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AFRICA'S DEVELOPMENT
IN THE AGE OF STRANDED ASSETS

Discussion Paper
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Content

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About UNU-INRA

The United Nations University Institute for Natural Resources in Africa (UNU-INRA) is one of the 15 research and training centres of the United Nations University (UNU) and is the only one focusing predominantly on Africa. We provide cutting-edge solutions and knowledge outlets for natural resource planning and management from an African perspective.

UNU-INRA serves as a platform to amplify African voices and showcase made-in-Africa solutions. We harness the incredible talent on the continent and also strengthen and develop capabilities by equipping African researchers, entrepreneurs and policy actors with the requisite knowledge to sustainably manage natural resources. We deliver research, capacity development and policy advice, and we convene spaces for knowledge sharing.

Our operating units across 5 countries in Africa (Senegal, Ivory Coast, Cameroon, Zambia and Namibia) give us on-the-ground knowledge, while our global network of experts and the wider UNU group give us a comparative advantage in the production and export of knowledge.

It is our vision for Africa to realise the transformational potential of natural resources in the context of sustainable development and deliver a prosperous, fair and resilient future.

We **know** | We **connect** | We **contest**

AFRICA'S DEVELOPMENT
IN THE AGE OF STRANDED ASSETS

Key messages

- Africa is at a crossroads. Governments are caught between two agendas: meeting their developmental needs using available natural resources and at the same time achieving climate action ambitions. At the intersection are stranded assets.
- Climate change is a known driver of asset stranding but awareness is low among African policymakers. Instead, governments are increasingly concerned with how to use extractive resources to drive economic growth and transformation.
- Stranded assets risks are playing out against the backdrop of Africa's difficult history with its extractive resources, in which many resource-rich African countries have achieved only poor development outcomes.
- Asset stranding brings both risks and opportunities. Managing the risks will be fundamental to sustaining vital government revenue from extractive resources.
- The opportunities presented by asset stranding include better resource planning, developing regional markets and catalysing research and development in the natural resource space.
- Unlocking these developmental opportunities will require good governance and effective institutions to drive a common goal: utilising extractive resources to build competitive value addition and manufacturing processes.
- African countries have the right to use the resources at their disposal to support development: this includes investing in adequate infrastructure and tackling the continent's energy poverty. In this regard, natural resource endowments are matters of national sovereignty and African countries urgently need to exercise greater agency in exploiting these resources to fulfil their unmet development needs.
- Most African countries lack the resources and capacities to simply switch to cleaner fuels and technologies in the near future. Hence, the continent may require a delayed transition.
- Major polluters like China and the US are shirking their responsibilities to mitigate carbon emissions. Meanwhile, Africa is responsible for less than 5% of emissions but bears the impacts of climate change. African governments must negotiate to use the resources at their disposal to accelerate socioeconomic transformation while at the same time pursuing low-carbon development.

Introduction

There is a growing global sense of urgency to act on climate change. International climate policies and the advance of low-carbon technologies are already reducing the demand for – and value of – some fossil fuels. Substantial proportions of Africa's carbon wealth could become uneconomic to extract and process: a phenomenon we refer to as stranded assets. Yet recent research by the United Nations University Institute for Natural Resources in Africa (UNU-INRA) reveals that the risk of climate-related asset stranding is not on the African policy agenda.

Climate change may not be at the top of many African policymakers' lists of factors that will keep Africa's hydrocarbon resources in the ground, but it may indeed drive a new form of marginalisation for Africa if richer nations transition to viable substitutes to fossil fuels. In a region that has stood on the periphery of socio-economic development for centuries, Africa's evolving story of growth will suffer new setbacks if resource planning and effective governance are not factored into its natural resources risk mitigation strategy.

Africa's past, present and future is closely linked to the management of its natural resources. These resources – here we focus on hydrocarbons and other mineral resources – have not fulfilled their promise to bring shared prosperity. As the global appetite for hydrocarbons as the main fuel for growth diminishes, this paper asks whether urgent resource management planning – with foresight – can lead to effective strategies for Africa to leverage the stranded assets risks to its advantage and enable industrialisation and development without being left behind.

With population growth set to reach 2.3 billion by 2050, Africa will remain the youngest continent for the foreseeable future. Governments have to manage rapid urbanisation, climate change impacts and bring more people into the labour market. Resource planning with foresight could lead to an effective strategy for Africa to turn stranded assets to its advantage. The region can encourage greater intra-continental trade, especially with the advent of the African Continental Free Trade Area, decide on a phased approach to transition and utilise some of the proceeds of its rich resource base to enable industrialisation.

Africa stands at the frontline of climate change impacts. It is the region that will be the hardest hit and with the least ability to respond and insulate its economies against climate extremes and shocks. Africa is working toward implementing two agendas – the Agenda 2030 for sustainable development and the African Union's Agenda 2063. Both will require a strong commitment to keep climate change at bay and manage surface and underground resources for the benefit of the African people. That said, the question of equity and 'just transition' cannot remain hemmed into the folds. It is difficult to justify the position that developed nations, which have used up an inequitable slice of the global carbon budget and can now afford to turn to a new model of growth, ask those who have been sidelined to equally share the burden of reducing emissions. Yet, if we are to stay within safe levels of carbon emissions increases, fossil fuel reserves must be 'stranded'.

As African governments consider the best strategies for, and implications of, transition to a low-carbon economy – domestically and globally – a careful balance must be struck in each country between socioeconomic development and climate action. Policymakers are faced with a series of choices on when, what and how to transition away from fossil fuels. The diversity of countries and sectors at risk of asset stranding means there is no one-size-fits-all solution. Instead, governments will require bespoke policy options based on deep and specific contextual understanding.

This discussion paper recognises the difficult trade-offs that African policymakers must make; that many African countries, while keen to 'go green', might delay transition as they simply lack the prerequisites that will help them move away from fossil fuels. It points to new realities and norms that are changing carbon markets across the world and asks whether this might in fact be Africa's opportunity to design its own resource future that is aligned with its model of growth.

UNU-INRA's research on stranded assets foregrounds African voices and insights that are too often missing from the global conversation on resource management and climate change. This discussion paper is based on a review of publications, economic data, eight field case studies and other sources related to fossil fuel and mineral resources across Africa. A survey was conducted of key stakeholders in African ministries and national agencies, international and African-based private companies, research institutions, civil society and community-based organisations. The desk research was initiated in March 2019 and was followed by field visits to Angola, Ghana, Namibia, Niger, Nigeria, Tanzania, South Africa and Zambia, resulting in close to 100 consultations. In addition, to address the scarcity of data and statistical information related to stranded assets, an online stakeholder survey was carried out.

The discussion paper is a primer for a report that will explore, in more depth, whether African countries have a full understanding of the implications of asset stranding across the value chain. It serves as an alert, drawing attention to an issue that has been neglected or misunderstood on the continent and aiming to elevate it to a prominent policy matter.

We begin by outlining the threat that stranded assets pose to Africa's development, before grounding it in the global context of the transition towards renewable energy. We then explore factors that shape African responses to the stranded assets threat, including domestic energy poverty, issues of inequity relating to development and the extractives sector, and the risk that Africa could become 'locked in' and 'locked out' by an emerging global low-carbon economy. These risks are then examined at the country-level using the findings from our case study research, and explored in more detail through the case of Niger. Finally, we suggest that the stranded asset risk could instead unlock opportunities for greater economic development and diversification, proposing several options for further exploration.

While this paper may not induce a radically new orientation, it seeks to bring about a new consciousness and that may enable resource-rich countries to seize the opportunities that comes with resource planning for a changing climate.

What are stranded assets?

Stranded assets are assets that become devalued before the end of their economic lifetime or can no longer be monetised due to changes in policy and regulatory frameworks, market forces, societal or environmental conditions, disruptive innovation or security issues. Natural resource deposits are also commonly regarded as 'stranded' when the quantity and market value is below thresholds set by investors.

It is through this lens that we assess fossil fuel and mineral resource assets in Africa against the context of global carbon emissions reduction targets.

Assets typically considered at risk of stranding due to carbon emission reduction targets are fossil fuels such as coal, oil and gas.

Risks of stranded assets under the United Nations Framework Convention on Climate Change (UNFCCC)

Stranded assets fall under what the UNFCCC refers to as the implications of 'response measures' – a hotly contested set of issues in the negotiations.

Response measures are the actions that parties to the UNFCCC should undertake to reduce their greenhouse gas emissions. The economic and social consequences of these measures is one of the most controversial areas of the international climate change negotiations. The Convention recognises that countries should take into full consideration the specific needs and concerns of developing countries arising from both the adverse effects of climate change and the impact of response measures.

What has become known as the 'improved forum' on the impact of the response measures has been established under the UNFCCC. A synthesis report published by the UNFCCC Secretariat in late 2018 notes that, to date, the work of the improved forum 'has not sufficiently addressed the needs of developing country Parties related to the assessment and analysis of cross-border impacts of the response measures on other countries' domestic plans … and inclusive growth.'

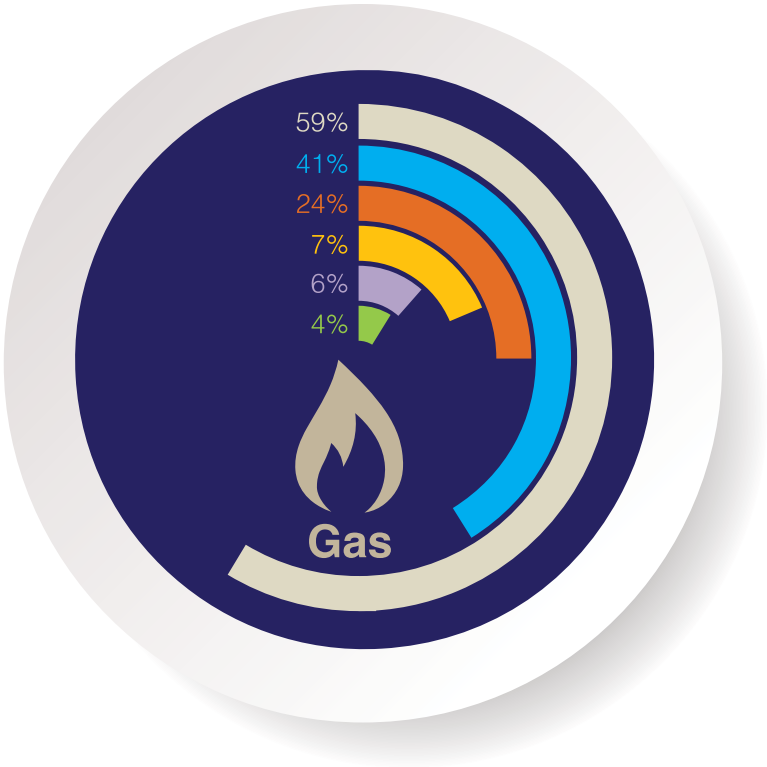
The report also recognises that many developing countries, especially African countries, do not participate in the response measures work programme effectively as they lack information, experience and case studies on the impacts of the implementation of response measures. Some UNFCCC parties have proposed focusing on economic transformation and the socioeconomic impacts of divestment and stranded assets on developing countries, particularly those in Africa.

Threats to Africa's development

Across the continent, natural resources – and hydrocarbons in particular – power African societies, drive industry and generate income. However, the growing risk of stranded assets presents a very real threat.

African countries are endowed with 7.3% of the world's gas reserves and 7.2% of the world's oil reserves (BP, 2019). Some 70% of African exports are derived from the oil, gas and mineral sectors, accounting for about half of Africa's gross domestic product (GDP), as well as contributing significantly to government revenues. In sub-Saharan Africa it is estimated that recoverable energy resources include 115.34 billion barrels of oil and 21.05 trillion cubic feet of gas. New oil and gas discoveries are being made in Mozambique, South Sudan and Ethiopia; the Ogaden Basin alone contains 8 trillion cubic feet of natural gas reserves – worth a potential $7 billion a year once at full capacity. Between 2000 and 2012, expansion of the mineral extractive sector increased foreign direct investment into Africa from $10 billion to $50 billion (Halland et al., 2015).

Share of global gas discoveries
2011 — 2018



Source: Africa Energy Outlook 2019, IEA

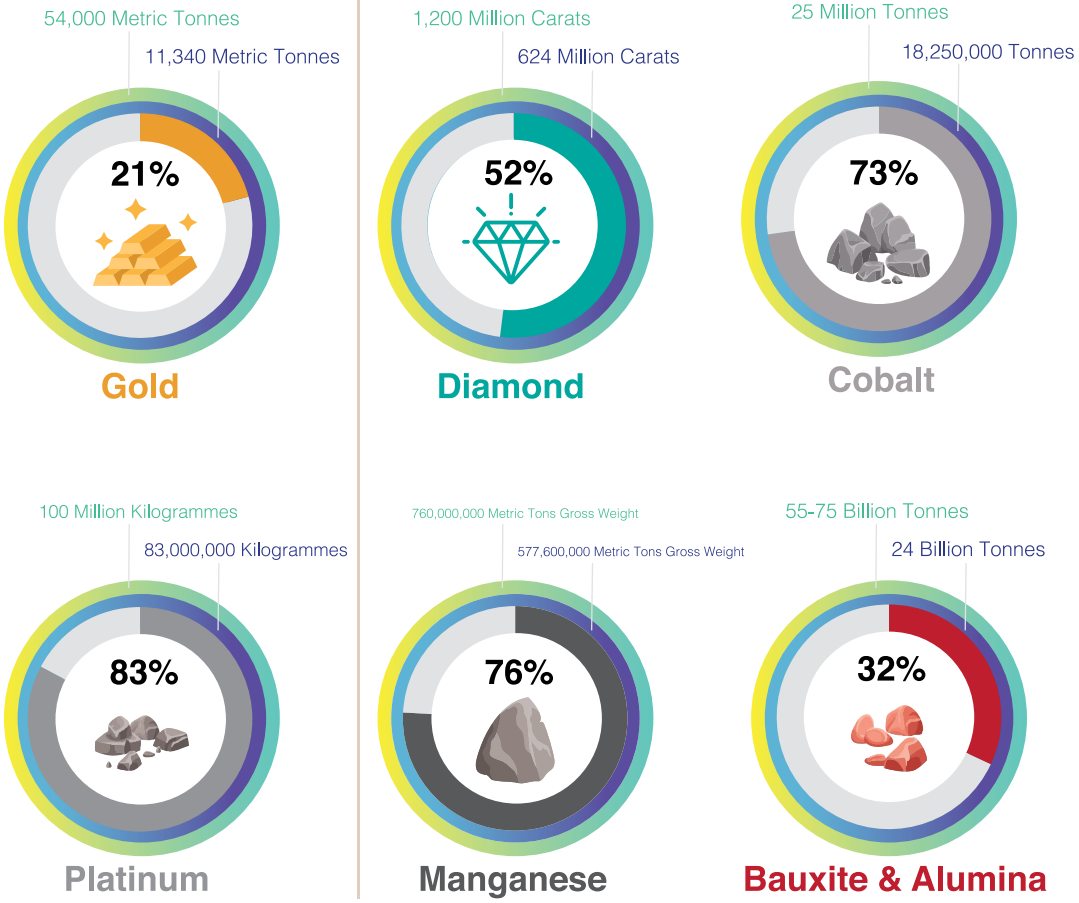
However, beneath the immense potential for economic development through the exploitation of these resources lies the risk that potential gains may be written off before they are enjoyed. Financial losses from stranded assets could amount to more than $2 trillion (Carbon Tracker Initiative, 2015). African governments, who depend hugely on revenue windfall from mineral resources, could be the losers. These revenue flows will be at best reduced and at worst cut.

Africa average net income from oil & natural gas from 2010-2018 was **$184 Billion**

Source: Africa Energy Outlook 2019, IEA

Extractive resource reserves and potential in Africa:

How critical are Africa's resources to the world?



KEY

- Global Value
- Value

Sources: US Geological Survey, 2019 and UNU-INRA, 2019

Carbon market risks (including the likelihood that fossil fuel prices will fall, making extraction unviable) are uncertain: predicting how much and how quickly the global climate regime will move towards regulation for greater greenhouse gas mitigation is difficult. Meanwhile, countries, including those in Africa, have domestic incentives to make the most of their fossil fuel assets before their value decreases – this is what we call the 'green paradox'.

Already civil society movements are pushing to divest from fossil fuels, influencing institutional investors, such as pension funds, to shift their portfolios towards clean energy investments (Carbon Tracker and Grantham Institute, 2013; Piggot, 2018). Such campaigns aim to burst the 'carbon bubble' by calling for ambitious climate policies that would in effect devalue fossil fuel reserves. In a significant recent move the European Investment Bank announced a moratorium on fossil fuel investments (EIB, 2019).

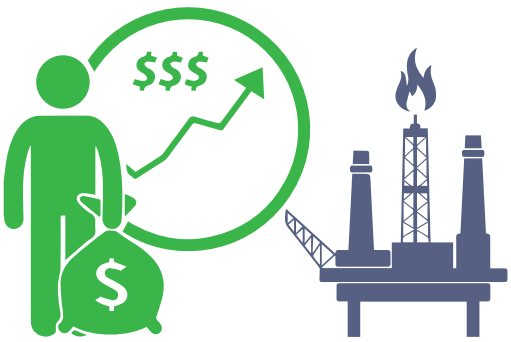
Box 1: Consumer pressure for cleaner and cheaper energy in South Africa

Private sector participation and consumer choices are markedly shaping the energy landscape. The phenomenon of consumer-driven electricity supply accounts in large part for the decreased energy demand on Eskom in South Africa. There is a growing preference among the middle class for off-grid electricity sources, such as solar PVs for retail shops and homes and gas-powered electricity for small-scale industry. The shift is further catalysed by renewables achieving highly competitive costs.

Research institutes, policy think tanks, civil society organisations, NGOs and workers' unions have been influential in expounding climate change mitigation through emissions reductions as well as the potential to alter South Africa's development trajectory to make it more pro-poor and structurally ready for a just transition. For example, social pressure and protest from institutions such as Centre for Environmental Rights and Federation for a Sustainable Environment have been instrumental in preventing shale gas exploration, halting the development of several new coal mines and ensuring proper rehabilitation and closure of existing mines.

Even fossil fuel groups are coming under growing investor pressure to address global warming. In 2017, Exxon company shareholders voted to push Exxon to disclose policies for tougher emissions reductions. In 2018, investors holding £28 billion in assets under management declared support for a shareholder resolution that would force Royal Dutch Shell to adopt tougher targets for reducing carbon emissions (Donovan, 2018).

Meanwhile, there were mixed signals at the September 2019 United Nations General Assembly 'climate summit'. Sixty-five countries plus the European Union (EU) committed to net-zero carbon emissions by 2050. Some nations pledged to stop coal-fuelled power station construction. Fifty-nine countries stated intentions to submit more ambitious Nationally Determined Contributions (NDCs) toward a sub-2°C Paris target. However, these did not include the major emitter countries of the US, China and India (The Economist, 2019).



Investment in fossil fuel exploration, extraction and delivery infrastructure could remain at about **$1 trillion** annually through 2040

Source: The Production Gap Report, 2019

The Principles for Responsible Investment group warns of abrupt and disruptive climate policies within five years. Private sector companies have announced greenhouse gas emissions reduction plans for their value chains and 650 companies have subscribed to the science-based targets initiative. This movement is set to grow: currently members account for 14% of global stock market value and 2% of private sector carbon emissions. Major fossil fuel companies involved in the Oil and Gas Climate Initiative plan to reduce methane emissions and to invest in carbon capture and sequestration. Yet, they still intend to develop new oil and gas extraction.

Despite the erratic pace of change, it seems inevitable that the global shift to renewable energy will eventually result in substantial decline in demand and value for fossil fuels, putting the potential wealth of many African nations at risk (Cust et al., 2017; Bradley et al., 2018). Rapid advances in renewable energy technologies are reducing demand for and increasing cost disadvantage of fossil fuels (IRENA, 2015). Adoption of renewables is accelerating such that 30–75% coverage is expected by 2050, while in some regions the figures will exceed 90% (GEA, 2012; UNU-WIDER, 2018).

The bridging role of gas-fired power plants (which emit less CO_2 per unit of energy produced than coal-fired plants) in the transition to a carbon-free future has been challenged (McJeon et al., 2014). Experts argue that increased supplies of natural gas only delay decarbonisation of the global energy system (Davis and Shearer, 2014). However, with its huge development and energy needs as well as significant gas reserves, can Africa afford to change its development model away from fossils fuels overnight?

The African countries beginning to unlock the potential of their natural gas reserves to boost power supply and economic growth, such as Angola, Ghana, Mozambique, Nigeria, Republic of Congo and Tanzania, need to factor in stranded asset risks. African governments that continue unabated investment in fossil fuel assets could face massive economic losses, just as Angola experienced after the 2014 global oil price decline (World Bank, 2015). New and stronger global climate policies will exacerbate the situation.

Businesses reliant on Africa's high-value minerals also face reduced profitability, compounding the stranded asset effects. In Angola, the oil and banking sectors are closely linked. The Angolan government controls three banks that hold an equivalent of 11% of total assets, and Sonangol, the state-owned oil company, holds minority stakes in seven banks (IMF, 2018). The sharp decline in oil prices from mid-2014 heavily impacted Angola's banking system, which comprises 90% of the country's financial sector. This resulted in foreign currency shortages and imbalances in the foreign exchange markets, leading to depreciation of the local currency. To anchor inflation and offset the impact of the exchange rate devaluation, the Banco Nacional de Angola (BNA) adopted a restrictive monetary policy.

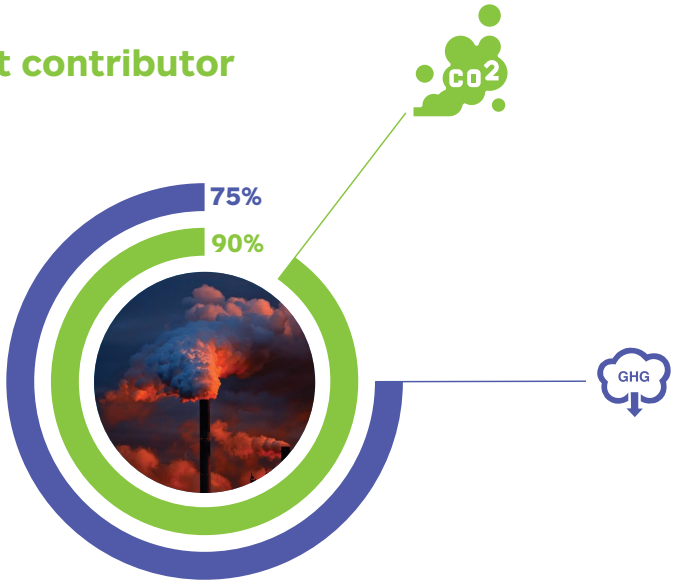
Meanwhile the profitability of high-value minerals is challenged. Gold, uranium, chromium, calcium carbide and platinum production face high labour costs, stringent unions, electricity and water shortages, and changes in environmental protection legislation. In addition, lower-grade, deeper mines result in more costly operations (Global Business Reports, 2016). Platinum, which is used in smartphones and solar panels and more than 75% of which is found in South Africa, has also suffered a dramatic decline in production resulting in more than 23,000 job losses (Global Business Reports, 2016).

Fossil fuels are the largest contributor to climate change

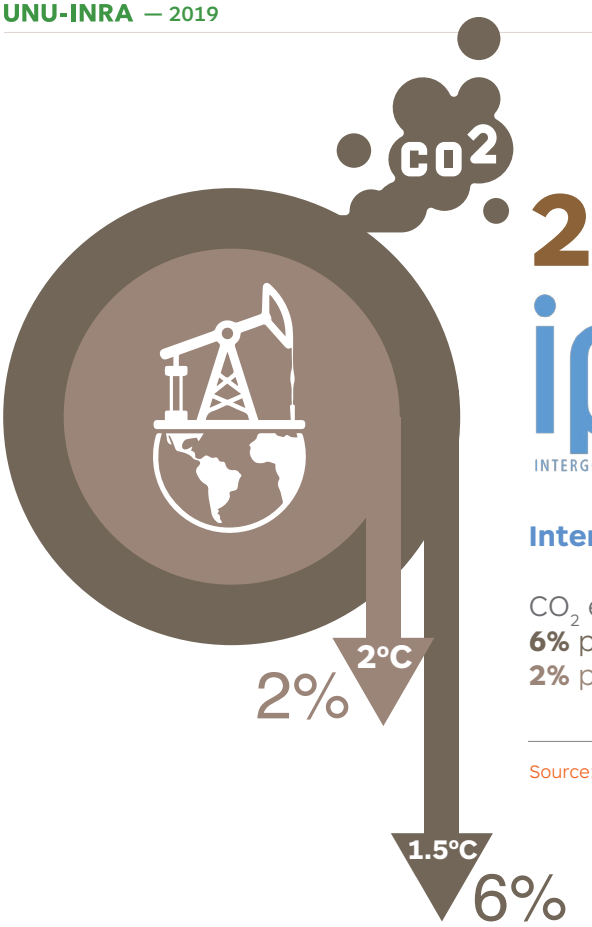
Over **75%** of global GHG emissions
90% of all carbon dioxide (CO_2) emissions

KEY

- Global GHG emissions
- Carbon Dioxide (CO_2) emissions



Source: World Poverty by World Data Lab 2019



2018

ipcc

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Intergovernmental Panel on Climate Change (IPCC)

CO_2 emissions from fossil fuels will need to decline by:
6% per year to remain on a **1.5°C**
2% per year to remain on a **2°C**

Source: The Production Gap Report, 2019

Global shifts and climate change

Global markets are also beginning to shift towards renewable energy alternatives. Carbon Tracker (2018) estimates that by 2030 new wind and solar energy will be cheaper than 96% of existing coal power, and that 42% of global coal capacity is currently unprofitable. Countries could therefore save several billions of dollars by moving to clean energy sources in line with the Paris Agreement targets. This will leave infrastructure geared towards the use of fossil fuels stranded, while the costs of new infrastructure will need to be met from national budgets.

Some industrialised countries like France are managing a low-carbon transition by out-sourcing production to other parts of the world, so while greenhouse gas emissions are falling in some parts of the global North, they are rising in emerging economies. Last year, the French oil and gas company Total, along with the government of Angola, inaugurated the Kaombo project, which is set to produce 230,000 barrels per day. Total, which holds a 30% stake, will operate the Kaombo's reserves, estimated at 658 million barrels (Total, n.d.).

Aid and trade agencies based in the global North support the transfer of carbon-intensive technologies to developing countries (see Burrows, 2018; Hermann, 2018). This may increase energy access in the global South, but it ameliorates the costs of stranded assets (technologies, knowledge, labour) in the global North while passing the burden of climate change mitigation onto developing countries and increasing their risk of carbon lock-in (Tienhaara, 2017).

An additional element in the political economy of how to manage or avoid stranded assets is the little understood risk of developing countries becoming liable to pay compensation to private sector fossil fuel companies under investor law. The legally binding Energy Charter Treaty applies to UN Economic Commission for Europe (ECE) countries and supports investor confidence in part with mechanisms for investor–state dispute settlement (ISDS). It is perhaps not surprising, then, that two-thirds of claims settled so far were found in favour of the foreign investor (Bos and Gupta, 2019).

African responses to stranded asset risks

9 out of **10** countries in sub-Saharan Africa depend on commodities (including fossil fuels and minerals) for growth and revenues.

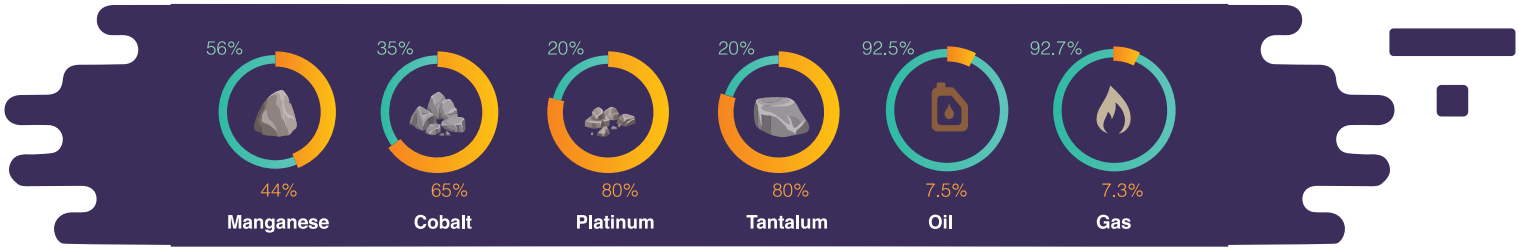
The stranded assets phenomenon is insufficiently researched from the perspective of developing regions such as Africa. Delaying the assessment of the range of risks associated with asset stranding will increase the costs of remedial action – something that African countries can ill afford. Yet the stakeholder survey and case study investigation by UNU-INRA indicate that, in many African countries, policymakers either are insufficiently aware or underestimate the risk of stranding to resources and assets.

An important question, therefore, is how serious a problem are stranded assets for Africa, and to what degree does the phenomenon pose a risk to the achievement of the Sustainable Development Goals (SDGs), the African Union's Agenda 2063 and equitable economic growth and prosperity?

To achieve the targets of the Paris Agreement on climate change, integrated assessment models estimate that Africa must forego burning 90% of known reserves of coal, 34% of gas and 26% of oil (McGlade and Ekins, 2015). But Africa's economic growth trajectory is, to a great extent, dependent on these resources. In fact, nine out of 10 countries in sub-Saharan Africa depend on commodities (including fossil fuels and minerals) for growth and revenues (UNCTAD, 2019). Meanwhile, resource exploitation has historically served foreign and elite interests. Many resource-rich countries in Africa have still not been able to capitalise on resource rents in ways that will serve broader sustainable development. Africa's resources have been 'stranded' in a sense from the colonial period onward, as the real value of resource wealth has not brought prosperity to the wider populations of Africa.

Carbon Tracker estimates that 60–80 % of the coal, oil and gas reserves of publicly listed companies could be classified 'unburnable' if the world is to avoid disastrous climate change (Carbon Tracker, 2013). What would this mean for African countries such as Nigeria, where petroleum and petroleum products account for 90% of export earnings and more than 70% of total government revenues (Export.gov, 2019); or Tanzania, whose newly discovered gas reserves could accelerate electrification for the next generation of Tanzanians and their neighbours?

Africa's share of global minerals production 2018

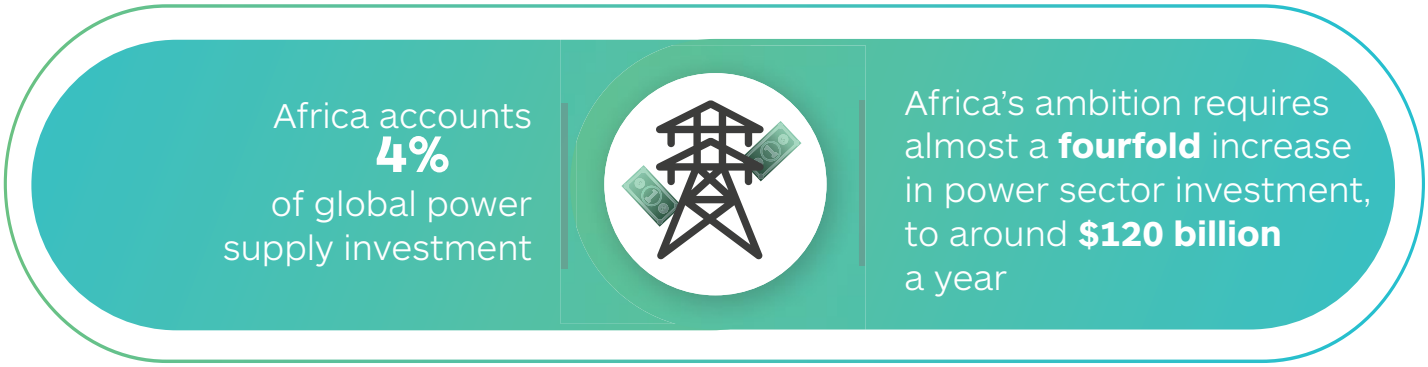


Source: Africa Energy Outlook 2019, IEA

Powering Africa

Africa is energy-rich. Its solar, wind, hydro, and geothermal power resources offer the region a remarkable opportunity to build low-carbon energy systems for all. Yet around 600 million Africans – or two-thirds of the continent's population – still live without access to electricity (IEA, 2019).

Africa needs adequate and reliable electricity to power its quest for industrialisation, and some African countries still depend on fossil fuel for that electricity. In 2014, 80.5% of the continent's installed power generation capacity was comprised of thermal fuels – mostly oil, coal and natural gas – and a fifth of the remainder was hydro (Patel, 2019). By 2030, Africa's total net electricity generation is expected to be between 1,800 TWh and 2,200 TWh, a threefold increase from 650 TWh in 2010. To achieve this will require investment of $420–800 billion, but the stranding of fossil fuel assets could mean foregoing some choices of fuel (Miketa and Nawfal, 2015).



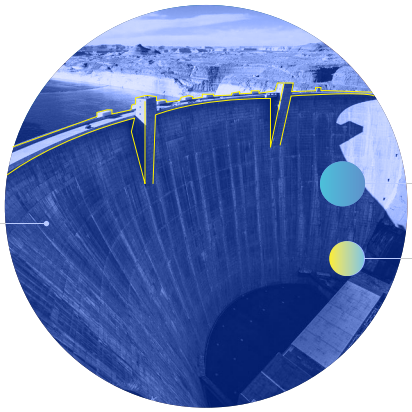
Source: Africa Energy Outlook 2019, IEA

Access to electricity is an important indicator of how the power sector supports national development. Africa's household electrification rate is the lowest in the world, averaging just 45% in 2018 (IEA, 2019). It is home to a fifth of the world's population, yet it accounts for only 6% of global energy demand and little more than 3% of electricity demand (IEA, 2019). Between 2010 and 2018, Africa's total installed generation capacity increased from 155 GW to almost 245 GW. This is just about a quarter of the capacity in EU countries.

Sub-Saharan Africa's
electrification rate of **45%** in 2018

Source: Africa Energy Outlook 2019, IEA

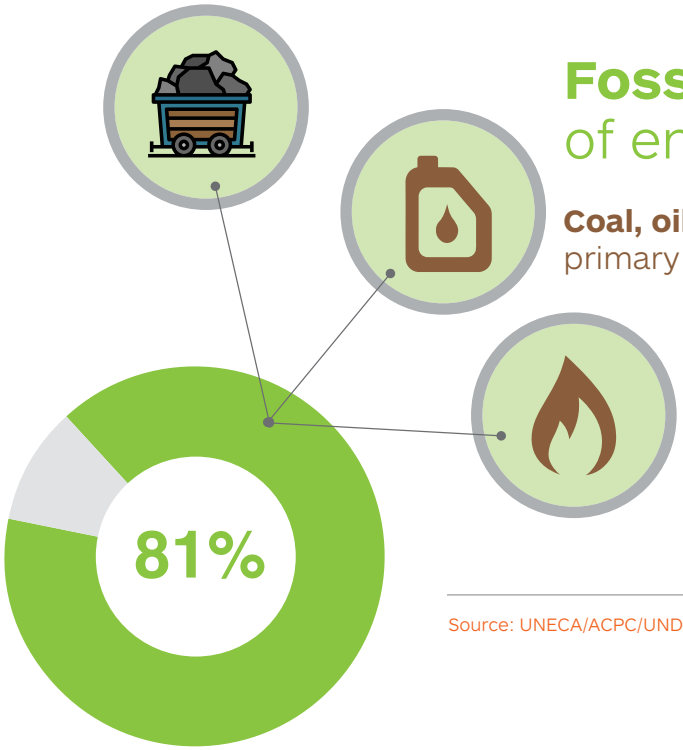
Hydropower capacity added in 2018



Source: Renewables 2019 global status report (REN21)

In rural areas, where about 60% of Africans live, only one-quarter have access to electricity. In urban areas, three-quarters of the population have access (IEA, 2019). There are also huge disparities between nations: in some countries (including Niger, Chad, Central African Republic, Democratic Republic of Congo and South Sudan) more than 75% of the population is without electricity. In fact, only 14 countries in sub-Saharan Africa have electricity access rates exceeding 50% (Blimpo and Cosgrove-Davies, 2019).

A report by the World Bank concludes that utilities in the region operate at a major deficit (an average of $0.12/kWh), hampering their ability to provide consistent, universal energy access (Kojima and Trimble, 2016). Zambia, for example, was a net importer of energy from neighbouring countries such as Mozambique until 2018. Heavy debt burdens and devaluing currency have since inhibited the country's ability to import energy. The 2016/17 drought caused by El Niño Southern Oscillation (ENSO), which affected all of southern Africa, severely constrained Zambia's domestic power generation, of which 80% derives from hydro-electric dams. Large-scale and frequent load-shedding took place, affecting industry and consumers alike (AfDB, 2019b).



Fossil fuels - main source of energy in 2018

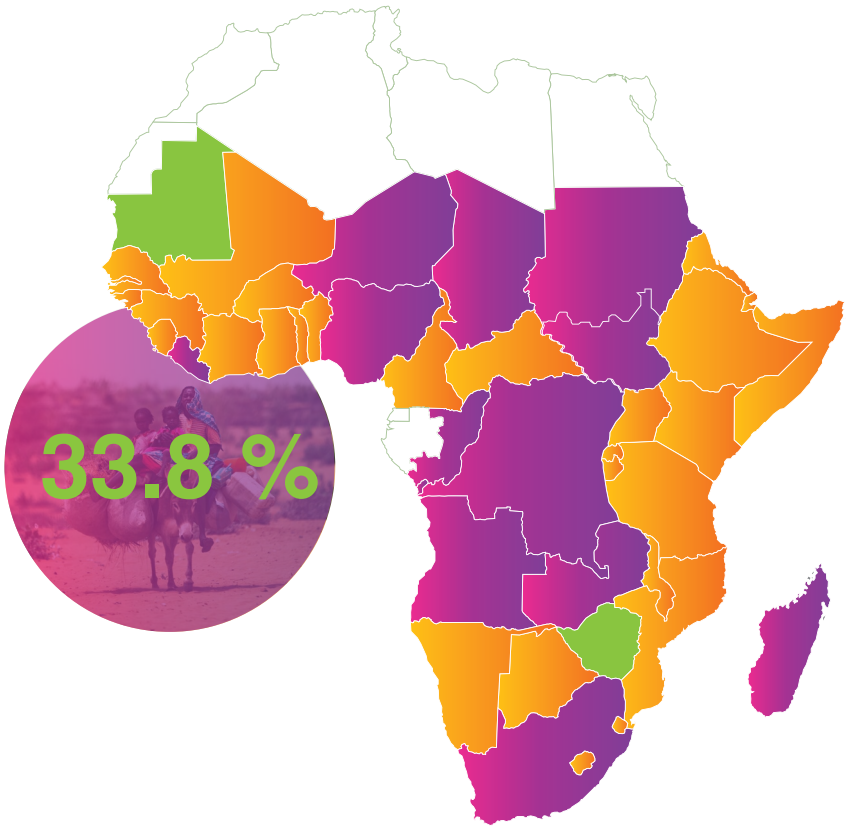
Coal, oil, and **natural gas** - **81%** of global total primary energy supply

Source: UNECA/ACPC/UNDP 2017

Inequities: legacies and possible futures

Risks of asset stranding are compounded by the fact that key development sectors, such as education and health, have still not benefitted adequately from the proceeds of resource extraction in many resource-rich African countries. Poor levels of domestic development investment are associated with the high proportion of foreign companies operating in the African oil and gas sector. Of the 500-plus oil and gas companies across Africa, only six are African owned (Matereke, K. 2015).

Africans living in extreme poverty
428,343,246 out of 1,265,749,065



Source: World Poverty by World Data Lab 2019

Of the 500-plus oil and gas companies across Africa, only six are African owned

In addition, many African countries have not been able to add value to the products of primary extraction, nor has the full export value been capitalised. For example, Angola's economy is overwhelmingly driven by its oil sector: in 2017, the sector contributed more than 30% of the country's GDP, 52% of fiscal revenue and more than 90% of exports (Muzima, 2018). Yet the country imports up to 80% of refined petroleum products for domestic consumption. Similarly, in Nigeria, crude oil production peaked in 2017 at 2.07 million barrels per day, but the total installed capacity of the local refineries was 446,000 barrels per day, with capacity utilisation at an abysmal 8.67%. The availability of petroleum products for the domestic market remains mainly dependent on imports.

Abundance of natural resources in those parts of the African continent lacking strong institutions, human capacity and effective governance has led to conflicts of interests in exploiting resource wealth. Large-scale exports of resources has led to appreciation of exchange rates to artificially high levels and this has slowed productivity in other sectors of the economy (NRGI, 2015).

Unemployment rates are rising, especially among the youth, and social inequality is increasing. Unemployment would increase further in the event of poorly managed asset stranding, creating 'stranded' jobs and communities. Nonetheless, 'just transition' pathways are emerging to emphasise high-employment options and energy distribution choices that can power local economies. For example, the renewable sector employed 11 million people worldwide at the end of 2018, with solar PV the highest employer: in India, an estimated 115,000 people were employed in grid-connected solar PV (REN21, 2019).

Africa's poor, especially those in the leading oil- and gas-exporting countries, have also suffered the environmental impacts of resource exploitation without receiving the benefits. Mining and other forms of resource exploitation are associated with waste contamination and pollution. The disposal of waste is often poorly regulated and exploration activities tend to involve huge ecological damages, loss of biodiversity and problems linked to contaminated water. The Niger Delta exemplifies this: ill-regulated operations, social tension and a sector dogged by corruption and under-valuation of resources have 'stranded' poor communities and excluded them from the wealth associated with resource rents.

Environmental impact of oil exploration in the Niger Delta region from **1976 - 2010**

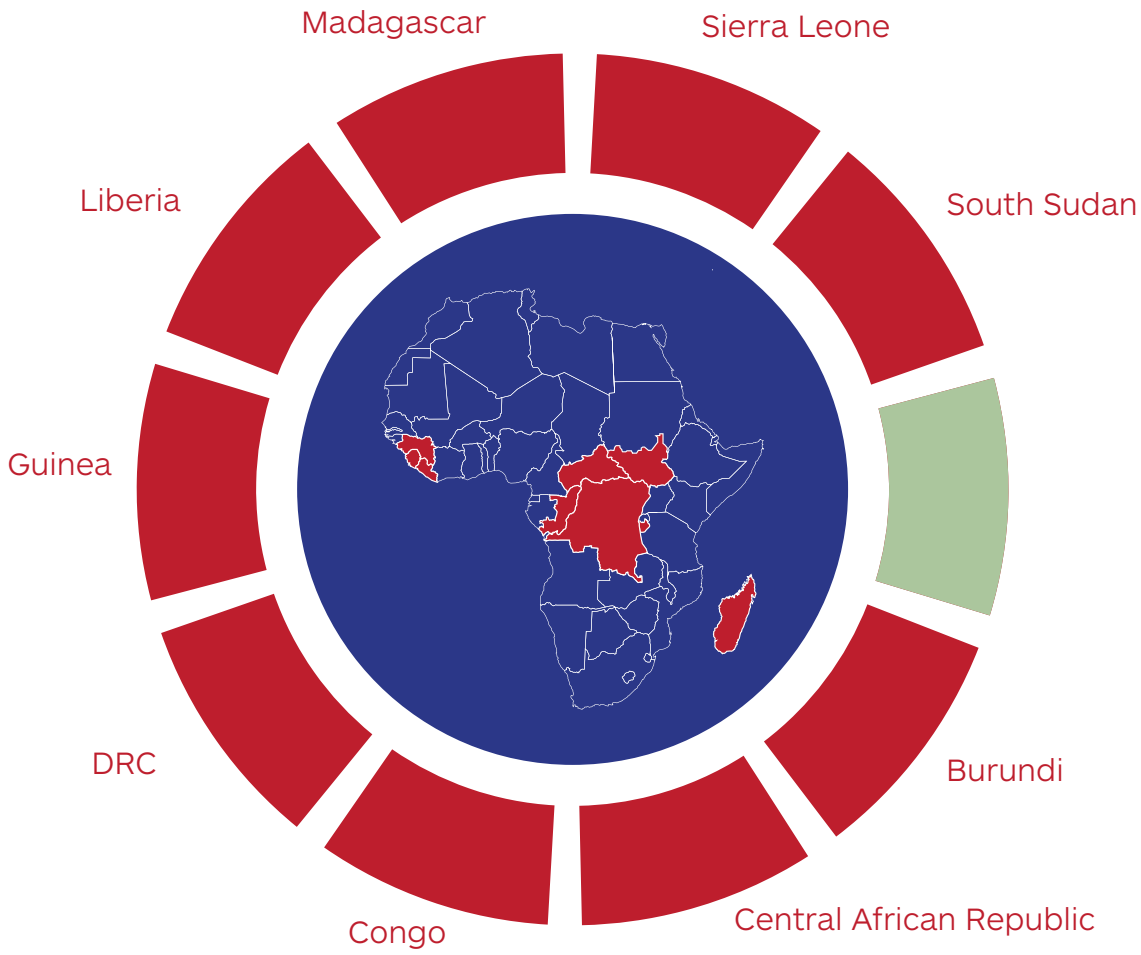
- 13,030 oil spills
- 3,257,362.44 barrels of oil discharged into the terrestrial, coastal and marine environment

Source: Chinweze , Abiola-Oloke and Jideani, 2012

The development options being taken by some African governments depend upon the continued extraction and use of mineral resources. There have been new discoveries of oil and gas and several African countries plan to increase their oil production. Choosing to strand assets in the context of widespread poverty is a risky political strategy. Dr John Kwakye, research director at the Institute of Economic Affairs (IEA) Ghana, says: '$12 trillion is underground and we are sitting on it. Whilst we are very poor above ground […] Ghana uses 46% of its national revenue to pay debt interest meaning that only half of revenue can finance development projects' (Cromwell, 2019).

Many respondents to the UNU-INRA survey echo this point, arguing that Africa cannot afford to leave its resources in the ground when rents can help to lift millions of people out of poverty and bring much-needed growth. The majority of stakeholder survey respondents believe that the real drivers of asset stranding are not climate change regulation but poor planning, ineffective governance and conflict and insecurity in fragile regions. On the other hand, given that the African population has never truly reaped the rewards of resource wealth – and with billions of dollars lost to capital flight and illicit financial flows – some of the respondents in the UNU-INRA stakeholder survey argue that stranding assets by choice could help to reverse the 'resource curse'.

9 out of 10 of the countries most vulnerable to climate change are in sub-Saharan Africa



Source: The Climate Vulnerability Index (CVI)/Time, 2019

$222 billion for climate resilience for NDCs

$377 billion for climate mitigation

Sub-Saharan Africa will require an estimated **$377 billion** in financing for climate mitigation investments and **$222 billion** for climate resilience investments in order to reach its NDCs.

Source: Climate Investment Funds 2017

Box 2: China in Africa

In order to boost infrastructure, economic growth, and global competitiveness, African countries have increasingly looked to China for support and Chinese development assistance to Africa has expanded rapidly in recent years, along with a growth in trade flows (MofCom, 2019).

Since the turn of the new millennium, China has disbursed more than $140 billion in loans to African nations (Sun, 2018) and an additional pledge of $60 billion was recently committed at the Forum on China–Africa Cooperation (FOCAC) in 2018. These loans have financed a slew of mega infrastructure projects across the continent. However, many believe this is contributing to Africa's increasingly unsustainable levels of indebtedness. Without improvements in debt servicing capacity, these loans will have negative implications for growth and debt sustainability.

The top African exporters to China in 2017 were resource-rich countries, namely South Africa, Angola, Zambia, Republic of Congo and the Democratic Republic of Congo. In 2011, African mining accounted for nearly 75% of China's total foreign mining investment and, in 2017, South African natural resources accounted for more than 85% of the country's exports to China (IIED, 2016).

Additional facts:

- In 2017, China and Guinea agreed to $20bn infrastructure loan in exchange for the development of bauxite, and aluminum ore projects (Samb, 2017).
- In 2018, China announced $14.7 billion investment in South Africa. As part of the agreement, Chinese banks lent a combined $2.8 billion to struggling South African state power utility Eskom and logistics company Transnet (MofCom, 2018).

Risks of being locked in, locked out and pushed out

South Africa generated $6.2 billion of export revenue from coal in 2018.

The impacts, if poorly managed, could be dire.

As the international climate movement gains momentum, it is likely that Africa will increasingly face asset stranding scenarios as divestment policies bite and the value of fossil fuel assets depreciates. The UNU-INRA case study research reveals that most African officials in the hydrocarbon sector have not given this matter sufficient attention. The exception is South Africa, where stakeholders in both the private and public sectors have a clear understanding of the concept of stranded assets. This awareness is demonstrated in the formulation of policy documents such as South Africa's 2010 Integrated Resource Plan (IRP), which was revised and gazetted in October 2019, and the Renewable Energy Independent Power Producer Procurement (REIPPP) programme that began in 2011.

Elsewhere on the continent, the absence of forward-thinking and planning in a sector so crucial to the development of many African countries is likely to have grave consequences. Declining costs of wind and solar energy generation are already dimming the prospects for struggling energy sources such as coal. Most coal-producing African countries are already closing mines. In South Africa, which generated $6.2 billion of export revenue from coal in 2018 (ranking second in extractives to platinum and ahead of gold), the impacts, if poorly managed, could be dire.

Whatever the rate of Africa's transition to a low-carbon economy, other countries will be looking towards new energy technologies. Africa risks being technologically 'locked out' – left without the relevant infrastructure and technologies to transition, and unable to change course. This prospect is particularly worrying given that Africa is already stuck in something of an energy 'time warp'.

Another troubling prospect is that, if Africa looks to bolster fossil fuel demand through intra-regional trading, it could cut itself off from other regions that are moving to new, cleaner energy generation. Worse still, Africa could be pushed out from the 'fourth industrial revolution' and become a dumping ground for old technologies and unwanted waste – a phenomenon already in play (Burrows, 2018; Hermann, 2018; Bos and Gupta, 2019).

Stranded asset impacts on economies

The concept of ‘stranded nations’ focuses attention on fossil fuel-rich developing countries (FFRDCs) that are most exposed to climate market risk. Several African countries are FFRDCs, and others have carbon wealth high enough to be significant to national development.

While these countries have domestic incentives to make the most of their fossil fuel assets before their value decreases, they must balance this with the risk of being overly reliant on an uncertain carbon market (see Box 3). The UNU-INRA survey results suggest that, across Africa, private sector companies are already taking measures based on their advanced knowledge of the issues – and that governments will have to follow their lead or risk being left behind (see Box 4).

Box 3: Oil revenue and public spending in Ghana and Angola

The dynamic relationship between oil revenue and public spending often means volatility in the oil market exposes countries to negative socioeconomic impacts.

Ghana
Ghana's Petroleum Revenue Management Act (PRMA) makes provision (section 21) for part of the revenue to be invested in diversification strategies. The priority areas, decided through public consultation, include agriculture, education, health, roads and sanitation. Through this provision, the government has rolled out a free senior high school (SHS) educational policy since September 2017. The free SHS policy aims to develop the country's human capital and encourage progress and prosperity. Since the roll-out of the policy, 400,000 students (out of a current SHS student population of 1.2 million), who would previously have been denied secondary education, have had access. Ghana's president describes supporting a free educational policy as the most 'equitable and transparent use of the oil revenue, instead of it finding its way into the pockets of politicians and bureaucrats'.

Angola
The global oil price collapse of 2014/15 caused fiscal revenues in Angola to decline from 0.7% of GDP in 2014 to less than 19.2% of GDP in 2017. As such, Angola adopted a contractionary fiscal policy, limiting investments in social sectors and infrastructure projects. For instance, the number of beneficiaries covered by social safety nets dropped from 421,000 in 2015 to less than 319,000 in 2017. Public subsidies were also reduced from 5.4% of GDP in 2014 to less than 0.9% of GDP in 2018, as the government gradually phased out fuel and energy price subsidies (Muzima, 2018).

Box 4: Zambia - Country/company divergence

There is a marked divergence in the approach to managing stranded assets risks by state actors and private sector investors. For the latter, the importance assigned to stranded assets risks is dependent on the lifespan of their licenses and concessions and the potential implications for profits within the short to medium term. Although private companies have higher extraction cost portfolios than state owned companies – following the trend of the coal industry – and are therefore more prone to financial stranding, their integrated corporate governance structure is better suited for mitigating the risks they face.

Conversely, for countries, the perception of and response to stranding is highly dependent on political dynamics, as seen in the 2017 decision of the US to pull out of the Paris Agreement on the grounds of national economic interest. Similarly, the respondents from key ministries in each of the case study countries for this paper held diverse opinions on the risk of stranding and response measures, while stressing that environmental treaties and commitments were often contracted by politicians without input from the technocrats who are responsible for the implementation process. This affects the level of compliance as very often the infrastructure and systems needed to ensure implementation are missing.

In the case of Zambia, fuel switch from coal to biomass is part of the renewable energy and energy efficiency programme for climate change mitigation in the NDC. Nonetheless, respondents from the Ministry of Mines were aware and tacitly supportive of planned expansion of coal production by private companies with concessions for about 25 years. Respondents from the Ministry of Finance, however, highlighted the potential of solar energy (more favourably priced than coal at 4:13).

Poor cross-sectoral coordination within public institutions inhibits effective response to stranding risks and could further expose national economies to the negative impacts of stranding. Meanwhile, national development energy demands strongly support the need for continued coal exploitation in the medium term, even though the future risk of coal being stranded is very real. Private sector investors in coal are encouraged by the medium-term status and strategise accordingly.

Risks at the country level: an overview

Here we summarise insights into stranded asset-related risks in some of the case study countries investigated for this research.

Angola

In 2018 Angola earned **$10.6 billion** in tax revenues from oil exports.

- Stranding will be significant and widespread for Angola, the second largest oil-producing country in sub-Saharan Africa. In 2018, the oil and gas industry accounted for more than 30% of the nation's GDP and more than 85% of exports.
- Existing oil and gas fields are seeing base declines, so Angola has begun several new oil projects to help maintain and boost current production levels. There is significant potential in untapped oil reserves in the Congo and Kwanza basins, mostly at deep and ultra-deep waters. The challenge is not only bringing fields online to offset declines but also the complexities associated with the high cost of deepwater projects and uncompetitive economic terms.
- Under the recent Angolanisation policy, international companies are required to employ at least 70% of their workforce from the local labour force. Additionally, the policy requires companies to source productive goods from local suppliers. This has promoted local employment, skills development and local industry. Stranding would therefore have serious adverse impacts at the micro-economic level.
- Stranding will also negatively affect the banking industry. International companies are required to make all transactions using local banks and the withdrawal of these companies due to stranding would in turn lead to huge losses in investments locally and potential collapses in the banking sector.
- Under the National Development Plan 2018–2022, revenues from oil and gas have been prioritised for social protection, supporting government programmes such as the universal child benefit for under-fives. As such, the impacts of stranding will be felt in these areas.

Ghana

Until recently, Ghana incurred up to **$40 million a month** as a result of a 'take or pay' agreement with ENI/Vitol.

- Both oil and gas are at risk of stranding. Ghana's economy suffered from the low oil prices on the international market between 2015 and 2016. Figures available from the Ministry of Finance show that petroleum revenue as a share of export revenue dropped from a high of 28.3% in 2014 to 18.7% in 2015 and then 12.2% in 2016 (Aryeetey and Ackah, 2018).
- Government revenue from oil and gas dropped from 11.6% in 2014 to 4.9% and 3.0% in 2015 and 2016 respectively. The country requested an International Monetary Fund facility in 2015, while cutting back on its capital budget by as much as 52.4% (Aryeetey and Ackah, 2018).
- A substantial portion of the country's natural gas reserves are already stranded, albeit temporarily, due to lack of domestic capacity for consumption.
- Until recently, the country incurred huge losses (up to $40 million a month) as a result of a 'take or pay' agreement with ENI/Vitol (Aklorbortu, 2018). Ghana entered the agreement because it was unable to develop its own infrastructure to offtake gas from the offshore Cape Three Points (OCTP) Sankofa field to thermal plants for electricity generation.
- Compounding this problem, Ghana had previously signed other gas supply agreements (e.g. with Nigeria), to the extent that the current gas supply exceeds the country's requirements.

Namibia

The mining industry also directly **employed** more than **16,000** people in 2018, and indirectly created more than **113,000 other jobs**.

- Namibia is Africa's fourth largest exporter of non-fuel minerals, contributing around half of all exports. The country is the world's fourth largest producer of uranium and is among the top 10 gem-quality diamond producers, mined both on land and offshore. It also mines copper, zinc, gold, magnesium, silver, lead, tin, lithium, cadmium, salt and vanadium.
- Mining contributed 14% to GDP in 2018, compared to 11.9% in 2017. The strong performance was a result of increased production of uranium and diamonds, which grew by 64.8% and 13.7% respectively.
- Mining generated $226 million in revenue in 2018, accounting for 54% of export earnings and 40% spent on goods and services from local supplies. Through these linkages the mining industry hugely influences local economic development, primarily in jobs, local supply chains and wealth creation. The mining industry also directly employed more than 16,000 people in 2018, and indirectly created more than 113,000 other jobs.
- Mining makes a sizeable contribution to the Namibian economy, generating around 7% of government income. In 2018, the sector paid $116 million in corporate taxes, $140 million in royalties and $15 million in export levies.
- Some asset stranding is already occurring:
  - Several uranium projects have been abandoned due to the decline in international commodity prices.
  - Some diamond mines are being abandoned because of water shortages
  - The African Tantalum mine is also facing significant reduction in production and retrenchment of 94 employees due to water shortages.

Nigeria

The oil sector contributed **9.14%** to Nigeria's total real **GDP** in quarter one of 2019, but oil revenue forms **52.7% of government revenue** in 2019.

- Nigeria is the world's 12th biggest producer of petroleum and has the largest natural gas reserves in Africa. Oil currently accounts for more than 95% of exports and foreign exchange earnings.
- The oil sector contributed 9.14% to Nigeria's total real GDP in quarter one of 2019, but oil revenue forms a disproportionately large chunk of government revenue: 52.7% in 2019. Moreover, the country's oil revenue has been subject to allegations of mismanagement and corruption.
- The drivers of stranding of oil and gas assets include poor refining capacity and widespread infrastructural deficit, inefficient logistics and transportation systems, insecurity in the Niger Delta and poor linkages of the upstream and downstream sectors.
- The constant steep decline in oil prices from around mid-2014 led to a recession in the national economy during the second half of 2016. Consequently, the growth rate of the economy rapidly declined from 6.3% in 2014 to -1.6% in 2016, before gradually rising to 1.2% in 2017.
- The recovery in the oil sector in 2017 was partly due to growing domestic demand for petroleum products and an improved security situation in the Niger Delta. Nonetheless, there was an average production deferment of 725,859 barrels per day and a total deferment of 264,938,662 barrels in 2017, mainly caused by pipeline vandalism and operational problems.
- The country has historically lost significant opportunities for earnings from associated gas flare. Within the Niger Delta region alone, there are more than 178 gas flare sites flaring around 1 billion scf of gas. This exceeds the quantity of gas applied in power generation and domestic industry.

South Africa

In 2018, 253 million tonnes of **coal** was produced, with **70% consumed domestically**. This amounted to total coal sales of $9.9 billion.

- South Africa is highly coal and energy intensive, with an economy characterised by extremely high levels of poverty and inequality.
- Coal currently accounts for 91% of electricity production by Eskom, the power utility company, and 25–30% of liquid fuels consumption through the conversion of coal-to-liquids (CTL) by Sasol (where coal is also an important input into the chemicals sector). In 2018, 253 million tonnes of coal was produced, with 70% consumed domestically. This amounted to total coal sales of $9.9 billion.
- The coal industry spent $4.1 billion procuring goods and services, most of it locally, thus contributing to jobs in other industries. The coal sector directly employed 86,647 people in 2018, representing about 19% of total employment in the mining sector.
- South Africa also produces more than 70% of the world's platinum. In 2018 it contributed $24 billion to GDP, $1.5 billion in taxes, $513 million in royalties and $6.3 billion to fixed investment.
- Mining employed 453,543 people in 2018, resulting in around 1.4 million indirect jobs and paying employees $8.6 billion.
- Awareness and understanding of stranded assets is high among key stakeholders in both the private and, unusually, the public sectors. This is reflected in the 2010 IRP, an electricity infrastructure development plan based on the least-cost electricity supply and demand balance that aims to minimise negative emissions and water use.
- Some coal mines have already become stranded and the risk of stranding will continue due to the falling international market price and lack of major investments by banks in coal projects. Big mining houses are divesting their coal assets thanks to the transition to renewables and off-grid feed-in tariffs.

Mining employed **453,543** people in 2018, resulting in around **1.4 million indirect jobs** and paying employees $8.6 billion.

- Two of the biggest mining companies, Anglo American and South32, are selling their South African coal mines rather than face divestment pressure from investors that would affect their overall holdings. BHP Billiton has signalled its intention to exit the thermal coal business; in 2018 Rio Tinto divested from large coal assets; and Glencore has agreed to cap its current coal production.
- Gold and platinum mining are also in decline as most of the mines have become inaccessible due to the current depth of the reserves and fluctuating market prices.
- Uranium mining has declined considerably following the Fukushima Daiichi nuclear disaster, with some mines such as Shiva Uranium (Pty) Ltd closing down. Shiva's shortfall for environmental rehabilitation is $2.5 million; the state will inherit these liabilities if the mine is finally liquidated.

Tanzania

- Tanzania does not have oil; its energy minerals are natural gas, coal and uranium. Natural gas reserves are currently 57 trillion cubic feet (tcf): 10 tcf onshore and 47 tcf offshore. So far, commercial production of natural gas takes place only in onshore basins.
- Tanzania also has 1.9 billion tonnes of coal reserves, 25% of which are proven (MEM, 2015).
- According to the Tanzania Electricity Supply Company (TANESCO), it is currently more expensive to produce electricity from coal than from gas; apart from a few cement companies that mine and use coal, the resource is not used. Consequently, companies cannot proceed with plans to invest in coal plants to sell electricity to TANESCO.
- Despite this, the government of Tanzania still plans to generate up to 400MW of electricity from the Kiwira coal mine and to develop the Mchuchuma and Katewaka mines to generate an additional 600MW (MEM, 2015a). Such investments could be at high risk of stranding.
- Uranium is also showing signs of stranding due to low demand on the international market and the high cost of utilisation.

Zambia

Climate change is contributing to the stranding of hydropower assets (due to lower rainfall) and coal has become an important alternative source of domestic energy.

- Zambia's economy has been driven by copper ever since large-scale copper mining started in 1908; in 2017 copper made up 79% of the country's total export value.
- Zambia also has a broad range of mineral resources including cobalt, uranium, coal, gold, emeralds, amethyst and industrial minerals (feldspars, silica sand, talc, barite, phosphate, limestone clays, dimension stone, graphite, gypsum, kyanite, asbestos and fluorite).
- Nonetheless, critical development sectors are grossly underfunded. According to the Centre for Trade Policy and Development, out of the total $5.9 billion budgeted for the 2019 fiscal year, 50.1% was allocated to the payment of emoluments, 40% to debt servicing and only 9.9% was available for social spending and economic development.
- Climate change and climate variability have become major threats to extractives and other key sectors of Zambia's national economy. Climate change is also contributing to the stranding of hydropower assets (due to lower rainfall) and coal has become an important alternative source of domestic energy, though it also faces stranding.
- Processing gold also requires lots of water, and consequently gold mining fields are being abandoned due to drought, forcing former miners to migrate in search of livelihoods.
- The country's NDC puts the climate change-related aggregated total GDP loss to key sectors of the economy in the range of $4.3–5.4 million.
- Non-fossil fuel resources such as copper, which is likely to remain in high demand and is used in renewable energy technologies, could still risk being stranded thanks to poor understanding of the quantity of the country's reserves. The available figures are informed by institutions or investors with a vested interest – and the resource is a wasting resource/non-renewable.
- In addition, the structure of the mining industry has made the country vulnerable to primary commodity prices, since the copper is mostly sold as cathodes or rod, which has very limited value addition.
- Uranium, produced in Zambia as a by-product of copper mining, is currently stranded due to safety concerns and a shift in consumer preference away from nuclear power.

Risks and opportunities: the case of Niger

Three-quarters of Niger is desert that contains huge deposits of natural resources. The country is the world's fourth largest producer of uranium and it produces significant amounts of oil and gold. Uranium and oil currently account for half of the country's total exports (World Bank, 2018).

Located in the heart of the Sahara Desert and spanning 30,000 square kilometers, the Agadem Rift Basin could be the field that will make Niger a major oil producer. This year, the Government of Niger and China National Petroleum Corporation (CNPC) signed an agreement to build a 1,980 kilometer-oil pipeline from the Agadem Rift Basin to the Atlantic coast in Benin. The $4.5 billion project, to be completed in three years, will see Niger produce up to 90,000 barrels of oil per day.

In Zinder, a refinery with a capacity of 20,000 barrels a day is being constructed, run by Soraz, a company 40% owned by the State of Niger and 60% by the Chinese. The refinery transforms crude oil into finished products for domestic consumption and for export to neighbouring countries.

These resources could be Niger's opportunity to transform its economy and improve the lives of its people. But despite such natural resource wealth, it is one of the world's poorest countries, ranking lowest of the 189 countries in the 2018 Human Development Index. The number of people living in poverty has increased from 6.8 million in 2005 to 8.2 million in 2014. Niger is experiencing a severe level of hunger, ranking 101 out of 117 in the 2019 Global Hunger Index.

And the dependence of Niger's economy on its natural resources puts the country at further risk. The extractive industry contributes 17% of state revenues, leaving the economy vulnerable to the volatile global commodities market. Low uranium prices in 2015 saw a sharp drop of 28% in extractive revenues to the Nigerien government, and uranium's contribution to GDP plummeted from 9.8% in 2012 to 3.5% in 2017.

The Niger-Benin crude oil pipeline to be completed in three years, will see Niger produce up to 90,000 barrels of oil per day.

An even bigger threat is the stranding of assets, already happening in Niger's extractive industry. In recent years, two uranium mines have been closed or suspended. The Société des mines d'Azelik (SOMINA), a joint venture between the Chinese company China National Nuclear Corporation (CNNC) and the Nigerien state, operated for only five years before being suspended due to fiscal management and production levels. Cominak mine, largely exploited by majority-French state-owned corporation Orano, will close in 2021, resulting in all jobs being lost (WISE, 2019). The cost of mining uranium and transporting it to the port in Benin is now too expensive to be viable given the low global price of uranium. This is effectively enforced stranding by a foreign company.
The trickle-down effect of resource stranding can already be seen in Niger's uranium and coal industries. In Niger, coal is mainly used as an energy source for uranium mining. When uranium is in decline or mines are closed due to unfavourable market conditions, the demand for coal decreases, leading to both coal and uranium stranding.

In the context of the global agenda on low-carbon development, can Niger therefore afford to build its economic revival on oil from the Agadem Rift Basin?
With its unrestrained dependence on extractive resources for exports and revenues coupled with its low level of development and looming climate and security threats, Niger is a prime example of why African countries must urgently address the issue of stranded assets. If this is not tackled, asset stranding will cause uranium mines in Agadez to close and oil from Agadem will cease to flow.

The plummeting prices of uranium and oil and the suspension of mines suggest that Niger – and other resource-rich African countries – must urgently diversify away from economic dependence on extractive resources, while developing a strong, resource-led value chain. These actions can provide shock absorbers against the dual threats of volatile commodity prices and stranded assets.

Niger faces another dual challenge of climate change and related conflict in the Sahel region. Climate-induced drought and desertification is damaging agriculture, which engages 80% of the country's workforce. Conflict, insecurity and terrorism – in part influenced by climate-related impacts – have been on the increase, too. And just as uranium in Agadez has fueled rebellion in the past, revenues accruing from Agadem could also cause tension.

In addition to the security context, low electrification rates are a key factor impeding economic development. In 2017, only 12% of the population had access to electricity, one of the rates in the world. Around 80% of its energy needs are imported from neighbouring Nigeria; load shedding and blackouts are common as this power supply is frequently interrupted. Niger, as stated in the National Strategy for Access to Electricity (SNAE), aims to achieve 80% access to electricity by 2035; according to the CEO of NIGELEC (La Société nigérienne d'électricité), this will require raising around $1.7 billion over the next 15 years (Alhassane, 2019).

As part of a drive for energy independence, the Niger goverment plans to build a coal-fired power plant that will produce 200 MW, using coal from the Salkadamna mine, which has an annual production capacity of 1.1 million tonnes and reserves estimated at 69 million tonnes (Niger Renaissant, n.d.). It could be the first in the country to supply local consumers – and it is difficult to see how the Nigerien government could resist, given the cost of importing energy from Nigeria against Niger's falling revenues thanks to the collapse in the uranium market.

Yet the growing evidence for asset stranding presents an opportunity for Niger's government to expand electricity access using the country's rich solar irradiation – the US National Aeronautics and Space Administration (NASA) has identified Niger as the sunniest place in the world, with average daily sunshine of 7 kWh/m2 (AfDB, 2019a). Investing in solar energy generation could allow Niger to expand electrification while limiting its greenhouse gas emissions and saving money: since 2012, the cost of generating PV solar has fallen 70% to $57 per MWh, while coal remains between $58 and $73 per MWh.

To achieve 80% access to electricity by 2035 will require Niger to raise around $1.7 billion over the next 15 years.

Unlocking Africa's opportunities

While the prospect of asset stranding poses risks to Africa, it also presents the continent with opportunities to reset development policy, particularly in the areas of land use, resource diversification and value chain development, renewable energy generation, better resource planning and management, and the potential to play a key role in the world's 'fourth industrial revolution'.

Stranding of assets is already happening. It cannot be reversed or prevented. African policymakers cannot delay in managing the risks associated with asset stranding: costs will escalate the longer strategies are not in place. Most mineral resource economists advocate early action and this is the route being taken by private interests already. The threat of asset stranding is an urgent call for the diversification that African countries have long wished for.

Policy options do exist. To develop these, African policymakers must consider the following:

- How to best reduce the level of exposure to carbon market risk.
- How to monetise carbon capital.
- How to diversify the economy away from high-carbon-risk components.
- How to avoid increasing climate market risk.

The UNU-INRA case study investigations identified some opportunities to be further explored by stakeholders; these are outlined below.

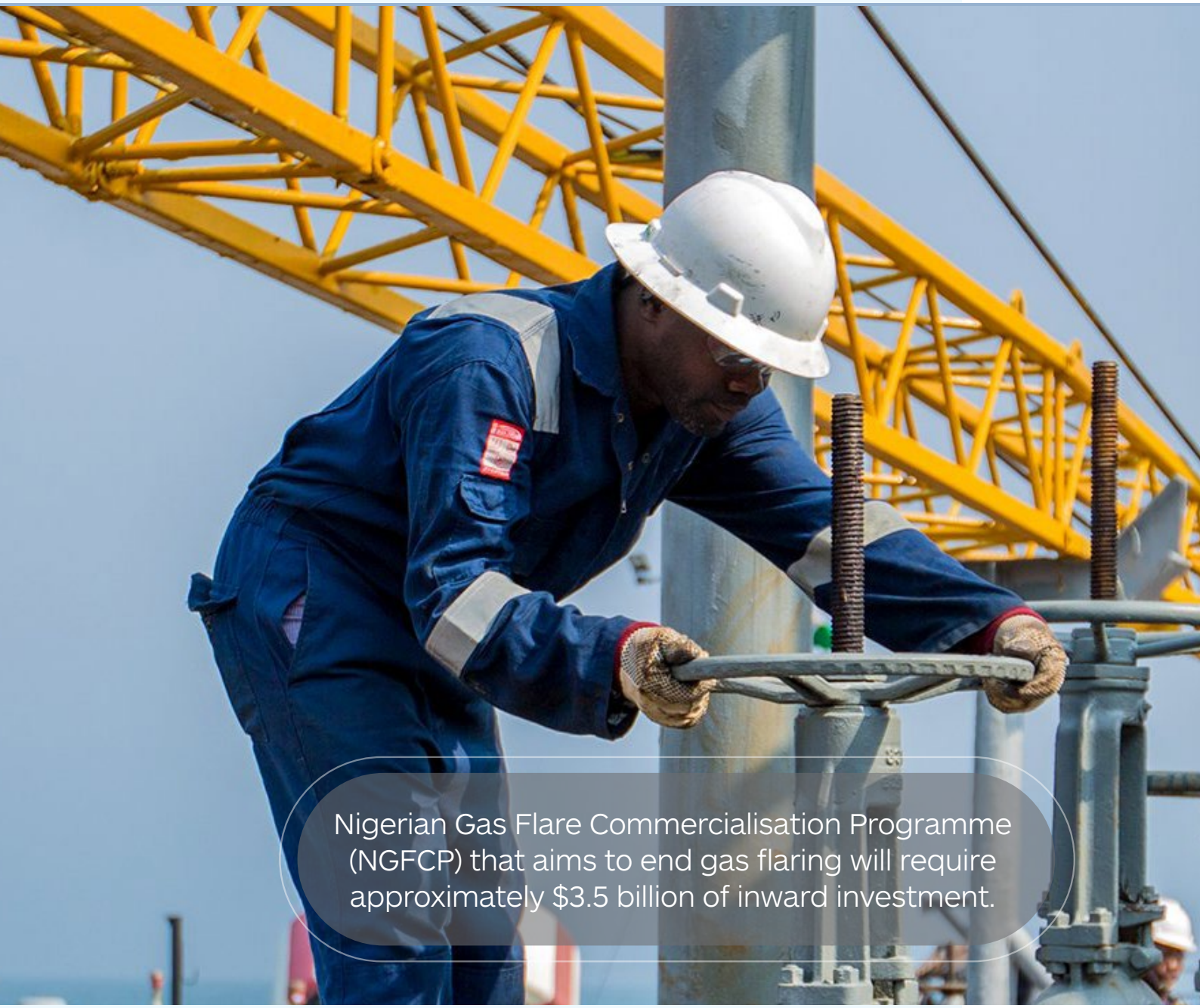
Maximising benefits from natural resources

Though it hosts enormous deposits of natural resources, Africa has been unable to seize this opportunity for economic transformation. Building prosperous economies in Africa must therefore go beyond 'business as usual'. UNU-INRA research shows that countries are taking key steps; while these are good news for the continent, there is an urgent need to scale up and build a transformative economy that not just survives on raw commodities but thrives on value addition.

In Ghana, fossil fuel wealth is being used to support the government's flagship development programmes. In 2017, the government launched an industrialisation agenda dubbed One District, One Factory (1D1F), proposing to build one factory in each of the country's 260 districts in order to make Ghana export-oriented and reduce the country's dependence on foreign aid as well as natural resources. Closely linked to this is a programme to increase agricultural production, enhance food security, create jobs and reduce Ghana's reliance on food imports. Through the industrialisation agenda, government aims to increase agro-processing and value addition for the export market and generate revenue for the country.

These initiatives, especially 1D1F, require a substantial energy base, and the country's excess electricity generation capacity provides an opportunity. Ghana could strategically develop its natural gas wealth and the required infrastructure to power its industrialisation agenda while investing in follow-up low-carbon technologies to power future factories with affordable and clean energy.

Nigeria could focus on value addition to maximise revenues from fossil fuels while demand and prices make extraction and processing economic. Improved domestic refining capacity can increase local access to heavy-end refining products such as coke, asphalt and high pour fuel oil (HPFO) that could boost value addition in manufacturing processes. The associated gas can be utilised to generate electricity to power homes, hospitals, schools, local businesses and industry; to provide fuel for vehicles; to produce fertilisers for agriculture, thereby promoting the agricultural sector and food production; and to provide fuel for heating and other domestic and industrial purposes, reducing reliance on bioenergy and other forms of energy with higher carbon footprints. These outcomes would advance social, economic and environmental development objectives. Already, Nigeria is investing in large-scale, value-adding infrastructure, such as the $10 billion oil refinery by Dangote, which is set to be one of the world's largest (650,000 barrels of crude a day) once in full capacity by mid-2020 (Wallace, 2018).



Nigerian Gas Flare Commercialisation Programme (NGFCP) that aims to end gas flaring will require approximately $3.5 billion of inward investment.

The current Nigerian Gas Flare Commercialisation Programme (NGFCP) also ambitiously aims to end gas flaring a decade ahead of the country's commitments in the NDC. The NGFCP requires approximately $3.5 billion of inward investment. This presents opportunities for host community participation and inclusive development through providing services to meet local needs; addressing local content requirements throughout the project life cycle; promoting local equity participation; and investing in social amenities for the benefit of the local communities, taking into consideration the special needs of women and girls, children, the elderly and any other vulnerable group. Hence, through domestic oil refining and flare capture and utilisation, the Nigerian government has the opportunity to boost local industry, food production to ameliorate the significant level of hunger in the country, and also improve foreign exchange earnings through the export of gas, fertiliser or food produce as well as value addition.

In Zambia, as coal and copper mine closures loom, it is important to manage the decline by establishing guidelines for decommissioning mines that protect the infrastructure and wellbeing of the employees and host communities. Employees could be trained with skills that are transferable to other sectors to ensure their employability during a future low carbon transition. Communities, especially women who offer support services around mines, should also be supported to diversify their livelihoods and local economies independent of mining activities in the medium to long term.

Cleaner energy to power Africa

Countries could expand electricity access, power industrialisation and diversify their economies by taking the prospect of asset stranding as an invitation to develop renewable energy generation (see Box 5 and 6).

Box 5: Promoting renewable energy in Namibia through the multiple buyer model

Namibia is a net importer of electricity and is promoting solar to reduce its dependence on domestic hydro-electricity and power imports from neighbouring South Africa, Botswana, Zambia and Zimbabwe. The government recently permitted independent power producers (IPPs) to sell directly to consumers, replacing the former single buyer model which stipulated that electricity suppliers could sell only to NamPower.

As a result, IPPs are venturing into the renewable energy sector. Alten Solar Power Hardap PV Plant, the largest photovoltaic solar plant in Namibia, has an installed capacity of 45.5 MWp with 140,000 crystalline silicon panels mounted on solar trackers. It is expected to generate about 112GWh of electricity that will feed into Namibia's national grid to meet the electricity demands of more than 70,000 residents. The plant is an affordable, clean, renewable power source that will help reduce Namibia's carbon footprint and avoid 33,000 metric tonnes equivalent of carbon dioxide emissions.

There are other mini renewable projects such as InnoSun, which has a total capacity of 10 MW. The Trekkopje solar power plant built by Sertum Energy Namibia, an IPP, has a capacity of 5 MW but with a potential to produce 27 MW. The electricity produced in Trekkkopje is fed into Zambia's national electricity grid from a substation not far from the plant, which is intended to supply the Trekkopje uranium mine. Nampower, Namibia's electricity utility company, plans to add 150 MW of new generation capacity through 20 MW of solar, 40 MW each of biomass and wind, and 50 MW of guaranteed 'firm' electricity output. The renewables plan is aligned with the National Integrated Resource Plan.

Box 6: South Africa: decarbonisation, digitalisation and decentralisation

Given the commitment to reduce greenhouse gas emissions, continued investment in high-emitting infrastructure may create costly risks for South Africa. Decarbonisation, digitalisation and decentralisation are three key enablers underpinning the energy transition. The integrated resource plan (IRP) 2019 provides for uncapped procurement of distributed generation until 2022, after which procurement will be capped at 500 MW per year up to 2030. Distributed generation refers to small-scale technologies to produce electricity close to the end users of power. This includes projects between 1 and 10 MW and excludes mines and commercial and industrial entities that are seeking to develop generation capacity in excess of 10 MW.

Decarbonisation: Renewables are at the centre of the energy transition and are now the fastest growing energy source. Renewables are cost-competitive compared with fossil fuel-sourced power in most markets. Not much consideration is being given to base load and storage capacity challenges.

Digitalisation: Innovations in the storage and digitalisation space are opening up new ways to mass-deploy renewables, while the convergence of smart energy networks and digital solutions better allow for controlling energy demand and trade.

Decentralisation: Distributed energy systems and community-based energy models are gaining ground. Increased off-grid resources, such as rooftop solar PVs, electric vehicles and battery storage, will further decentralise energy systems in the future. This is an opportunity for small-scale generators, including those from biomass, biogas, landfill gas and co-generation.

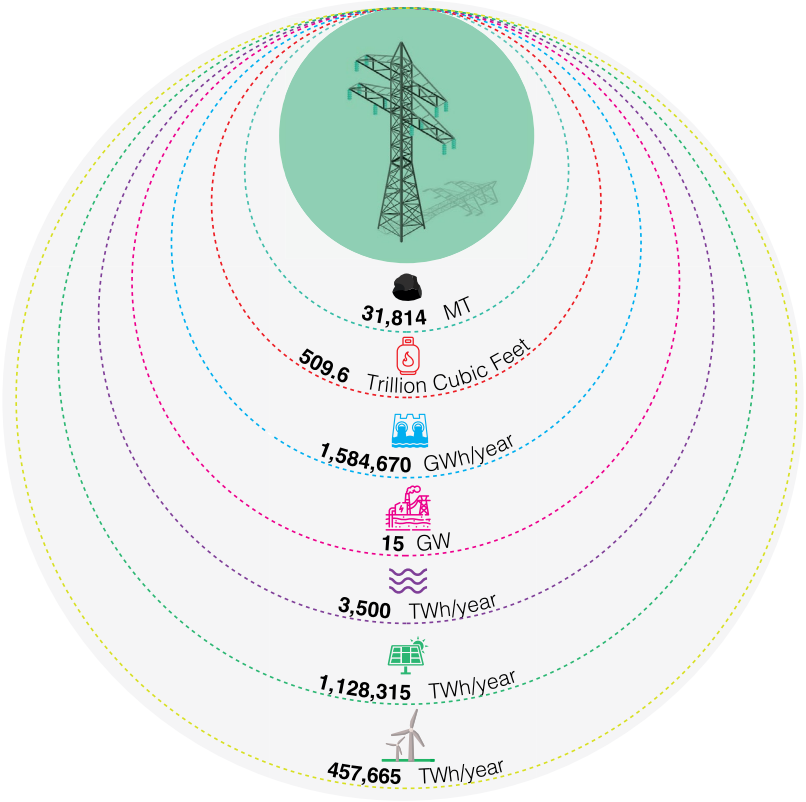
In **rural** parts of **Zambia**, as much as **95%** of energy consumed is generated from **wood biomass** and **charcoal**.

South Africa is an energy-intensive economy, currently reliant on coal, but has committed to global agreements to reduce emissions. This requires new investments in high efficiency, low emissions (HELE) technologies, underground coal gasification and the development of carbon capture and storage. There is a strong focus on renewables in the country's IRP, with 48% of new energy capacity by 2030 to come from wind (14,400 MW), 20% from solar (6,000 MW), 10% from gas and 8% from hydro. In support of regional integration and energy trading, South Africa has entered a treaty for the development and purchase of 2,500 MW of hydro-electric power from the Grand Inga Project in the DRC, with some of the power intended for transmission to South Africa and across DRC, Zambia, Zimbabwe and Botswana. Eskom is working on 5,000MW battery storage to be commissioned by 2030.

In rural parts of Zambia, as much as 95% of energy consumed is generated from wood biomass and charcoal. The growing population and related increase in energy demand means this is negatively affecting forest cover. Investments in more efficient energy systems and off-grid renewable energy sources such as solar PV could provide alternatives to improve energy security while reducing the carbon footprint. Zambia's mean solar insolation of 5.5 kWh/m²/day offers a good potential for generating electricity (REEEP, 2013). Furthermore, the falling cost of solar energy presents good prospects for transition from fossil fuels. For instance, while the Maamba Coal plant has a tariff of about 13 cents per kwh, the first solar plant established achieved 6 cents per KWh and the second around 5 cents per KWh.

Given the high energy consumption by Zambia's mining sector, improvements in energy efficiency in the mines would go a long way towards increasing electricity availability for other uses while reducing mining's carbon footprint. In addition, mining companies can invest in solar energy generation, given the competitive costs of solar power. Government can facilitate this process by providing financial incentives to mining companies to have more energy-efficient systems.

Energy resources and Africa's potential to power itself



KEY

- Coking coal (mt)
- Natural gas (tcm)
- Hydroelectricity (GWh/year)
- Geothermal electricity (GW)
- Hydrokinetic (tides, waves, etc.) (TWh/year)
- Solar (TWh/year)
- Wind (TWh/year)

Source: Atlas of Africa Energy Resources. 2017

Box 7: Regional markets and the African Continental Free Trade Agreement (AfCFTA)

Many of the case study countries with rich gas reserves, particularly Nigeria, Angola and Tanzania, expressed optimism that, despite the global aversion to hydrocarbons, they can continue to trade their resources within the continent.

Falling commodity prices, cheap manufactured goods and international standards regulations are just a few ways in which global trade structures are weighted against African countries. Within this structure, natural resources are extracted and sold in their primary state while value is added outside the continent. The AfCFTA presents an opportunity for Africa to take control of its resources and trade based on regionally determined prices and standards.

Regional power pools in Africa are already making significant progress towards intra-Africa trade. A high-profile example is the West African Gas Pipeline (WAGP), a 678 km pipeline running through Nigeria (Lagos), Ghana (Takoradi and Tema), Benin (Cotonou) and Togo (Lome). The WAGP connects with the existing 800 MMscfd Escravos–Lagos pipeline. It conveys purified natural gas up to an initial capacity of 170MMscfd – the capacity is expected to peak at 460MMscfd. Takoradi Thermal Power Plant (Ghana), and CEB (Benin and Togo) already use gas from the WAGP in their operations.

Also noteworthy is the Nigeria–Morocco Gas Pipeline (NMGP) project involving the Nigeria National Petroleum Corporation (NNPC) and the Morocco National Office for Hydrocarbons and Mines (ONHYM). The NMGP seeks to extend the WAGP to Morocco. This will be an important opportunity to harness markets along the pipeline corridor and utilise Nigeria's stranded natural gas resources in power plants and industrial processes.

As part of the AfCTA framework, a free trade area (FTA) will be created through the gradual removal of tariff and non-tariff barriers to intra-community trade and the establishment of a customs union that operates a common external tariff. Coupled with investments in transportation infrastructure, logistics and value addition, this could provide alternative uses and a regional market for otherwise stranded assets.

In addition, the AfCFTA can potentially promote cooperation and regulatory frameworks for improved energy services in the region. Regional trade can also drive energy diversification as countries rely on their comparative advantage.

Land use and resource diversification

Angola **imports** more than half of its **food**, spending about **$3 billion annually.**

Powered by **natural gas** Tanzania has begun a **$3 billion fertiliser plant** intended to be the biggest in Africa.

In Angola, land use diversification to expand agriculture will be critical as two-thirds of the population depend on this sector for food, income and employment. Currently, the sector's contribution to Angola's GDP is around 12%. Before the civil war, Angola was a major exporter of coffee, sisal, sugar cane, banana and cotton, and it was self-sufficient in certain food crops. However, the civil war decimated the sector and Angola currently imports more than half of its food, spending about $3 billion annually on imported food products, half of which are staples (50% of the maize consumed in Angola comes from Zambia).

Strengthening the agricultural sector will support efforts to minimise heavy dependency on oil revenues, limit the adverse impacts of stranding, reduce dependence on food imports and improve the livelihoods of Angolans.

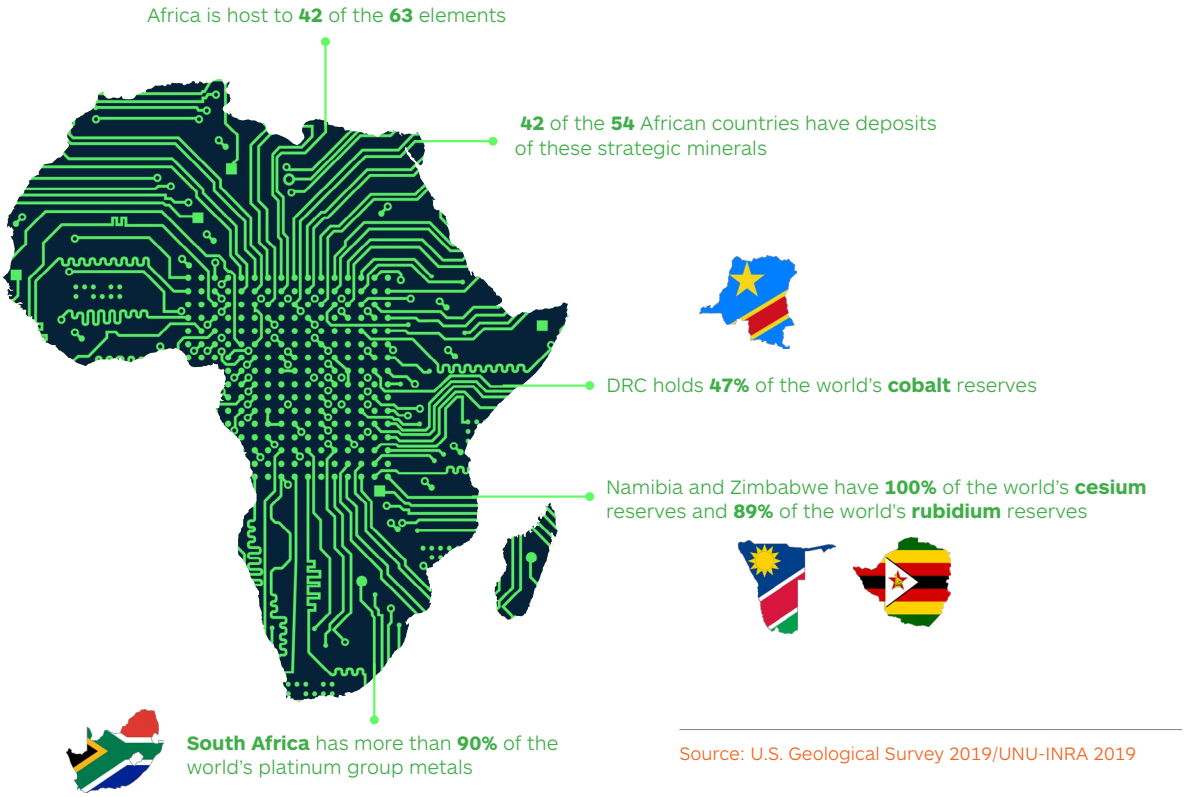
In a bid to attain middle-income status by 2025, Tanzania's industrial sector is one of the fastest growing in Africa, partly powered by the discovery of natural gas in commercial quantities (MEM, 2015). Its large and as-yet undeveloped offshore reserves also present further opportunities for growth and diversification that can support the economy in the event of natural gas stranding. For example, work has begun on a $3 billion fertiliser plant intended to be the biggest in Africa, with a capacity of 3,800 tons per day when it becomes operational in 2021 (Ng'wanakilala, 2016). Powered by natural gas, the plant will provide affordable fertiliser to farmers to increase agricultural production and reduce the current reliance on imports and huge fertiliser subsidies.

Africa is host to **42** of the **63** elements used by low carbon technologies and the 4th industrial revolution

Green economy minerals

While it is important to acknowledge that the socio-environmental externalities of so-called 'green economy minerals' require stringent scrutiny, a potentially important support for resource diversification is the wealth of such resources in Africa. These are the minerals required for low-carbon technologies, such as those used in solar PV technology (aluminium, cadmium, copper, gallium, indium, iron, lead, nickel, silica, silver, tellurium, tin and zin) and in lithium-ion batteries (aluminium, cobalt, iron, lead, lithium, manganese, nickel and graphite). Low-carbon technologies for the 'fourth industrial revolution' will require more minerals than are currently being produced (World Bank, 2017). A 2018 UNU-WIDER study estimates that an increase of about six times in iron/steel production is needed to service wind turbines (Addison, 2018). Strategic planning and management of these resources and industries could position Africa as a key player in the fourth industrial revolution.

Minerals for low carbon technologies and the 4th industrial revolution



Source: U.S. Geological Survey 2019/UNU-INRA 2019

South Africa, for example, has some of the world's largest high-grade resources in vanadium, platinum, palladium, nickel, manganese, rare earths, copper and cobalt, and could use these minerals to create new industry and local economic development. Similarly, Namibia could take advantage of the increasing demand for electric vehicles and expand lithium and cobalt production to become a leading supplier of batteries. In fact, Namibia entered the world's top 10 lithium producers for the first time in 2018, with 500 tonnes produced; further exploration is planned, and historic mines are being reactivated (Chutel, 2018). Future developments could also create market opportunities in the storage, disposal, recycling and recovery of used batteries.

It is important to note that the production of green economy minerals could firstly be managed through supporting and expanding artisanal and small-scale mining in different parts of Africa. It could also focus on value addition, to ensure that African countries reap the maximum benefits from the fourth industrial revolution.

Conclusion

African governments find themselves between two critical positions: meeting their developmental needs using available natural resources and at the same time achieving climate action ambitions. Though they are not mutually exclusive, they have proven difficult to reconcile. At the intersection of these two positions are stranded assets.

It is clear from UNU-INRA's research that African governments are preoccupied with meeting the development needs of their people and economies, a priority that has created dependence on extractive resources for growth and revenue generation. This discussion paper suggests that not only will resource-rich African countries continue to suffer from commodity price volatility, including carbon market risks; they also risk losing massive amount of revenue due to investments and assets being stranded.

Climate change is a trigger for stranded assets. African countries, which emit less than 5% of global carbon emissions, already bear the brunt of climate change risks and impacts. A significant emerging risk is that stranding could endanger the continent's social and economic fortunes and reverse the gains that have been made.

Alternatively, the stranded asset risk can be viewed more optimistically as reinforcing the need for African economies to diversify by building value addition and a viable manufacturing base. This paper emphasises that resources at risk of stranding must be carefully managed in order to protect revenue flows, diversify economies and pursue low-carbon development. African leaders must throw their energies into comprehensive resource planning strategies that integrate both the risks and opportunities of stranded assets.

At the same time, it is a state's sovereign right to exploit its own natural resources, and African countries need to exercise greater agency in using their mineral assets to meet their many developmental needs – including its energy poverty. But if this entails continued usage of fossil fuels beyond that of developed economies, it must be supported by strong policies based upon the recognised right to 'development first' principles carefully balanced with recognition of the risk of stranding.

The UNU-INRA case study research reveals that African policymakers are already exploring ways to unlock the developmental opportunities available and move towards more sustainable management of natural resources. These options include maximising the short- and longer-term benefits from natural resources in line with distributive equity, utilising diverse energy to power economic sectors, leveraging resource diversification and developing a competitive resource value chain.

African governments must not underestimate the economic, social, developmental and geopolitical implications of stranded assets. UNU-INRA therefore urges decision-makers to prioritise the assessment and management of stranded asset risks through better resource planning and economic diversification. Climate change is seen as an emergency; Africa's development should not be a causality. The developmental opportunities of just transitions are within grasp.

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ACRONYMS

1D1F	One District, One Factory
AfCFTA	African Continental Free Trade Agreement
AfDB	African Development Bank
BNA	Banco Nacional de Angola
CNNC	China National Nuclear Corporation
CNPC	China National Petroleum Corporation
CSIR	Council for Scientific and Industrial Research
CTL	coal-to-liquids
ECE	UN Economic Commission for Europe
ENSO	El Niño Southern Oscillation
EU	European Union
FFRDCs	fossil fuel-rich developing countries
FOCAC	Forum on China–Africa Cooperation
FTA	free trade area
GDP	gross domestic product
HELE	high efficiency, low emissions
HPFO	high pour fuel oil
IEA	Institute of Economic Affairs
IPP	independent power producers
IRP	integrated resource plan
ISDS	investor–state dispute settlement
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined Contribution
NGFCP	Nigerian Gas Flare Commercialisation Programme
NIGELEC	Société nigérienne d'électricité
NMGP	Nigeria–Morocco Gas Pipeline
NNPC	Nigeria National Petroleum Corporation
OCTP	offshore Cape Three Points
ONHYM	Morocco National Office for Hydrocarbons and Mines
PRMA	Petroleum Revenue Management Act
REIPPP	Renewable Energy Independent Power Producer Procurement
SDGs	Sustainable Development Goals
SHS	senior high school
SNAE	National Strategy for Access to Electricity
SOMINA	Société des mines d'Azelik
TANESCO	Tanzania Electricity Supply Company
tcf	trillion cubic feet
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNU-INRA	United Nations University Institute for Natural Resources in Africa
WAGP	West African Gas Pipeline

Knowledge to Induce Change

About UNU-INRA

The United Nations University Institute for Natural Resources in Africa (UNU-INRA) is one of the 15 research and training centres of the United Nations University (UNU) and is the only one focusing predominantly on Africa. We provide cutting-edge solutions and knowledge outlets for natural resource planning and management from an African perspective.

UNU-INRA serves as a platform to amplify African voices and showcase made-in-Africa solutions. We harness the incredible talent on the continent and also strengthen and develop capabilities by equipping African researchers, entrepreneurs and policy actors with the requisite knowledge to sustainably manage natural resources. We deliver research, capacity development and policy advice, and we convene spaces for knowledge sharing.

Our operating units across 5 countries in Africa (Senegal, Ivory Coast, Cameroon, Zambia and Namibia) give us on-the-ground knowledge, while our global network of experts and the wider UNU group give us a comparative advantage in the production and export of knowledge.

It is our vision for Africa to realise the transformational potential of natural resources in the context of sustainable development and deliver a prosperous, fair and resilient future.

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