). The results in the above Tables highlight the lack of domestication of continental and regional policy frameworks on green industrialization. For example, SADC has a clear green industrialization strategy; however, the national industrial policies of the member states do not articulate how they plan to implement the regional priorities. Also, despite climate change documents highlighting efforts to promote sustainable practices, often green industrialization is not articulated in terms of concrete priorities and actions.

Although comprehensive regional frameworks support industrialization, some of the main challenges include the slow domestication of agreed policies and legal frameworks. The implementation of regional agreements is delayed as member states ratify them at different times (some taking years) based on different processes. This is also worsened by the lack of capacity to unpack regional statutes and little appreciation of their role in shaping domestic priorities.

Despite the strong commitment, in some cases, this is not followed through to implementation due to weak institutions or an unfavorable political economy (Lopes & te Velde, 2021). This has severely affected the realization of industrialization goals and the development of regional value chains. One of the challenges has been lack of resources and weak institutional environments to drive the implementation of the initiatives. This calls for the urgent need to mobilize domestic resources (public and private) to implement industrialization initiatives, including fostering private sector investments and participation in national and regional value chains strategic to industrial policies. Innovative financial instruments (such as public-private partnerships, blended finance etc.) are required to ensure national and regional green industrialization initiatives are implemented to yield expected socio-economic and environmental goals.

Many industrial policy and institutional frameworks have been developed, and some have been successfully implemented while others were not. Although some industrial policies and institutional frameworks have been successful in some countries, there are no blanket recommendations to transfer the same to other countries. Still, lessons can be learnt to inform and adapt to country contexts.

5. Selected cases of green industrialization experiences in Southern Africa

5.1 Introduction

This section discusses successful case studies of green industrialization experiences from the focus countries, where possible experiences from other parts of the continent will be discussed. The case studies were selected based on the literature review and evidence for demonstrating experiences driving green industrialization in the region. The identified case studies include the Eco-Industrial Parks Programme and the Industrial Energy Efficiency (IEE) Project, both from the National Cleaner Production Centre, South Africa (NCPC-SA), a green hydrogen project in Namibia and a project to support the transition to green and inclusive industrialization of the SADC region through supporting women businesses. Each of the case studies is discussed in detail below, highlighting some of the best practices and lessons learned that could be used to spur the drive for green industrialization.

5.2 Eco-Industrial Parks Programme[13]

Description of the Program

The concept of the eco-industrial park (EIPs) is defined by the United Nations Industrial Development Organization (UNIDO) as 'a community of businesses located on a common property in which companies seek to achieve enhanced environmental, economic and social performance through collaboration in managing environmental and resource issues'[14]. The EIP approach fosters the exchange of synergies (industrial symbiosis) by facilitating companies to gain competitive advantage through the physical exchange of materials, energy, water and by-products that reduce/eliminate resource waste and environmental impacts of their activities. The IEP also enhances inclusive and sustainable development by embracing community collaboration. Figure 5-1 illustrates the key components of eco-industrial parks.

The benefits of eco-industrial parks include the following:

- Industrial synergies facilitate companies to benefit from greater collaboration.
- Reduced environmental impact through resource-efficient and cleaner production (RECP) practices.
- Inclusion of EIPs in government plans encourages greater collaboration between companies, government and service providers.
- EIPs enable companies and management to turn environmental problems into solutions.
- Improve capacities for increased competitiveness, business development, production continuity and a better reputation with key stakeholders.
- Strong collaboration with surrounding communities embracing inclusiveness.

[13] Material in this section heavily relies on information from the NCPC: https://www.industrialefficiency.co.za/eco-industrial-parks-programme/. Accessed 11 September 2022.
[14] https://www.industrialefficiency.co.za/eco-industrial-parks-programme/. Accessed 11 September 2022.

Figure 5-1: Illustration of the key components of eco-industrial parks[15]

The National Cleaner Production Centre, South Africa (NCPC-SA)'s Eco-Industrial Parks Programme demonstrates a practical example of efforts to facilitate the transition of industries to a green economy and/or green industrialization. The East London Industrial Development Zone (ELIDZ) – South Africa is an example of the international best practice of the EIP approach (see Figure 5-2). The South African government established the ELIDZ in 2003 to provide a robust catalyst for economic development and diversification in the country. It is part of the government's Special Economic Zones (SEZ) Programme aimed at developing, operating and maintaining modern purpose-built infrastructure and attracting strategic investments. Also, the ELIDZ is one of three EIP parks capacitated by the NCPC-SA through various RECP interventions. The ELIDZ is 100% government-owned.

Figure 5-2: The East London Industrial Development Zone – South Africa[16]

[15] https://www.industrialefficiency.co.za/eco-industrial-parks-programme/. Accessed 11 September 2022.
[16] https://www.elidz.co.za/. Accessed 11 September 2022.

Figure 5-3 shows the strategic outcomes of the ELIDZ. To date, the ELIDZ has more than forty operational investors, has attracted more than R7.7 billion worth of private sector investment and created more than 3 945 active jobs.

Figure 5-3: ELIDZ's strategic outcomes

Lessons learned

The EIP approach can be adopted in existing or new industrial parks, making it scalable to many settings. Also, the EIP approach helps develop a conducive business environment that can attract global investments in green technological innovations and applications to drive green industrialization. The EIPs help build global competitiveness for local companies encouraging them to enter regional and global value chains. This helps create new markets for small businesses that generally would face challenges accessing such opportunities.

Helping companies reduce their cost of doing business is critical in improving the competitiveness of their products in regional and global markets. The ELIDZ provide customized investment and property solutions, helping industries streamline their business operations and lower their cost of doing business. The thriving businesses in the ELIDZ range from renewable energy, agro-processing, aquaculture, automotive, ICT and electronics and general manufacturing. The companies have grown in competitiveness to participate in regional and global value chains.

The ELIDZ demonstrates how EIPs create opportunities for their feeder communities through corporate social initiatives that facilitate socio-economic growth and create jobs. The EIPs promote sustainable socio-economic transformation and development of the feeder communities by implementing innovative and sustainable solutions that integrate national and local development priorities.

The ELIDZ also show the best practice of driving green industrialization by a sustained commitment to 'green' environmentally sustainable industrial development. The EIP business ecosystem helps decouple environmental impacts from productive economic activities, helping meet socio-economic objectives while addressing environmental challenges from industrial activities. Strict entry criteria in EIP zones are critical to driving green industrial growth and development in the target regions. By only targeting 'clean industries', the ELIDZ has facilitated the development of the renewable energy sector as an alternative to fossil fuel energy.

EIPs help with the implementation of government policy and strategic frameworks. Through developing and operationalizing an Environmental Management Framework that

guides investment activities in the EIP, the ELIDZ demonstrates how it contributes to helping the government implement policy and strategic priorities. Therefore, green industrial development objectives can be operationalized and sustained in EIP settings as private sector investments consciously integrate environmental constraints related to their activities.

Based on the experience of the ELIDZ, it is critical to develop and operationalize monitoring systems to ensure that industrial growth and socio-economic benefits do not fail to integrate environmental issues into business activities. This is important to ensure positive socio-economic and environmental benefits.

5.3 Industrial Energy Efficiency (IEE) Project[17]

Description of the Project

Established in 2010, the National Cleaner Production Centre, South Africa (NCPC-SA)'s international award-winning Industrial Energy Efficiency (IEE) Project is the largest energy efficiency initiative in South Africa. The IEE Project is a multistakeholder initiative supporting increased and sustained energy efficiency in industrial and selected commercial sectors such as agro-processing, chemicals and liquid fuels; metals processing and engineering; automotives; and mining. The IEE Project promotes the adoption of Energy Management Systems (EnMS), Energy Systems Optimization (ESO), and the Energy Management Standard ISO 50001 Series. The first phase of the IEE Project was from 2010-2015, and the second phase was from 2016-2020. Phase I served as an international pilot project. Based on its experiences, similar EnMS/ESO projects have been established through UNIDO in 16 other developing and emerging countries worldwide. In October 2020, the IEE Project was awarded the highest international accolade for an energy program by the global Association of Energy Engineers (AEE): the International Energy Project of the Year.

[17] Material in this section heavily relies on information from the NCPC: https://www.industrialefficiency.co.za/industrial-energy-efficiency-iee-project/. Accessed 11 September 2022 and NCPC-SA (2020)

Figure 5-4: Summary of Phase II of the IEE Project

Source: NCPC-SA (2020)

The IEE Project's second phase targeted to achieve direct energy savings of 1 000 GWh and financial savings through efficiency as well as to reduce greenhouse gas emissions by 1 million tons of CO_2e and indirect greenhouse gas emissions by 3.3 million tons of CO_2e. Since 2010, the IEE Project has provided energy efficiency services to more than 450 large and small industrial companies helping save an estimated 6.5 TWh of energy (the equivalent of five years of load shedding at the 2019 level of 1.352 TWh). The energy savings translate to cumulative cost savings of R5.3 billion in the supported companies. The case studies of supported companies demonstrate significant energy and financial savings by implementing energy efficiency recommendations and interventions. The project improved the competitiveness and capacity of businesses adopting energy management systems. The cleaner production processes produce more competitive products on the markets as consumers increasingly become environmentally sensitive to the goods and services they consume. Therefore, the IEE project principles helped increase the country's competitive products for domestic and export markets. The use and adoption of industrial energy efficiency and management systems contributed to national objectives of reducing carbon dioxide emissions.

Lessons learned

Partnerships play an essential role in delivering green industrialization projects: The IIE Project was implemented with financial support from the Global Environment Facility (GEF) with co-funding from the South African Department of Trade and Industry (the dti). The UNIDO, NCPC-SA, the Department of Energy and the South African National Energy Development Institute (SANEDI) delivered the implementation. The second phase of the IEE Project (2016-2020) focused on increasing investment in industrial energy efficiency through the wide-scale adoption of EnMS, ESO and the Energy Management Standard ISO 50001

through a holistic approach involving government, industry and selected regulatory bodies and education institutions. This was facilitated by a multi-stakeholder component approach led by different partners focused on: supporting energy efficiency policy, developing IEE skills in relevant sectors; technical support to industry and demonstrating the impact of IEE through sharing of achieved energy savings. The IEE project brings together national and international partners pulling resources and expertise together to implement the project. For example, the government department help ensure an enabling policy environment, as well as resources and international partners bring resources and expertise. Other key actors, such as the NPC-SA as a key player, ensure practical implementation of the project and build the national capacity to enhance the use and adoption of industrial energy efficiency in the country.

Effective energy management practices can contribute to cost savings and competitiveness improvement: The IEE project helped companies reduce production costs and improve their competitiveness by promoting industrial energy efficiency and energy management systems. For example, Toyota South Africa showed that companies that adopt energy efficiency and management systems could significantly reduce production costs and improve their competitiveness.

Industrial energy efficiency can significantly contribute to carbon dioxide emissions reduction: The IEE project principles contributed to the sustainable transformation of industrial energy usage practice in South Africa to reduce CO_2 emissions and demonstrate the positive impact of energy management to increase profitability. This has significant implications regarding contributions to national carbon dioxide emissions reduction targets.

IEE principles can significantly cut national energy use and improve energy security: Promoting improvements in the energy efficiency of industrial facilities through energy management and the use and adoption of energy-efficient industrial technologies can significantly reduce energy demand. This can contribute to improving national energy efficiency and security for the country.

Cost reduction, improved productivity, and competitiveness can help promote sustainability of industrial energy efficiency and management systems: The reduced costs and improved productivity and competitiveness from adopting industrial energy efficiency and management systems are key to the sustainability of the IEE project principles. Companies that realize these benefits after adopting the IEE principles have positive incentives to continue improving their energy efficiency. The companies also provide learning examples for others, which can help promote the IEE principles across the South African industry. The considerable energy and financial savings resulting from implementing energy efficiency recommendations and interventions are key to the sustainability of the IEE project. The demonstrated savings from participating companies provide practical evidence of the success and are an excellent opportunity for widespread adoption of the IEE project concepts.

Skills and capacity building help sustain the implementation of green industrialization activities: The IEE Project developed relevant skills in the industry as a core component of the support. The capacity building and transfer of skills to industry ensured sustained energy savings, and the implementation was mainly carried out in the process of training IEE experts. The training courses were developed by UNIDO and delivered by the NCP-SA at the end-user and expert level covering EnMS aligned to ISO 50001, ESO in a range of energy-intensive systems and focused courses in basic energy management and energy performance indicators.

Gender mainstreaming: Regarding inclusiveness, the IEE Project ensured and promoted an improved gender balance within the energy efficiency industry in South Africa. The IEE Project encouraged greater participation of women in energy efficiency through policy engagement, including women in capacity development and participation in leadership, networking and role model initiatives and outreach programs at tertiary institutions.

5.4 The Southern Corridor Development initiative: Tsau //Khaeb National Park (Hyphen SCDI) Project[18]

Description of the Project

Namibia has a long-term competitive advantage in the production of green hydrogen and green ammonia. The country is one of the top five locations globally that boasts world-class wind and solar resources near sea and land export routes. The global demand for green hydrogen is increasing, creating new market opportunities for this alternative renewable energy source. The World Bank's preliminary analysis of the green hydrogen market and levelized cost of hydrogen (LCOH) showed that Namibia could produce highly competitive green ammonia. Namibia, an emerging early entrant in the new market, is ambitious to be a leading exporter of Green Hydrogen in Africa.

The Namibian government's strategic focus is to achieve large-scale, low-cost renewable energy development and design models for sustainably maximizing fiscal revenue and local development in renewable energy investments and green ammonia production. The national growth and economic plan (the Harambee Prosperity Plan II) adopted the development of green hydrogen as an essential industry to drive economic growth and contribute to achieving global decarbonization goals. The government conceived the Southern Corridor Development Initiative (SCDI) as the country's first-gigawatt-scale fully vertically integrated green hydrogen project. The SCDI, comprising ~26,000mk2, has the potential to produce up to 3 million tons per annum of green hydrogen.

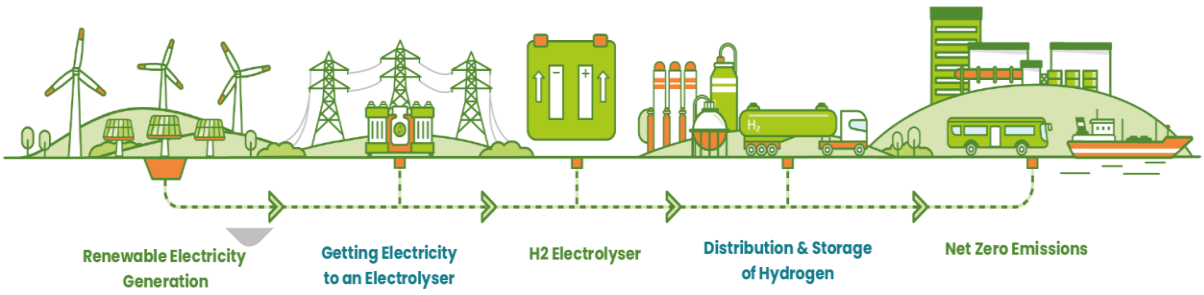

Figure 5-5: Illustration of green hydrogen production

The development of Namibia's first fully vertically integrated GW scale green hydrogen project was awarded to Hyphen in November 2021 following a competitive bidding process involving regional and international developers. Namibia was assisted in adjudicating bids to develop the first project by NREL, a national laboratory of the U.S. Department of

[18] Information from this case study heavily relies on the following sources: GoN (2022), https://hyphenafrica.com/projects/ and https://gh2namibia.com/. Accessed 11 September 2022

Energy and two experts appointed by the European Union Global Technical Assistance Facility on Sustainable Energy. The project is situated on ~4,000km2 of land within the Tsau //Khaeb National Park. The US$9.4 billion project (entirely financed by Hyphen) is being implemented in phases. At full development, the targeted output is 300 000 metric tons of green hydrogen production a year from 5GW of renewable generation capacity and 3GW electrolyser. In addition to local use, green hydrogen is earmarked for regional and global markets before the end of the decade, and the first production is expected in 2026. The first project is designed to act as a catalyst for the rapid scaling up of green hydrogen production in the SCDI. The project will help establish the industry's legal and regulatory framework and the master plan to realize the SCDI's production potential. Hyphen is expected to build the first components of the common-use infrastructure to be used by subsequent projects.

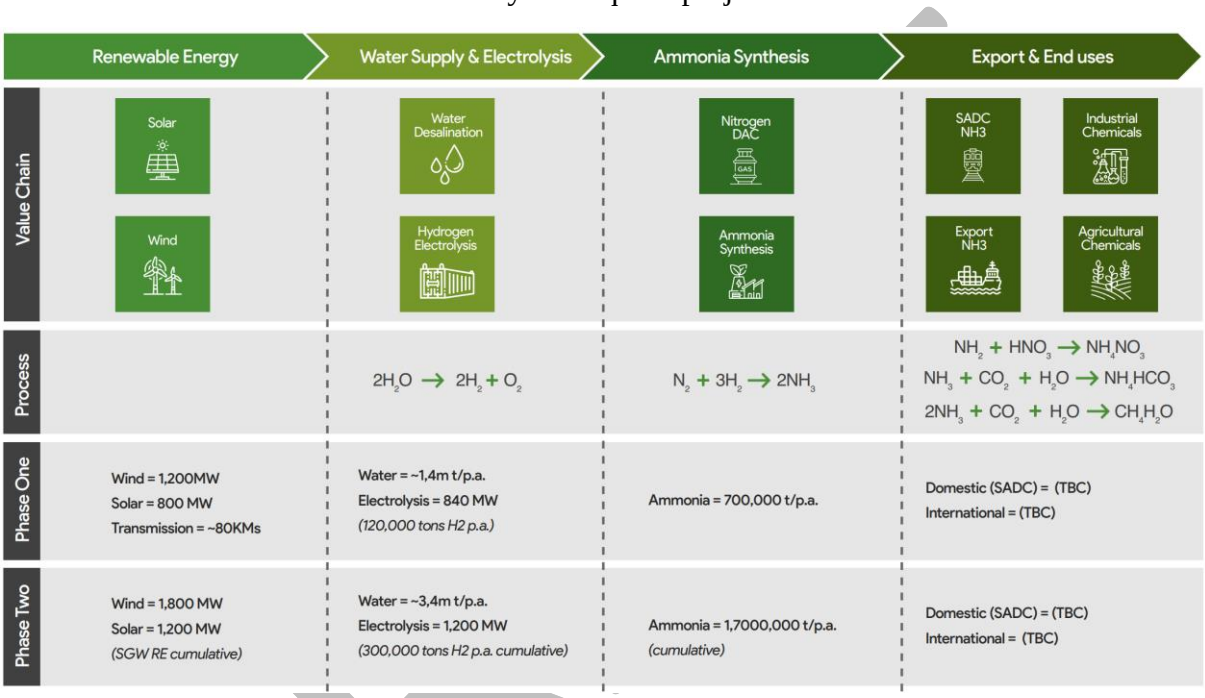

Figure 5-6: Summary of some of the key project components and phases

Source: GoN (2022)

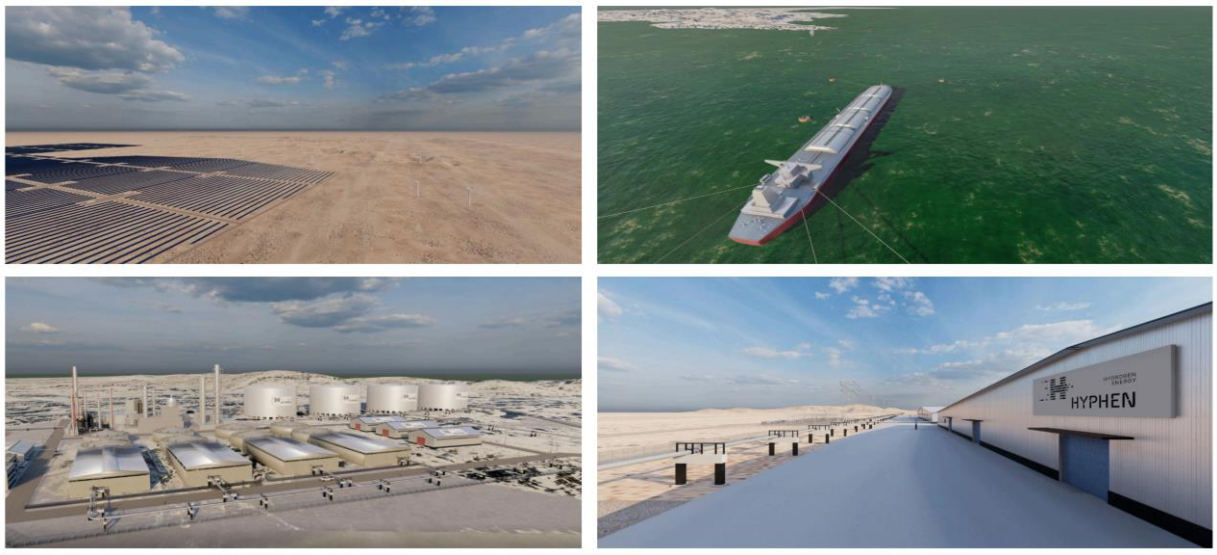

Figure 5-7: Proposed Hyphen Wind and Solar Generation

Source: GoN (2022)

Figure 5-8: Simplified visual layout of the SCDI (Southern Corridor Development initiative) in the Tsau //Khaeb Region

Source: GoN (2022)

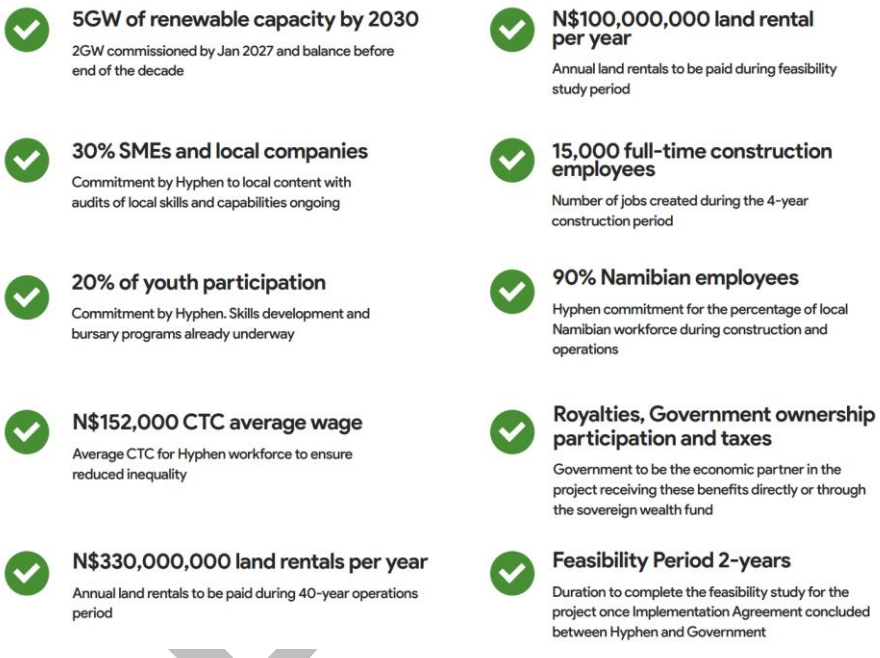

Figure 5-9: Key highlights of expected outputs from the Hyphen SCDI Project

Lessons learned

Increased production and utilization of green renewable energy and other opportunities: The project will provide a renewable energy capacity of 5GW by 2030 (2GW to be commissioned in January 2027). In addition to green hydrogen, other downstream products include green ammonia and methanol that can be produced in Namibia and exported globally at lower cost than local production. Figure 5-10 summarizes other opportunities created by the green hydrogen initiative in Namibia. These include support to target off-taker sectors such as

fertilizer, shipping and chemicals, with early movers already taking steps to consume clean hydrogen and hydrogen-related products such as synfuels and steel.

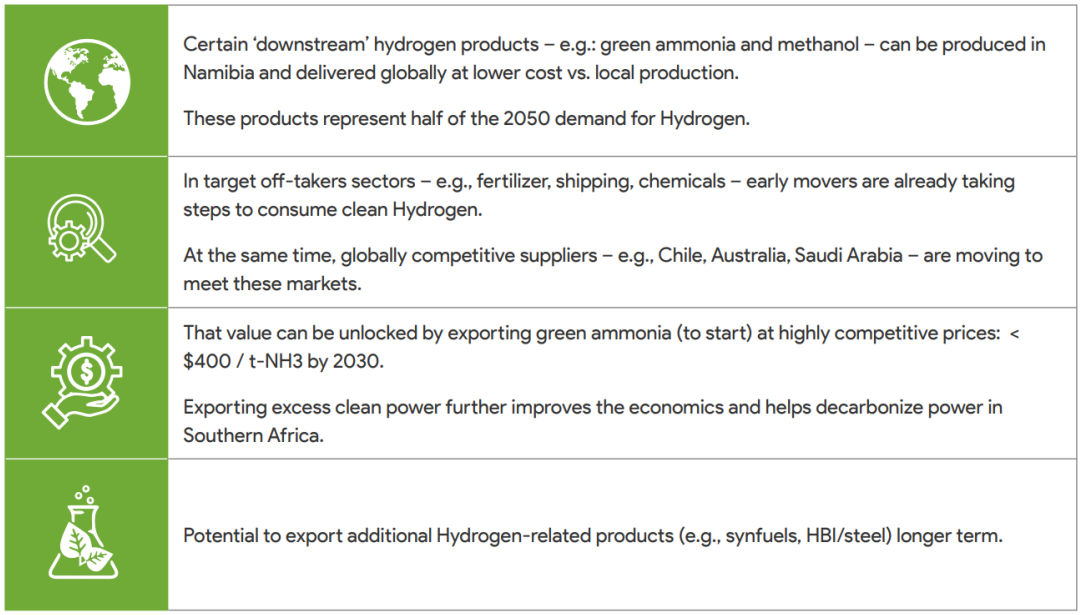

Figure 5-10: Namibia's green hydrogen opportunities

Source: GoN (2022)

Entrenched inclusive socio-economic benefits: The project will create opportunities for the local industry, including SME participation and local industry that will benefit from increased low-cost renewable energy. Renewable energy will also support regional industrialization through energy export into the regional power pool (SPP). The SCDI initiative creates opportunities for entry into global value chains, first through green energy exports to other parts of the world, such as Europe, and green ammonia to regional and global markets. Furthermore, other local industries that will benefit from low-cost green energy from the initiative complemented by other regulatory measures will improve their competitiveness to enter into regional and global value chains.

Local job creation: As part of the local benefits that the Namibian government will audit, the project will create about 15 000 full-time construction jobs during the four-year construction period, and 90% of these will be Namibians. Also, the project will ensure 20% youth participation, and Hyphen has already started skills development and bursary programs.

Global economic and environmental benefits: With the global economy transitioning towards net zero emissions, Namibia's world-class renewable resources create unique opportunities to jump-start the country's industrialization, achieve energy security and developmental goals in the Harambee Prosperity Plan II and Vision 2030 and simultaneously contribute to the global climate challenges and meet the country's pledges to the 2021 Glasgow Breakthrough Agenda. The potential development outcomes for Namibia over time and by 2040 could surpass: a GDP boost of USD$15 billion - USD$19 billion per year, USD$6 billion – USD$8 billion contribution to the trade balance. The project could ensure national; energy independence with the potential for improved energy access which is critical for the country's industrialization. More than 100 000 domestic jobs are expected to be created from opportunities spurred by the green hydrogen project (GoN, 2022).

In terms of climate outcomes for the world, the Namibia green hydrogen project is expected to export 14GW of clean power into the Southern Africa Power Pool (SAPP) and avoid GHG emissions of 45-60 Mt CO_{2e} per year, which could increase to 140-180Mt CO_{2e} per year by 2040 assuming 5% of expected global green ammonia market served by Namibian exports. Renewable energy to the Southern Africa Power Pool will significantly contribute much-needed green energy to spur the region's industrialization with clean energy.

Overall, the Namibia green hydrogen project offers potential local, national, regional and global socio-economic and environmental benefits. These include the supply of secure and low-cost renewable energy, supply chain and infrastructure development, reduced emissions, boost to GDP and jobs, and improved access to electricity and clean water.

National and international coordination is essential to deliver the project's expected outcomes: The awarding of the first project to Hyphen was supported by local and international stakeholders from the USA and Europe. Similar support is required in the implementation of the project.

5.5 Supporting the Transition to Green and Inclusive Industrialization of the SADC Project[19]

Description of the Project

The Supporting the Transition to Green and Inclusive Industrialization (STGII) of the SADC Project focuses on facilitating the financial sector towards supporting women-led businesses while encouraging sustainable industrial practices. The STGII Project is implemented by the Industrial Development Corporation, South Africa, with financial support from the African Development Bank (AfDB). The project's primary outcomes include gender mainstreaming and advancing its Climate Change Action Plan. The R1, 050 billion STGII's targeted beneficiaries are women-led businesses in industrial sectors in the SADC region. In addition to alignment with the AfDB strategic programs, the STGII Project aligns with various regional integration strategies that include: SADC Treaty, the Green Economy Strategy and Action Plan for Sustainable Development, the SADC Industrial Development Policy Framework, the SADC Industrialization Strategy and Roadmap.

The STGII supports women's entrepreneurial activity to promote and sustain women-led businesses. By supporting the transition to the circular economy, the STGII Project creates opportunities for private sector engagement in addressing emerging social and economic issues such as hazardous industrial effluent and emissions, persistent organic pollutants, mercury releases and proliferation of plastic waste.

Expected development outcomes: The project is expected to close the gender financing gap in the SADC region by supporting women-led businesses. Furthermore, the STGII Project will generate a demonstration effect for the private sector and facilitate increased financing toward a sustainable, green and inclusive industrialization process. Building on the IDC's track record in financing projects in various sectors in RMCs such as agri-business, manufacturing, infrastructure and trade, the project is expected to unlock additional financing for critical business segments and enhance productive capacity in various RMCs. The STGII Project will unlock liquidity that will benefit women-led businesses that are usually underserved. This is important to ensure inclusive and sustainable green industrialization in the region. The

[19] Material in this section heavily relies on information from the AfDB **Invalid source specified.**

additional benefit expected from the STGII Project is the contribution of the supported businesses to the transition to circular economies in the targeted industries. Economic benefits from supporting women-led businesses through the STGII Project include increased incomes for the women businesses, local, national and regional economies. Through building their capacities, women-led companies can participate in regional value chains, earn export incomes, and create new jobs as their businesses expand.

Innovative blended financial instruments are critical to inclusive green industrialization, especially the participation of underserved populations such as women-led businesses: The STGII Project will address capacity and liquidity constraints to women-led companies across the region while simultaneously helping the businesses reduce industrial waste. The AfDB, through the STGII, is providing an innovative, flexible and scalable package that consists of a blend of instruments and financing partner profiles (development finance, climate finance, commercial finance).

STGII helps underserved populations participate in the formal economy: The STGII Project addresses constraints limiting women-led businesses' integration into the formal economy and building their capacity and competitiveness to participate in regional and global value chains. Despite SADC member states having elaborate policies, strategies and programs to promote SME development, implementation has not been effective. Supply-side constraints affecting implementation include the lack of medium to long-term finance for start-ups and expansions, inappropriate terms and conditions for short-term credit, for example, trade finance, working capital, and insufficient financing and non-financing instruments to support the SME sector.

6. Priority sectors to jump-start green industrialization

6.1 Introduction

The ECA (2020) political economy of a green economy report identified the main sectors of focus in the transition to a green economy across the continent. The sectors include agriculture, energy, mining, industry and manufacturing, transport infrastructure, construction and green building, water and environment, urban infrastructure development and waste management. In addition, the review of Southern African regional and country documents and the above discussions demonstrate the importance of agriculture and agro-processing, energy, manufacturing, waste, transport and infrastructure sectors. Implementing greening alternatives discussed above offers opportunities to jump-start green industrialization in the region. Also, the importance of these sectors to the regional economy and individual countries makes them priority sectors for green industrialization. This section discusses green industrialization opportunities in each of the identified sectors. It is important to note that the selection is not prescriptive, and different options can be selected based on requirements.

6.2 Agriculture and agro-processing

The agriculture and agro-processing sector is identified in both the COMESA and SADC policy frameworks such as in the industrial policies. Three pathways can be used to green the industrial sector: (a) transitioning out of brown industries, (b) greening existing industries through increasing resource productivity, cutting pollution and managing chemicals more safely and (c) creating new green enterprises, for example, generating renewable energy, producing green capital goods and providing environmental advisory services. Much of these pathways are referred to as ‘decoupling’, implying attaining economic growth through the use of lower levels of materials intensity (relative decoupling) or with a reduction in the overall use of materials (absolute decoupling). Increasing the efficiency of input use at the firm level and reducing environmental pollution from the production process is critical to achieving decoupling (ECA, 2016).

Agriculture remains an important sector for most countries in the region; for example, at least 60% of the region depends on agriculture for their livelihoods. In addition to making a significant contribution to GDP, a significant proportion of the population in the region depend on the agriculture sector for their livelihoods, and the sector employs about 35% of the region’s population (AUC & OECD, 2022). The sector is also an important source of inputs for the manufacturing sector. Although the agriculture sector has remained traditional in structure, it is important to address poverty in the continent and unlock development as most of the population depends on the sector for their livelihoods and employment (ECA, 2020).

Many developing countries, especially in sub-Saharan Africa (including in southern Africa), lack a robust agro-industrial sector that can lift millions from poverty and increase global food supply chains (UNIDO, 2022). There is limited value addition in many focus countries, and most products are exported in raw form, particularly in agriculture and mining (COMESA, 2017). There is increasing pressure on agroecosystems from the ever-growing global demand for food, feed, fiber and clean energy. The increasing demand for food, feed and fiber in the region, together with current and projected changes in climate, requires an

urgent transition to resource-efficient and high-productivity food production and processing systems.

The agriculture sector presents opportunities for green industrialization, given the intensity of resource use in the sector. Fostering a sustainable transformation of the sector offers opportunities to increase productivity, create much-needed employment, and address poverty and the environmental impacts of agricultural activities. Also, embracing sustainable production and consumption in agricultural value chains offers an important entry point to reduce the natural resource footprint and increase the sector's productivity.

Digital technologies offer opportunities to scale up the application of sustainable and resource-efficient management practices in food production and processing systems to ensure increased productivity and improved efficiency in resource use. For example, digital technologies and innovations can transform agricultural activities through access to real-time information, such as competitive pricing, disaster mitigation support, disease prevention tips, and monitored crop information for informed decision-making. These will help improve productivity and incomes and increase demand in the region. New startups and entrepreneurs across the continent are increasingly using the Internet of Things to help farmers optimize productivity and reduce waste through data-driven 'precision farming' technologies (Ndung'u & Signe, 2020).

Also, digitalization is increasingly being applied in various agricultural supply chain stages such as production, processing, packaging, delivery, consumption and agro-waste management (Mondejar, et al., 2021). Digitalization benefits in food production and processing systems range from real-time monitoring, automation of different supply chain stages, and planning to deal with upcoming challenges such as pests and diseases. Digital technologies can help select high yield-oriented optimum practices, precise resource inputs, crop data management, post-harvest services and agro-based industries.

Jump-starting green industrialization in the agro-processing sector in the region should upscale various digital technologies and internet of agricultural things-based technologies already being applied in the region and other parts of the continent and world. These will help improve productivity and incomes and increase demand in the region. For example, jobs created in agro-food downstream segments such as processing, marketing, transport and retail generate up to eight times more output per worker compared to jobs in farming (AUC & OECD, 2022; Tschirley, et al., 2015).

6.3 Energy sector

Access to reliable energy is critical to growing the manufacturing sector, fostering economic transformation and accelerating green industrialization in the region. Access to energy remains a challenge for southern Africa), and millions live without access to electricity. Also, access to modern energy sources is usually costly, insufficient and unreliable (ECA, 2020).

The region has sufficient energy resources to meet its needs, but they are mainly underdeveloped and unevenly distributed, which calls for the need for regional energy

integration. Member states face challenges in maintaining existing energy generation capacity and investing in new generation capacity. Implementing the regional energy sector programs such as the Southern African Power Pool will contribute to savings on electricity production costs through power interconnectors that will integrate the region's power market. This is important to improve access to energy to support manufacturing and trade activities.

The region has sufficient energy resources to meet its needs, but they are mainly underdeveloped and unevenly distributed, which calls for the need for regional energy integration. As part of the solution, the energy vision for Programme for Infrastructure Development in Africa (PIDA) is to "harness all African energy resources to ensure access to modern energy for all African households, businesses and industries by developing efficient, reliable, cost-effective and environmentally friendly energy infrastructure resulting in poverty eradication and vigorous, sustainable development of the continent" (AfDB & AUC, 2013b).

The transition to less-energy-intensive industries, cleaner technologies and fuels and the implementation of energy efficiency policies will significantly contribute to the reduction in the carbon intensity of the GDP in the region. Extensive investments in green infrastructure and management practices and skills upgrades are critical for the transition to resource and energy-efficient outcomes. Foreign investors and local financiers are increasingly looking for countries with good energy planning and smart regulatory reforms which strengthen markets for clean energy (Lopes & te Velde, 2021). Renewable energy sources (mainly bioenergy, geothermal, hydropower, ocean, solar and wind) are the fastest-growing energy sources, with solar and wind energy experiencing rapid growth (IRENA, 2019). Member states have designed and implemented various renewable energy initiatives such as solar water heating, energy-efficient management initiatives etc. Learning from rapidly expanding renewable energy experiences and sustainable energy management practices is critical to driving industrialization in the region.

6.4 Manufacturing

The focus countries boost abundant natural resources that provide important inputs for the industrial/ manufacturing sector critical for economic transformation. The countries are endowed with mineral resources such as gold, platinum, copper, uranium, nickel phosphate etc and they have abundant agricultural resources, for example, land, flora and fauna. The challenge is many countries in the region are exploiting natural resources and exporting them in their raw form with limited value addition (COMESA, 2017). Furthermore, the lack of diversification of national industries remain a major challenge in the manufacturing sector, and top ten export products are resource based generating limited value added for the regional economy (SADC, 2015). Despite vast natural resources, countries in the region have inadequate infrastructure that constrain the development of national industries and intra-regional trade. Some of these limitations include obsolete energy, transport and logistics services and not fully developed information and communication technologies (SADC, 2015; SADC, 2013). Improvements in the value addition of natural resources within member states will create opportunities for increased incomes and new jobs. This also presents opportunities to invest in green technologies and innovations in the manufacturing sector to ensure the manufactured goods meet minimum international standards to be competitive in global value chains.

The manufacturing sector in the region is dominated by low-technology industries that include food processing, beverages, textiles, clothing and footwear (SADC, 2015). Another challenge in southern Africa is low trade in locally manufactured products which works against regional integration efforts and adversely affect economic growth and job creation (COMESA, 2017). The AfCFTA will help create an enabling environment to enhance intra and inter regional trade in inputs, semi-processed and processed products. Member states need to ensure measures that enhance movements of goods and services across borders as well promote local manufacturing industry. This include developing strategic infrastructure such as transport and logistics, digital, energy etc. ensuring effective quality management systems, product certification schemes for manufactured products to meet regional and international market standards.

Climate change and extreme events also affect the region's manufacturing sector, impacting main industrial sectors such as construction, food processing, and energy production. By affecting the availability and access to natural resources required for industrial production such as agricultural products, water, energy, oil etc.), climate change and extreme events threaten the performance of the manufacturing sector (SADC, 2015). In addition, recent events such as cyclones and floods experienced, especially in the eastern parts of the region, disrupt infrastructure (transport, manufacturing, energy etc.), significantly affecting the movement of goods and services (raw materials and finished products) within and across countries. Investments in green industrialization, including green and climate-resilient infrastructure and sustainable production and manufacturing processes, help improve the competitiveness of the region’s products and services in global value chains.

Improvements of resource efficiency such as energy, water and other raw materials in the manufacturing sector is critical to sustainable use of the limited resources to meet growing demand in the region. Furthermore, mainstreaming of sustainable production and manufacturing processes are important to align with international standards and ensuring long-term profitability and social inclusiveness of the manufacturing sector while protecting the environmental resource base.

6.5 Waste

Waste management is critical in fostering green industrialization. The increase in industrial production and consumption due to increasing demand would require improvements in waste management to ensure the benefits from green industrialization are not eroded by waste damage on the environment. For example, the digital rebound discussed above, where e-waste can end up damaging the environment eroding the benefits of digitalization is not managed properly. Countries have different systems for waste collection and disposal and there are no regional policies or guidelines. At the regional level, SADC recognizes the need to enhance of regional cooperation on hazardous chemicals and e-waste management (SADC, 2015).

The treatment and disposal of hazardous chemical and e-waste as well as management of municipal solid waste is priority in many countries in the region. Some of the waste challenges in the region include illegal open landfills and dumping sites that threaten human health in many cities. Many local authorities face challenges in solid waste management ranging from lack of institutional arrangements, insufficient financial resources, inappropriate technology and inadequate information on the quantity and composition of waste (SADC, 2015).

The sustainable management and disposal of wastes is important in the transition to green industrialization. The reduce, recycle, reduce (3R approach) presents a guiding principle for all actors in the waste management chain. Green investments in waste management such as recycling plants or waste-to-energy technologies contribute towards the transition to more sustainable waste management systems. The harmonization of waste management standards and introduction of incentives/disincentives to waste recycling and reduction create enabling conditions for greening the waste sector (SADC, 2015).

Figure 6-1 summarizes the benefits of waste management policy contributions to sustainable development. Designing and implementing sound waste management policies and strategies is essential to promote sustainable development outcomes. A well designed and carefully implemented waste management policy contributes to sustainable development pillars (economic, social and environmental) through improvements in economic efficiency, especially in resource extraction and use (such as waste prevention, reuse, recovery or recycling); reducing the resources needed for solid waste collection services; reducing or eliminating negative impacts on health and the local and general environment; delivering more attractive and pleasant human settlements and social amenity; and creating new job opportunities that could contribute to improve incomes and reduce poverty (UNEP, 2013).

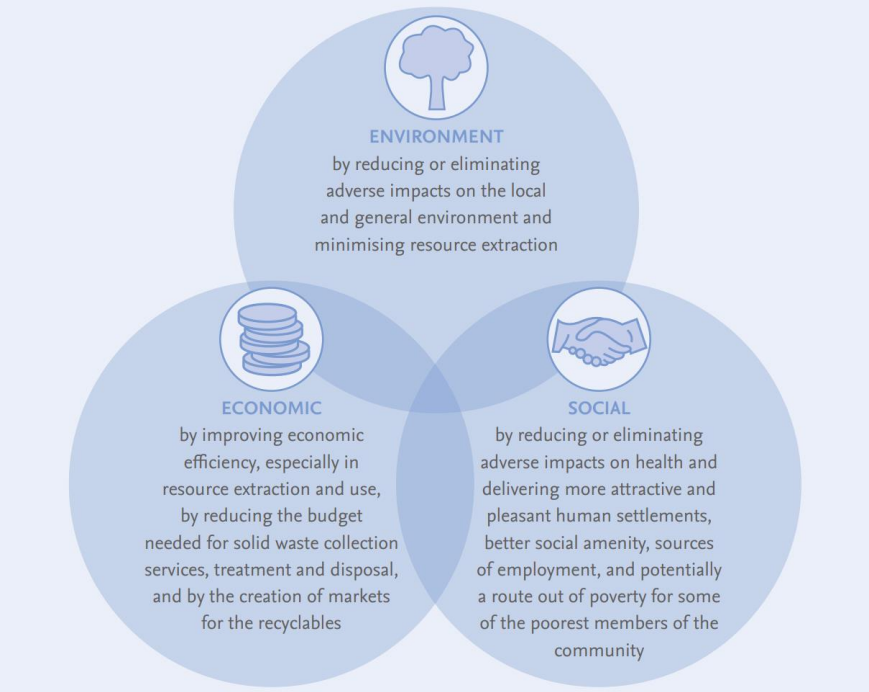

Figure 6-1: Waste management policy contributions to sustainable development

Source: UNEP (2013)

6.6 Transport and infrastructure

Several regional and national green economy strategies identified the transport and infrastructure sectors as key to the transition to a green economy. The transport sector is critical for the transition to green industrialization, improving intra-regional trade and entrenching regional integration. The dominant mode of transportation in the region is road for passenger

and freight transport (SADC, 2015). The development of transport infrastructure is important to ensure efficient, safe and cost effective transport services that meet the demands of a growing green industrial economy. Furthermore, it is important that designs of road infrastructure mainstream climate resilience and green principles to ensure green and climate resilient transport infrastructure. The recent experiences of extreme climatic events in the region such as cyclones and floods, for example, in Mozambique, Malawi and South Africa earlier this year highlights the urgent need for climate resilient transport infrastructure. The impacts of climate change and extreme events leads to deterioration of transport infrastructure affecting its sustainability. This significantly affects the transportation costs of goods and services across the region (SADC, 2012b).

The development of regional transport corridors in the region helps improve efficiency in transportation of goods and services within and across countries. This is important for improving intra-regional trade and facilitating regional integration. In addition to road transport infrastructure, the region should also ensure developments and improvements of sea ports ensuring they are upgraded with modern green technologies such as digital technologies as well as improvements of infrastructure to be climate-resilient. Sea-ports are critical for regional and international trade. Also, sea level rise would cause inundation of sea ports, coastal roads, railways and airports impacting on the quality of the infrastructure and increase maintenance and reconstruction costs. Overall the deterioration of transport infrastructure due to climate change and extreme events adversely affect intra-regional trade and regional integration efforts. All the regional economies are also affected by the disruptions of the movement of goods and services due to quality of the transport infrastructure.

The integration of climate change adaptation and resilience and green technologies in the transport infrastructure offers opportunities for green industrialization in the region. Also there are opportunities to diversify transport modes and develop clean transport networks. The diversification of regional transport networks help create new economic opportunities and jobs. Mainstreaming digital and other green technologies in the transport sector would also help improve efficiency, reduce costs and environmental impacts. Such developments contribute to improving the competitiveness of regional goods and services in global value chains. This is important in facilitating intra-regional trade and regional integration efforts. Furthermore, green technologies help reduce resource use in the transport sector, for example, green construction in transport infrastructure such as ports can reduce use of energy and increased use of efficient transport vessels reduce the environmental footprint from the sector.

Also, increasing access to improved transport infrastructure and services provide inclusive benefits to the poor and marginalized in society. This creates opportunities for the marginalized to engage in socio-economic activities that they would have been deprived of due to lack of transportation infrastructure and services. The priority in the transport sector is to foster the use and adoption of modern and energy-efficient technologies and fuel-efficient standards for passenger and goods vehicles (ECA, 2020).

The costs of investing in required infrastructure in the region are beyond the capacities of governments. Therefore, PPPs are required to contribute to financing investments in infrastructure in the region, including those outlined under the Program for Infrastructure Development in Africa (PIDA) (AfDB & AUC, 2013a). A clear and transparent regulatory framework is necessary to foster effective PPPs that help deliver the infrastructure gap requirements in the region. There are ongoing efforts for the establishment of regional corridors, including the North-South Corridor (NSC), the main traffic artery linking the Tripartite (COMESA, SADC and EAC) and the conduit to deepen economic integration of East and Southern Africa (COMESA, 2021).

7. Potential regional value chains to propel green industrialization

7.1 Introduction

The African Continental Free Trade Area (AfCFTA), which entered into force in January 2021, offers opportunities for the continent to accelerate productive transformation by developing regional production networks (AUC & OECD, 2022). The AfCFTA creates opportunities for deepening regional value chain integration. By addressing intra-Africa trade and non-trade barriers, the AfCFTA creates opportunities for new and existing value chains to expand their production and trade across the region. The rising demand driven by increased urbanization and population growth, among other factors, increases domestic and regional demand that further supports the development of production, processing and trade activities across sectors such as food, manufacturing, pharmaceutical, transport and the digital economy. Green industrialization presents opportunities to transform value chains across sectors in the region to integrate sustainability principles from production to the end of the life cycle. This section discusses potential green regional value chains which offer opportunities to propel green industrialization and facilitate intra-Africa trade under the AfCFTA.

7.2 Summary of global value chain participation

Most of the countries in the region participate in global value chains through raw natural resources and agricultural commodities exports. These are inputs into higher-value products produced by others and exported back into the region. Forward participation in value chains is less than 5% for most of the focus countries (see Figure below). On the other hand, backward participation (use of foreign input for domestic processing) within the same continent is zero in eight of the eleven study countries.

Country	Total backward participation (% of GDP), 2019	Total backward participation within same continent (% of GDP), 2019	Total forward participation (% of GDP), 2019	Total forward participation within same continent (% of GDP), 2019	Total value of national exports originating domestically (% of GDP), 2019
Mauritius	7	0	5	0	14
Lesotho	6	1	2	1	7
South Africa	6	0	9	0	22
Eswatini	4	2	2	2	10
Namibia	3	2	3	2	10
Angola	2	0	10	0	24
Zambia	2	0	6	0	16
Malawi	1	0	3	0	8
Botswana	1	0	2	0	8
Mozambique	1	0	2	0	5
Zimbabwe	0	0	5	0	1

Figure 7-1: Origin and destination of added value (GVC participation)

Source: Africa's Development Dynamics Key Indicators[20]

Strengthening regional production is important to grow domestic markets which can help improve backward participation in value chains and enhance private sector investments to create productive jobs. Enhancing private sector investments is critical in fostering domestic processing and manufacturing at national and regional levels to meet rising demand. Through

[20] https://www.compareyourcountry.org/africa-development-dynamics-indicators. Accessed 11 September 2022

the development of regional value chains, the region's member states can transform their productive capacities, enhance their competitiveness, diversify their economies and increase their participation in global value chains. Also, developing regional markets helps spur opportunities for many SMEs to participate in the industrialisation process . (AUC & OECD, 2022). This is important to create high-value non-farm jobs through increased downstream investments.

The focus countries' manufacturing intensity is very marginal (Figure 7-2). Southern African countries export more primary products than semi-processed and processed products. Furthermore, the region's backward participation in global value chains is usually low for primary goods exports, although higher than the continent (AUC & OECD, 2022). Through the development of regional value chains, the region's member states can transform their productive capacities, enhance their competitiveness, diversify their economies and increase their participation in global value chains.

Country	Exports of unprocessed goods, millions of USD, 2019	Exports of semi-processed goods, millions of USD, 2019	Exports of fully processed goods, millions of USD, 2019	Total exports of goods, processed and unprocessed, millions of USD, 2019
Angola	33 989	1 214	1 665	36 868
South Africa	28 943	58 426	21 171	108 540
Botswana	4 023	1 261	95	5 379
Mozambique	3 262	2 457	975	6 694
Namibia	2 190	4 304	515	7 009
Zimbabwe	1 278	2 340	410	4 028
Malawi	813	181	62	1 056
Zambia	534	9 228	348	10 110
Lesotho	220	231	464	916
Mauritius	127	1 525	1 019	2 671
Eswatini	97	3 255	312	3 665

Figure 7-2: Manufacturing intensity

Source: Africa's Development Dynamics Key Indicators[21]

Effective regional markets are important to spur opportunities for many SMEs to participate in the industrialisation process. Furthermore, removing trade barriers alone is not sufficient. It should be complemented by deeper integration that includes creating more competition behind the borders and strengthening the system of intellectual rights protection (Lopes & te Velde, 2021).

7.3 Potential green regional value chains

Agro-processing of main agricultural products: Based on the review above, the potential regional value chains include the agro-processing of agricultural products. The agro-processing industry mainly consists of grain milling, vegetable oil, fruits and vegetable processing, dairy, beverages, nuts, forestry and plantation products, fish and fishery products (COMESA, 2017). Promoting value addition and application of sustainable production and processing of these commodities presents potential opportunities for green industrialization. For example, at the production stage, efficient resource use, such as water management[22], helps reduce the environmental footprint of food production. Sustainable processing practices, such

[21] https://www.compareyourcountry.org/africa-development-dynamics-indicators. Accessed 11 September 2022

[22] Agriculture accounts for about 60-70% of freshwater withdrawals.

as energy efficiency, can also be applied at the processing stage. Digital technologies can also improve value chain efficiency across markets within and across countries.

The growth of the agro-processing sector in the above value chains has the potential to increase incomes and creates jobs. Also, this improves integrated manufacturing and sectoral linkages while diversifying the manufacturing base and product differentiation. Member states should create enabling environments and build capacity for private sector investments (especially SMEs) in processing agricultural products and ensuring that they meet minimum requirements on food safety, animal and plant health.

Renewable energy value chains: The drive for green industrialization presents opportunities for member states to scale up the use of innovative clean technologies powered by locally available renewable energy resources such as solar energy, small-scale hydro-power, biomass and biogas, and wind power. The member states boast abundant untapped energy resources such as hydro power, hydrocarbons, nuclear minerals and renewable energy (solar, wind, geothermal) that are available and affordable when processed (COMESA, 2017). Tapping on these energy resources, especially clean sources, is critical to address the energy challenges impacting the region's manufacturing sector.

An example of the renewable energy regional value chain is the Namibian green hydrogen project, the Southern Corridor Development Initiative (SCDI). The SCDI will export green energy into the regional power pool (SAPP), which will be critical in supporting regional industrialization efforts. In addition to exporting green energy, the SCDI initiative will also export green ammonia to regional and global markets. Angola is also exploring green hydrogen, which will also contribute to green energy in the installed generation capacity mix for the region. In March 2022, Sonagol announced plans for developing green hydrogen production as part of Angola's energy transition strategy[23].

Green fertilizer (such as ammonia) value chain: Renewable energy production, such as green hydrogen, produces downstream products, including green ammonia and methanol. The Namibian green hydrogen project expects to export green ammonia and methanol globally at a lower cost than local production. The experiences from Namibia show how investments in green energy (hydrogen in this case) strengthen linkages with other sectors through clean energy and downstream products. Given the importance of fertilizers in boosting agricultural productivity in the region, green ammonia will help reduce the environmental footprint of food production. The increased share of green ammonia used in food production in the region will also help improve the competitiveness of the region's agricultural products in global markets. In addition, by helping increase agricultural productivity, the green ammonia value chain contributes to strengthening sector linkages by enhancing the availability of raw materials for the agro-processing industry. The growth in the agro-processing sector helps grow national and regional incomes and create jobs while contributing to environmental sustainability goals.

[23] https://energycapitalpower.com/sonangol-announces-plans-to-produce-green-hydrogen-in-angola/. Accessed 15 October 2022.

8. Conclusions and recommendations

The report analysed the current state of green industrialization, digitalization and infrastructure development in Southern Africa. It identified gaps in the current industrial and development policies and frameworks and potential sectors and value chains that could anchor green industrialization. The key findings and policy recommendations of the study are presented below.

Summary of key findings

The state of green industrialization, digitalization, infrastructure development

Energy: Recurrent load shedding and power outages, shocks in oil and gas markets, inefficient energy supply and consumption patterns are some of the key challenges facing the region. Disruptions in the energy supply impact all economic sectors adversely. Furthermore, the impacts are more severe for vulnerable populations such as women and youth who engage in informal business activities that depend on the main electricity grid and cannot afford alternative sources that might be expensive, such as generators.

Energy resources across the remain are largely under-exploited. This contributes to energy supply challenges in the region. Some of the underlying factors contributing to this observation are limited financial capacity, constraining policy and a regulatory environment that fails to attract adequate private financing sources to address the energy infrastructure gap. The share of modern renewables in total final energy consumption is low. Only Eswatini and Malawi had at least a 40% share. However, there are increasing opportunities for increased investments in renewable energy to drive green industrialization. An example is the Renewable Energy for Sustainable Development in Zambia aimed at developing local and readily available renewable energy resources such as biomass, solar, and mini-hydro.

The Southern African Power Pool (SAPP) through trade in power contributes to enhancing regional integration efforts through enhanced energy access in deficit countries and facilitating surplus countries to sell energy across the region through the interconnectors. The initiative also contributes to accelerating the development of regional power interconnectors to enable member states in the SADC region to share and benefit from increased generation capacity across borders.

ICT and Digital Infrastructure: ICT and digital infrastructure sectors are growing across member states at different paces. This has facilitated the increasing penetration of ICT and digital technologies that contribute to improving economic growth and job creation by strengthening connections between goods, markets, people, and jobs. However, access to ICT and digital technologies and services varies across countries in the region. Some of the challenges that need to be addressed include improving accessibility ensuring wide coverage of the infrastructure, affordability, especially among women and youth and the capacity to benefit from the innovations effectively in the micro, small and medium enterprises.

Transport and logistics: The poor state of transport infrastructure (such as road infrastructure) and other factors, such as non-tariff barriers and weak logistics, adversely affect the transportation of goods and services across the region. High-trade costs adversely impact the development of regional value chains, and the effect is more severe for backward participation than forward participation. This trend reinforces the commodity-based, extractive

industry patterns of trade currently dominating the region and undermining value chain development within and across countries of the region. Causes of high trade costs include poor transport infrastructure, non-tariff barriers and weak trade-related services, like trade finance, payments, and logistics.

The role of technology, innovation, digitalization, and infrastructure in the process of greening industrialization policies and practice

Technology and innovation: Developments in technology and innovations such as robotics, additive manufacturing, data analysis and systems, digital platforms and digital supply chains are shaping production and distribution activities and services within and across value chains. New technologies and innovations are being applied to embed sustainable and environmentally friendly approaches to manufacturing, integrate resource efficiency and implement sustainable ways of disposing waste. These are important innovations to improve the competitiveness and the participation of stakeholders in regional and international value chains.

New technologies and modern production processes and innovations can allow for less resource-intensive use of inputs (decoupling) to ensure that the growth in manufacturing does not having negative environmental impacts. For example, The IoT can help contribute to energy management and conservation. Through the IoT, stakeholders can reduce operational expenses, optimize asset maintenance, reduce energy spending, integrate green energy, minimize carbon emission, comply with regulations and predict consumption and spending.

Green technologies and innovations can help meet the increasing demand for goods and services produced in environmentally friendly settings from production to consumption and the end of their life cycle. Unlike developed countries, which were able to address environmental and developmental challenges in sequence, for African countries and other developing countries, there is increasing pressure to integrate environmental challenges in producing goods and services. Emerging green growth opportunities include developing environmental products and services, adopting eco-labelling, certification in manufacturing and new financing sources.

Digitalization: Digitalization is having transformative impacts on the economy, society and the planet through the production, use and disposal of hardware (Information and Communication Technologies equipment, data centers, data transmission networks), software, digital technologies and applications ranging from robotics, big data, 3D printing, the Internet of Things, via distributed ledger technologies like blockchain, cloud computing and emerging platforms, to Artificial Intelligence

The expansion of digitalization, such as applications ranging from robotics, big data, 3D printing, and the Internet of Things, have transformative impacts on the economy, society and the planet. Digital technologies and innovations are improving the efficiency of production, logistics, customs and finances, enhancing cross-border trade and creating new opportunities for small and informal producers. The increased use and adoption of digital technologies can empower the poor (including youth and women) with access to information, job opportunities and services improving the inclusiveness of economic growth and development.

Infrastructure: Regional infrastructure facilitates the establishment of large competitive markets by providing lower-cost energy for all economic sectors (such as industry, agriculture, mining and communications). However, the infrastructure deficit (such as in energy, transport,

ICT and digital infrastructure) holds back the region's potential to grow and transform into an industrialized region. In addition to high costs of doing business and less competitiveness, the infrastructure deficit costs the region in terms of reduced potential output each year. Addressing the region's infrastructure gap is critical for green industrialization, economic growth and sustainable development. The costs of investing in required infrastructure in the region are beyond the capacities of governments, therefore, Public Private Partnerships are required to contribute to financing investments in infrastructure in the region.

The industrialization policies and frameworks

Continental and Regional Policy Frameworks: Regional Economic Communities (SADC and COMESA) have various documents that embed elements of green industrialization. These include the revised Regional Indicative Development Strategy (RISDP), the Industrialization Strategy and Road Map, the Regional Infrastructure Development Master Plan and other sector-specific protocols, COMESA Medium Term Strategic Framework, 2021-2025. Also, the 2017 COMESA Industrial Policy and Industrialization Strategy (2017-2026). For example, the SADC Green Economy Strategy and Action Plan identify priority green growth/ industrialization opportunities across priority sections in the region. Also, the COMESA Industrialization Strategy (2017-2026) aim to promote investments in green technologies to ensure environmental preservation, climate change adaptation and mitigation.

National Industrial and Industrialization Policy Frameworks: Green industrialization presents opportunities for countries to leapfrog from traditional carbon-intensive methods of industrial growth to cleaner, more sustainable patterns that are more competitive. The review of country-level policy frameworks showed that industrial policies do not explicitly elaborate on green industrialization. Mauritius and South Africa are the two countries that have a national policy or plan that articulates green industrialization. Green economy plans, where available, highlighted either green industrialization/ green jobs or green economy as a strategic focus for the country. Furthermore, climate change policies and nationally determined contributions to UNFCCC also show that green industrialization/ green economy/ green jobs are part of efforts to reduce greenhouse emissions. Overall, the reviewed documents highlight the strategic focus on sustainable development, especially those developed after 2015.

The review showed the limited domestication of the continental and regional policy frameworks on green industrialization. For example, SADC has a clear green industrialization strategy; however, the national industrial policies of the member states do not articulate how they plan to implement the regional priorities. The implementation of regional agreements is delayed as member states ratify them at different times (some taking years) based on different processes. This is also worsened by the lack of capacity to unpack regional statutes and limited appreciation of their role in shaping domestic priorities. Another challenge is although climate change documents elaborate efforts to promote sustainable practices, often green industrialization is not articulated in terms of concrete priorities and actions.

The strong commitment, in some cases, is not followed through to implementation due to weak institutions or an unfavorable political environment. One of the challenges has been the lack of resources and weak institutional environments to drive the implementation of the initiatives. This calls for the urgent need to mobilize domestic resources (public and private) to implement green industrialization initiatives, including fostering private sector investments and participation in national and regional value chains strategic to industrial policies. Innovative financial instruments (such as public-private partnerships, blended finance etc.) are required to

ensure national and regional green industrialization initiatives are implemented to yield expected socio-economic and environmental goals.

Selected cases of green industrialization experiences in Southern Africa

The case studies were selected based on the literature review and evidence demonstrating experiences driving green industrialization. The identified case studies include the Eco-Industrial Parks Programme and the Industrial Energy Efficiency (IEE) Project, both from the National Cleaner Production Centre, South Africa (NCPC-SA), a green hydrogen project in Namibia and a project to support the transition to green and inclusive industrialization of the SADC region through supporting women businesses.

Eco-Industrial Parks Programme: The National Cleaner Production Centre, South Africa's Eco-Industrial Parks Programme demonstrates a practical example of efforts to facilitate the transition of industries to a green economy and/or green industrialization. The East London Industrial Development Zone – South Africa is an example of the international best practice of the EIP approach. It is part of the government's Special Economic Zones Programme aimed at developing, operating and maintaining modern purpose-built infrastructure and attracting strategic investments. Also, the ELIDZ is one of three EIP parks capacitated by the NCPC-SA through various RECP interventions. The thriving businesses in the ELIDZ range from renewable energy, agro-processing, aquaculture, automotive, ICT and electronics and general manufacturing. The companies have grown in competitiveness to participate in regional and global value chains.

Some of the lessons learned contributing to the success of the ELIDZ include:

(f) Fostering the exchange of synergies (industrial symbiosis) by facilitating companies to gain competitive advantage through the physical exchange of materials, energy, water and by-products that reduce/eliminate resource waste and environmental impacts of their activities.
(g) Enhancing inclusive and sustainable development by embracing community collaboration.
(h) Ensuring a conducive business environment that can attract global investments in green technological innovations and applications to drive green industrialization.
(i) Building global competitiveness for local companies encouraging them to enter regional and global value chains. This helps create new markets for small businesses that generally would face challenges accessing such opportunities.
(j) Strict entry criteria in EIP zones are critical to driving green industrial growth and development in the target regions. By only targeting 'clean industries', the ELIDZ has facilitated the development of the renewable energy sector as an alternative to fossil fuel energy.

Industrial Energy Efficiency (IEE) Project: Established in 2010, the National Cleaner Production Centre, South Africa (NCPC-SA)'s international award-winning Industrial Energy Efficiency (IEE) Project is the largest energy efficiency initiative in South Africa. The IEE Project is a multistakeholder initiative supporting increased and sustained energy efficiency in industrial and selected commercial sectors such as agro-processing, chemicals and liquid fuels; metals processing and engineering; automotives; and mining. The IEE Project promotes the adoption of Energy Management Systems (EnMS), Energy Systems Optimization (ESO), and the Energy Management Standard ISO 50001 Series. In October 2020, the IEE Project was awarded the highest international accolade for an energy program by the global Association of Energy Engineers (AEE): the International Energy Project of the Year.

Some of the lessons learned contributing to the success of the ELIDZ include:

(f) Partnerships play an essential role in delivering green industrialization projects. The IIE Project was implemented with financial support from the Global Environment Facility (GEF) with co-funding from the South African Department of Trade and Industry (the dti).
(g) Effective energy management practices can contribute to cost savings and competitiveness improvement: The IEE project helped companies (such as Toyota South Africa) reduce production costs and improve their competitiveness by promoting industrial energy efficiency and energy management systems.
(h) The reduced costs and improved productivity and competitiveness from adopting industrial energy efficiency and management systems are key to the sustainability of the IEE project principles.
(i) IEE principles can significantly cut national energy use and contribute to improve energy security and to national carbon dioxide emissions reduction targets.
(j) Skills and capacity building help sustain the implementation of green industrialization activities: The IEE Project developed relevant skills in the industry as a core component of the support. Also, the IEE Project ensured and promoted an improved gender balance within the energy efficiency industry in South Africa.

The Southern Corridor Development initiative: Tsau //Khaeb National Park (Hyphen SCDI) Project: The Namibian government's strategic focus is to achieve large-scale, low-cost renewable energy development and design models for sustainably maximizing fiscal revenue and local development in renewable energy investments and green ammonia production. The government conceived the Southern Corridor Development Initiative (SCDI) as the country's first-gigawatt-scale fully vertically integrated green hydrogen project. The SCDI, comprising ~26,000mk2, has the potential to produce up to 3 million tons per annum of green hydrogen.

Some of the lessons learned contributing to the success of the ELIDZ include:

(b) The Namibia green hydrogen project offers potential local, national, regional and global socio-economic and environmental benefits. These include the supply of secure and low-cost renewable energy, supply chain and infrastructure development, reduced emissions, boost to GDP and jobs, and improved access to electricity and clean water, for example the project will:
    a. Provide a renewable energy capacity of 5GW by 2030 (2GW to be commissioned in January 2027) and other downstream products include green ammonia and methanol that can be produced in Namibia and exported globally at lower cost than local production.
    b. Create about 15 000 full-time jobs during the four-year construction period, and 90% of these will be Namibians. In addition, more than 100 000 domestic jobs are expected to be created from opportunities spurred by the green hydrogen project.
    c. Ensure 20% youth participation, and Hyphen has already started skills development and bursary programs.

Supporting the Transition to Green and Inclusive Industrialization (STGII) of the SADC Project: The project implemented by the Industrial Development Corporation, South Africa, with financial support from the African Development Bank (AfDB) focuses on facilitating the financial sector towards supporting women-led businesses while encouraging sustainable industrial practices. The R1, 050 billion STGII's targeted beneficiaries are women-led

businesses in industrial sectors in the SADC region. The STGII Project aligns with various regional integration strategies that include: SADC Treaty, the Green Economy Strategy and Action Plan for Sustainable Development, the SADC Industrial Development Policy Framework, the SADC Industrialization Strategy and Roadmap.

Some of the lessons learned contributing to the success of the ELIDZ include:

(a) Through building their capacities, women-led companies can participate in regional value chains, earn export incomes, and create new jobs as their businesses expand. The project addresses capacity and liquidity constraints to women-led companies across the region while simultaneously helping the businesses reduce industrial waste.
(b) Innovative financing helps support green initiatives that normally would not have the opportunity to grow. The project will provide an innovative, flexible and scalable package that consists of a blend of instruments and financing partner profiles (development finance, climate finance, commercial finance).
(c) By supporting the transition to the circular economy, the STGII Project creates opportunities for private sector engagement in addressing emerging social and economic issues such as hazardous industrial effluent and emissions, persistent organic pollutants, mercury releases and proliferation of plastic waste.

Priority sectors to jump-start green industrialization in Southern Africa

The priority regional sectors to jump-start green industrialization in the region include agriculture and agro-processing, energy, manufacturing, waste, transport and infrastructure. These were selected based on the review of regional and country-level policy frameworks and other publications and informed by the focus of this report. Opportunities in these sectors include integrating sustainable production and consumption practices, improving resource use efficiency to reduce resource footprint, and increasing sector productivity.

Agriculture and agro-processing: The agriculture sector is characterized by limited value addition and most products are exported in raw form or semi-processed. Also, there is increasing pressure on agroecosystems from the ever-growing global demand for food, feed, fiber and clean energy. The increasing demand, together with current and projected changes in climate, requires an urgent transition to resource-efficient and high-productivity food production and processing systems.

Digital technologies offer opportunities to scale up the application of sustainable and resource-efficient management practices in food production and processing systems to ensure increased productivity and improved efficiency in resource use. For example, digital technologies and innovations can transform agricultural activities through access to real-time information, such as competitive pricing, disaster mitigation support, disease prevention tips, and monitored crop information for informed decision-making.

Energy sector: Investing in the energy sector is central to green industrialization. The transition to less-energy-intensive industries, cleaner technologies and fuels and the implementation of energy efficiency policies will contribute to economic growth while significantly helping reduce the carbon intensity of the GDP in the region. Extensive investments in green infrastructure and management practices and skills upgrades are critical for the transition to resource and energy-efficient outcomes.

Member states have designed and implemented various renewable energy initiatives such as solar water heating, energy-efficient management initiatives etc. Learning from rapidly

expanding renewable energy experiences and sustainable energy management practices is critical to driving industrialization in the region.

Manufacturing: The focus countries boast abundant natural resources that provide important inputs for the industrial/ manufacturing sector critical for economic transformation. The challenge is many countries in the region are exploiting natural resources and exporting them in their raw form with limited value addition. Despite vast natural resources, countries in the region have inadequate infrastructure that constrains the development of national industries and intra-regional trade.

Improvements in the value addition of natural resources within member states will create opportunities for increased incomes and new jobs. This also presents opportunities to invest in green technologies and innovations in the manufacturing sector to ensure the manufactured goods meet minimum international standards to be competitive in global value chains. For example, improving resource efficiency such as energy, water and other raw materials in the manufacturing sector is critical to sustainable use of the limited resources to meet growing demand in the region.

Waste: Sustainable waste management and disposal are essential in the transition to green industrialization. The reduce, recycle, reduce (3R approach) presents a guiding principle for all actors in the waste management chain. Green investments in waste management, such as recycling plants or waste-to-energy technologies, contribute towards the transition to more sustainable waste management systems.

The growth in industrial production and consumption due to increasing demand would require improvements in waste management to ensure the benefits from green industrialization are not eroded by waste damage to the environment. For example, the digital rebound effects, where e-waste can end up damaging the environment and eroding the benefits of digitalization, are not appropriately managed.

The harmonization of waste management standards and introduction of incentives/disincentives to waste recycling and reduction create enabling conditions for greening the waste sector. Designing and implementing sound waste management policies and strategies is essential to promote sustainable development outcomes and support the creation of new sustainable industries.

Transport and infrastructure: The development of regional transport corridors in the region helps improve efficiency in the transportation of goods and services within and across countries. This is important for enhancing intra-regional trade and facilitating regional integration. There are opportunities to diversify transport modes and increase the use of clean energy sources in transport networks. An example is the clean fuel Bus Rapid Transit System for public transportation in the Tshwane Metropolitan City, South Africa. Mainstreaming digital and other green technologies in the transport sector would also help improve efficiency and reduce costs and environmental impacts. Such developments improve the competitiveness of regional goods and services in global value chains.

Increasing access to improved transport infrastructure and services benefits the poor and marginalized in society. This creates opportunities for the marginalized to engage in socio-economic activities that they would have been deprived of due to the lack of transportation infrastructure and services.

Potential regional value chains to propel green industrialization

The potential regional value chains were identified from the priority sectors and value chains in various regional and national strategies, policies and programs on green growth/ industrialization, climate change adaptation and mitigation, national and regional development plans. These include the 2015 SADC Regional Green Economy Strategy and Action Plan for Sustainable Development and the 2017 COMESA Industrial Policy and Industrialization Strategy (2017-2026). The identified value chains offer opportunities beyond national boundaries and present cross-sectional linkages to entrench regional integration and development.

Global value chain participation: Most of the countries in the region participate in global value chains through raw natural resources and agricultural commodities exports. These are inputs into higher-value products produced by others and exported back into the region. Forward participation in value chains is less than 5% for most of the focus countries while backward participation (use of foreign input for domestic processing) within the same continent is zero except in Eswatini, Lesotho and Namibia.

The potential value chains to anchor green industrialization across the member States include; agro-processing of main agricultural products, renewable energy value chains, and green fertilizer (such as ammonia) value chains. Promoting value addition and application of sustainable production and processing of these value chains presents potential opportunities for green industrialization, the creation of sustainable jobs and reduction in poverty and inequality.

Agro-processing of main agricultural products: The agro-processing industry mainly consists of grain milling, vegetable oil, fruits and vegetable processing, dairy, beverages, nuts, forestry and plantation products, fish and fishery products. Promoting value addition and application of sustainable production and processing of these commodities presents potential opportunities for green industrialization. For example, digital technologies can also improve value chain efficiency across markets within and across countries. The growth of the agro-processing sector in the above value chains has the potential to increase incomes and creates jobs. Also, this improves integrated manufacturing and sectoral linkages while diversifying the manufacturing base and product differentiation.

Renewable energy value chains: The member states boast abundant untapped energy resources such as hydro power, hydrocarbons, nuclear minerals and renewable energy (solar, wind, geothermal) that are available and affordable when processed. Tapping on these energy resources, especially clean sources, is critical to address the energy challenges impacting the region's manufacturing sector. An example of the renewable energy regional value chain is the Namibian green hydrogen project, the Southern Corridor Development Initiative (SCDI). The SCDI will export green energy into the regional power pool (SAPP), which will be critical in supporting regional industrialization efforts.

Green fertilizer (such as ammonia) value chain: Renewable energy production, such as green hydrogen, produces downstream products, including green ammonia and methanol. The experiences from Namibia show how investments in green energy (hydrogen in this case) strengthen linkages with other sectors through clean energy and downstream products. The increased share of green ammonia used in food production in the region will also help improve the competitiveness of the region’s agricultural products in global markets.

Recommendations

To accelerate green industrialization in Southern Africa, Member States should:

- Maintain and/or upgrade the existing energy generation capacity and promote/facilitate investments in new clean energy infrastructure to ensure an undisrupted supply to all regional citizens and stakeholders. The investment includes expanding the share of clean energy sources in the energy generation mix currently dominated by coal.
- Mobilize public and private sector funding and address policy and regulatory constraints to create an enabling environment that attracts adequate private financing sources to address the energy infrastructure gap.
- Promote investments that grow the share of modern renewables in the generation energy mix. This contributes to national targets towards reducing emissions while contributing to socio-economic goals.
- Strengthen the implementation of the regional energy sector programs to save on electricity production costs through power interconnectors that integrate the region's power market through Power Pools. This is important to improve access to energy to support manufacturing and trade activities.
- Ensure support for the effective functioning of the Southern African Power Pool to deepen deepening regional integration efforts. For example, member states should provide a conducive regulatory environment that facilitates trading in power between surplus and deficit countries and attract increased investments in new energy generation capacity, including modern renewable energy sources.
- Create enabling operational environments that attract public and private sector investments in growing the ICT and digital infrastructure sectors, including investment in developing entrepreneurial skills, targeting youth and women to help them engage in business activities in the growing digital economy;
- Support upscaling various digital technologies and internet of things-based technologies already being applied in the region and other parts of the continent and world to help improve productivity and incomes while addressing environmental goals.
- Invest in ensuring effective regulation that enables digital infrastructure expansion and makes connectivity affordable, reliable and universal. There is need for policy measures that address barriers to entry, such as restrictive licensing and exclusivity rights and promote competition on a level playing field, such as asymmetric regulation of dominant operators, infrastructure sharing and antitrust enforcement;
- Design and implement public-private partnerships to address the energy, ICT and transport infrastructure gaps;
- Develop regulatory and legal frameworks to stimulate digital innovations and incentivize the private sector and other partners to contribute to investing in an inclusive and dynamic digital economy. Some of the required investments include growing the digital infrastructure, developing digital skills and entrepreneurship (including among women and youth), digital platforms and digital financial services;
- Increase investments to maintain existing infrastructure and integrate climate resilience and green technologies into new infrastructure, including enhancing investment in connective infrastructure in the strategic industrial clusters to facilitate the development of regional value chains and foster private sector participation in green industrialization and the export of value-added products in the broader African market under the AfCFTA;
- Articulate green industrialization in their national industrial policies, including consolidating green industrialization priorities across all national documents and develop concrete action plans for green industrialization as well as allocate and mobilize resources for implementation;

- Design and implement strategic and focused policies that support increased domestic and foreign investments in green technologies and innovations. For example, increased investments in green technologies and modern production processes can allow for less resource-intensive use of inputs (decoupling) to ensure that the growth in manufacturing does not having negative environmental impacts.
- Develop effective institutions, capacity, favourable policy environment and mobilize resources (public and private) to operationalize regional and national green industrialization actions, including creating a transparent and predictable policy environment to incentivise private sector investments in green industrialization initiatives and priority value chains through fiscal incentives and other such mechanisms;
- Promote investments in improved and climate-resilient infrastructure to facilitate intra- and inter-regional and international trade, reduce the cost of doing business for private sector in the manufacturing and other sectors.
- Promote investments in connective infrastructure in the strategic industrial clusters in the region to help develop the regional value chain and foster private sector participation in green industrialization.
- Scaleup the implementation of green industrialization experiences that have demonstrated positive socio-economic and environmental benefits and share experiences across the region.
- Promote investments in sustainable production and consumption in agricultural value chains to reduce the natural resource footprint and increase the sector's productivity. This should include climate-smart, resource-efficient and high-productivity food production and processing systems;
- Strengthen regional production to support backward participation in value chains and enhance private sector investments to create productive jobs;
- Design and implement sound waste management policies and strategies to promote sustainable development outcomes and support the creation of new sustainable industries;
- Ensure a conducive environment that attracts investments in needed infrastructure and capabilities to scale the green industrialisation case studies such as in energy efficiency and renewable energy;
- Strengthen the domestic and regional regulatory framework concerning Investor State Dispute Settlement (ISDS) provisions which may increasingly come into conflict with environmental, mining rights, tax policies and, indeed, green industrialization priorities of member states;
- Develop a clear and transparent regulatory framework is necessary to foster effective PPPs that help deliver the infrastructure gap requirements in the region.

To deepen green industrialization, the private sector should:

- Continue to proactively invest in technologies to enhance productive and distributive efficiency and facilitate green industrialization, including through investments in clean energy, digital technologies and attendant infrastructure;
- Share experiences in the application and use of green industrialization technologies, especially how these technologies reduce costs and enhance product competitiveness;
- Seek opportunities to collaborate on the development and deployment of innovations which support green manufacturing processes.

- Embrace opportunities to engage in regional and global value chains with green manufacturing focus or linkages, which would assist in driving increased efficiency and competitiveness of MSMEs in the green economy.
- Invest in improving resource efficiency such as energy, water and other raw materials in the manufacturing sector to facilitate sustainable use of the limited resources to meet growing demand in the region.

To facilitate the sharing of experiences and accelerate the adoption of green industrialization, regional economic communities should:

- Strengthen regional frameworks on the same, set standards for adoption;
- Provide a platform for the member states and the private sector to share experiences periodically.
- Configure regional industrialization frameworks to favour green industrialization and the use of clean energy and energy efficiency.
- Institute standardization, quality assurance and quality management systems that meet international standards, including environmental regulations to facilitate intra-regional trade through AfCFTA.

To promote green industrialisation, development partners should:

- Support the development of green industrialization policy frameworks at regional and national levels.
- Support domestication, alignment and harmonization of green industrialisation policy frameworks.
- Provide a platform for the member states and the private sector to share experiences periodically.

References

AfDB, 2018. *African Economic Outlook 2018,* Abidjan, Ivory Coast: African Development Bank.

AfDB & AUC, 2013a. *The Programme for Infrastructure Development in Africa: Transforming Africa through Modern Infrastructure - Closing the Infrastructure Gap Vital for Africa's Transformation,* Abidjan and Addis Ababa: African Development Bank, African Union Commission.

AfDB & AUC, 2013b. *The Programme for Infrastructure Development in Africa: Transforming Africa through Modern Infrastructure - PIDA Brief Energy,* Abidjan, Addis Ababa: African Development Bank, African Union Commission.

AfDB & AUC, 2013c. *The Programme for Infrastructure Development in Africa: Transforming Africa through Modern Infrastructure - PIDA Brief ICT,* Abidjan and Addis Ababa: African Development Bank, African Union Commission.

AfDB, OECD & UNDP, 2017. *African Economic Outlook 2017: Entrepreneurship and Industrialisation,* Abijan, Ivory Coast: African Development Bank, Organisation for Economic Co-operation and Development, United Nations Development Programme.

Ahirwar, R. & Tripathi, A., 2021. E-waste management: A review of recycling process, environmental and occupational health hazards, and potential solutions. *Environmental Nanotechnology, Monitoring & Management,* Volume 15, p. 100409.

Altenburg, T. & Assmann, C., 2017. *Green Industrial Policy. Concept, Policies, Country Expeeriences,* Geneva, Bonn: UN Environment; German Development Institute / Deutsches Institut für Entwicklungspolitk (DIE).

Andreoni, A. & Anzolin, G., 2019. The Political Economy of Industrial Policy. *Structural Change and Economic Dynamics,* Volume 48, p. 136–150.

Andreoni, A. & Chang, H., 2017. Bringing production transformation and jobs creation back to development. *Cambridge Journal of Regions, Economy and Society*, 10(1), pp. 173-187.

Andreoni, A., Chang, H. & Scazzieri, R., 2019. Industrial policy in context: Building blocks for an integrated and comparative political economy agenda. *Structural Change and Economic Dynamics,* Volume 48, pp. 1-6.

Antràs, P. & De Gortari, A., 2020. On the geography of global value chains. *Econometrica,* 88(4), pp. 1553-1598.

Appio, F., Frattini, F., Petruzzelli, A. & Neirotti, P., 2021. Digital transformation and innovation management: A synthesis of existing research and an agenda for future studies. *Journal of Product Innovation Management,* 38(1), pp. 4-20.

Ardito, L., Petruzzelli, A., Panniello, U. & Garavelli, A., 2019. Ardito, L., Petruzzelli, A.M., Panniello, U. and Garavelli, A.C., 2018. Towards Industry 4.0: Mapping digital technologies for supply chain management-marketing integration. *Business Process Management Journal*, 25(2), pp. 323-346.

AUC, 2014. *Agenda 2063: The Africa We Want,* Addis Ababa, Ethiopia: African Union Commission.

AUC, 2015. *Agenda 2063: The Africa We Want in 2063.,* Addis Ababa. Ethiopia: African Union Commission.

AUC, AfDB & ECA, 2019. *Africa Regional Integration Index Report 2019,* Addis Ababa, Ethiopia, Abidjan, Côte d'Ivoire, and Addis Ababa, Ethiopia: African Union Commission, African Development Bank, and Economic Commission for Africa.

AUC & OECD, 2022. *Africa's Development Dynamics 2022: Regional Value Chains for a Sustainable Recovery,* Addis Ababa, Ethiopia and Paris, France: Africa Union Commission and OECD Publishing.

Baldé, C. et al., 2017. *The Global E-waste Monitor 2017,* Bonn/Geneva/Vienna: United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA).

Balogun, A. et al., 2020. Assessing the potentials of digitalization as a tool for climate change adaptation and sustainable development in urban centres. *Sustainable Cities and Society,* Volume 53, p. 101888.

Banga, K. & te Velde, D., 2018. *How to grow manufacturing and create jobs in a digital economy: 10 policy priorities for Kenya. Report,* London, UK: Overseas Development Institute.

Baxter, D., 2020. *Africa must embrace digital infrastructure governance. PPPs can help.* [Online] Available at: https://blogs.worldbank.org/ppps/africa-must-embrace-digital-infrastructure-governance-ppps-can-help
[Accessed 12 September 2022].

Beier, G. et al., 2020. Industry 4.0: How it is defined from a sociotechnical perspective and how much sustainability it includes–A literature review. *Journal of Cleaner Production,* Volume 259, p. 20856.

Bradu, P. et al., 2022. Recent advances in green technology and Industrial Revolution 4.0 for a sustainable future. *Environmental Science and Pollution Research,* pp. 1-32.

Bullis, K., 2014. A Plan B for Climate Agreements. *MIT Technology Review,* 117(4), p. 84–86.

Calderon, C. & Cantu, C., 2021. *The Impact of Digital Infrastructure on African Development. Policy Research Working Paper 9853,* Washington DC, USA: World Bank.

Ceipek, R. et al., 2021. A motivation and ability perspective on engagement in emerging digital technologies: The case of Internet of Things solutions. *Long Range Planning,* 54(5), p. 101991.

COMESA, 2015. *COMESA Industrialisation Policy 2015-2030,* Lusaka, Zambia: Common Market for Eastern and Southern Africa.

COMESA, 2017. *COMESA Industrialization Strategy 2017-2026,* Lusaka, Zambia: Common Market for Eastern and Southern Africa.

COMESA, 2021. *COMESA Medium Term Strategic Plan 2021-2025,* Lusaka, Zambia: Common Market for Eastern and Southern Africa.

Coroamă, V. & Mattern, F., 2019. *Digital rebound–why digitalization will not redeem us our environmental sins. In Proceedings 6th international conference on ICT for sustainability,* Lappeenranta: s.n.

Correani, A. et al., 2020. Implementing a digital strategy: Learning from the experience of three digital transformation projects. *California Management Review,* 62(4), pp. 37-56.

Dhir, A. et al., 2021. Behavioral reasoning theory (BRT) perspectives on E-waste recycling and management. *Journal of Cleaner Production, 280, p.124269.,* Volume 280, p. 124269.

Dogaru, L., 2020. The main goals of the fourth industrial revolution. renewable energy perspectives. *Procedia Manufacturing,* Volume 46, pp. 397-401.

ECA, 2015. *Inclusive green economy policies and structural transformation in Ethiopia,* Addis Ababa, Ethiopia: Economic Commission for Africa.

ECA, 2016. *Economic Report on Africa: Greening Africa's Industrialisation,* Addis Ababa, Ethiopia: Economic Commission for Africa.

ECA, 2016. *Greening Africa's Industrialization: Economic Report on ,* Addis Ababa, Ethiopia : United Nations Economic Commission for Africa.

ECA, 2020. *Political Economy of a Green Economy Transition in Africa,* Addis Ababa, Ethiopia: Economic Commission for Africa.

Frank, A., Dalenogare, L. & Ayala, N., 2019. Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics,* Volume 210, pp. 15-26.

GoN, 2022. *Traction, Namibia's Green Hydrogen Overview,* Windhoek, Namibia: Government of Namibia.

Google & IFC, 2020. *e-Conomy Africa 2020 Africa's $180 billion Internet economy future,* Washington DC, USA: World Bank.

Hallward-Driemeier, M. & Nayyar, G., 2017. *Trouble in the making?: The future of manufacturing-led development.* Washington DC, USA: World Bank.

Han, Y., Geng, Z. & Zhu, Q., 2016. Energy optimization and prediction of complex petrochemical industries using an improved artificial neural network approach integrating data envelopment analysis. *Energy Conversion and Management,* Volume 124, pp. 73-83.

Hawash, R. & Lang, G., 2020. Does the digital gap matter? Estimating the impact of ICT on productivity in developing countries. *Eurasian Economic Review,* 10(2), pp. 189-209.

Hazen, B., Skipper, J., Ezell, J. & Boone, C., 2016. Big data and predictive analytics for supply chain sustainability: A theory-driven research agenda. *Computers & Industrial Engineering,* Volume 101, pp. 592-598.

Hossein, M., Mohammadrezaei, M., Hunt, J. & Zakeri, B., 2020. Internet of Things (IoT) and the energy sector. *Energies,* 13(2), p. 494.

IEA, 2021. *World Energy Outlook 2021,* Paris, France: International Energy Agency.

IEA, 2021. *Energy Technology Perspectives 2020,* Paris, France: International Energy Agency.

ILO, 2016. *Green Jobs Report 2014-2015,* Geneva, Switzerland: International Labour Organization.

IPCC, 2021. Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva, Switzerland: Intergovernmental Panel on Climate Change.

IRENA, 2019. *A New World: The Geopolitics of the Energy Transformation.* [Online] Available at: https://irena.org/publications/2019/Jan/A-New-World-The-Geopolitics-of-the-Energy-Transformation
[Accessed 11 September 2022].

ITU, 2019. *Economic contribution of broadband, digitization and ICT regulation Econometric modelling for Africa. Regional initiatives,* Geneva, Switzerland: International Telecommunication Union.

Kagermann, H., 2015. Change Through Digitization—Value Creation in the Age of Industry 4.0. In: H. Albach, H. Meffert, A. Pinkwart & R. Reichwald, eds. *Management of Permanent Change.* Wiesbaden: Springer Gabler, pp. 23-45.

Katz, R. & Callorda, F., 2018. *Economic Contribution of Broadband, Digitization, and ICT Regulation,* Geneva, Switzerland: International Telecommunication Union.

Kunkel, S. & Matthess, M., 2020. Digital transformation and environmental sustainability in industry: Putting expectations in Asian and African policies into perspective. *Environmental Science & Policy,* Volume 112, pp. 318-329.

Kunkel, S. & Tyfield, D., 2021. Digitalisation, sustainable industrialisation and digital rebound–Asking the right questions for a strategic research agenda. *Energy Research & Social Science,* 82(102295).

Labrunie, M., 2019. *Digital Green Industrialisation: Reconciling Global Equality and Sustainable Development? ,* s.l.: s.n.

Liu, R. et al., 2019. *Impacts of the digital transformation on the environment and sustainability. Issue Paper under Task, 3,* Berlin, Germany: Institute for Applied Ecology.

Lopes, C. & te Velde, D., 2021. *Structural transformation, economic development and industrialization in post-Covid-19 Africa,* New York, NY, USA: Institute for New Economic Thinking.

Luken, R. & Clarence-Smith, E., 2019. *Green Industrialization in Sub-Saharan Africa: A Reference Guide for Policy Makers,* Vienna, Austria: United Nations Industrial Development Organization.

Matthess, M. & Kunkel, S., 2020. Structural change and digitalization in developing countries: Conceptually linking the two transformations. *Technology in Society,* Volume 63, p. 101428.

Mbungu, N. et al., 2020. An overview of renewable energy resources and grid integration for commercial building applications. *Journal of Energy Storage,* Volume 29, p. 101385.

Mondejar, M. et al., 2021. Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet. *Science of the Total Environment,* Volume 794, p. 148539.

Mulugetta, Y. & Urban, F., 2010. Deliberating on low carbon development. *Energy Policy,* 38(12), pp. 7546-7549.

Myovella, G., Karacuka, M. & Haucap, J., 2020. Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy,* 44(2), p. 101856.

NCPC-SA, 2020. *South African Industrial Energy Efficiency Project,* Pretoria, South Africa: National Cleaner Production Centre, South Africa.

Ndung'u, N., 2018. *Next steps for the digital revolution in Africa: Inclusive growth and job creation lessons from Kenya. Working Paper 20,* Washington DC, USA: Brookings Institution.

Ndung'u, N. & Signe, L., 2020. *The Fourth Industrial Revolution and digitization will transform Africa into a global powerhouse. Foresight Africa,* Washington, DC, USA: Brookings Institution.

Nnorom, I. & Osibanjo, O., 2008. Overview of electronic waste (e-waste) management practices and legislations, and their poor applications in the developing countries. *Resources, Conservation and Recycling,* 52(6), pp. 843-858.

Okereke, C. et al., 2019. Governing green industrialisation in Africa: Assessing key parameters for a sustainable socio-technical transition in the context of Ethiopia. *World Development,* Volume 115, pp. 279-290.

Panayiotou, G. et al., 2017. Preliminary assessment of waste heat potential in major European industries. *Energy Procedia,* Volume 123, pp. 335-345.

Plane, P., 2021. What factors drive transport and logistics costs in Africa?. *Journal of African Economies,* 30(4), pp. 370-388.

Ren, S. et al., 2019. A comprehensive review of big data analytics throughout product lifecycle to support sustainable smart manufacturing: A framework, challenges and future research directions. *Journal of Cleaner Production,* Volume 210, pp. 1343-1365.

Reveron, D. & Savage, J., 2020. Cybersecurity convergence: Digital human and national security. *Orbis,* 64(4), pp. 555-570.

Rodriguez, C. et al., 2019. *A new banking model for Africa: Lessons on digitization from four years of operations (No. 137298, pp. 1-47),* Washington DC, USA: World Bank.

Sachs, J. et al., 2019. Six transformations to achieve the sustainable development goals. *Nature sustainability,* 2(9), pp. 805-814.

SADC, 2012b. *Regional Infrastructure Development Master Plan. Transport Sector Plan,* Gaborone, Botswana: Southern African Development Community.

SADC, 2013. *SADC Industrial Development Policy Framework,* Gaborone, Botswana: Southern African Development Community.

SADC, 2014. *Southern African Development Community (SADC) Declaration on Regional Infrastructure Development,* Gaborone, Botswana: Southern African Development Community .

SADC, 2015. *Regional Green Economy Strategy and Action Plan for Sustainable Development,* Gaborone, Botswana: Southern African Development Community.

SADC, 2019. *Status of Integration in the Southern African Development Community (SADC),* Gaborone, Botswana: Southern African Development Community.

SAPP, 2021. *Southern African Power Pool Annual Report,* Harare, Zimbabwe: Southern African Power Pool.

Taylor, P., d'Ortigue, O., Francoeur, M. & Trudeau, N., 2010. Final energy use in IEA countries: The role of energy efficiency. *Energy Policy,* 38(11), pp. 6463-6474.

Tralac, 2022a. *Trade in the Digital Economy: A tralac guide,* Stellenbosch, South Africa: Tralac.

Tschirley, D. et al., 2015. Africa's unfolding diet transformation: implications for agrifood system employment. *Journal of Agribusiness in Developing and Emerging Economies,* 5(2), p. 102-136.

UNCTAD, 2021. *Green industrial policies key for developing countries to adapt to climate change.* [Online]
Available at: https://unctad.org/news/green-industrial-policies-key-developing-countries-adapt-climate-change
[Accessed 11 September 2022].

UNEP, 2011. *Decoupling natural resource use and environmental impacts from economic growth. A report of the working group on decoupling to the International Resource Panel,* Nairobi, Kenya: United Nations Environment Programme.

UNEP, 2011. *Towards a green economy: Pathways to sustainable development and poverty eradication,* Nairobi, Kenya: United Nations Environment Programme.

UNEP, 2013. *Guidelines for National Waste Management Strategies - Moving from Challenges to Opportunities,* Nairobi, Kenya: United Nations Environment Programme.

UNIDO, 2019. *Industrial Development Report 2020. Industrializing in the Digital Era,* Vienna, Austria: United Nations Industrial Development Organization.

UNIDO, 2019. *Quality infrastructure for sustainable development,* Vienna, Austria: UNIDO, Department of Trade, Investment and Innovation.

UNIDO, 2020. *Industrialization as the driver of sustained prosperity,* Vienna, Austria: United Nations Industrial Development Organization.

UNIDO, 2020. *Industrialization as the driver of sustained prosperity,* Vienna. Austria: United Nations Industrial Development Organization.

UNIDO, 2022. *The Potential of Integrated Agro-Food Parks for Rural Industrialization and Economic Transformation in Developing Countries. Policy Brief,* Vienna, Austria: United Nations Industrial Development Organization.

Vincent, R., 2016. The internet and sustainable development: Communication dissemination and the digital divide. *Perspectives on Global Development and Technology,* 15(6), pp. 605-637.

Wakeford, J. et al., 2017. Innovation for green industrialisation: An empirical assessment of innovation in Ethiopia's cement, leather and textile sectors. *Journal of Cleaner Production,* Volume 166, pp. 503-511.

WEF, 2014. *African Strategic Infrastructure Initiative Managing Transnational Infrastructure Programmes in Africa – Challenges and Best Practices,* Geneva, Switzerland : World Economic Forum.

World Bank, 2022. *World Development Indicators,* Washington DC, USA: World Bank.

Zeufack, A. et al., 2021. *Africa's Pulse, No. 23, April 2021: An Analysis of Issues Shaping Africa's Economic Future,* Washington, DC, USA: World Bank.