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Scaling up African clean energy

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This paper looks at possibilities for scaling up renewable energy deployment in African countries in the 2020s and 2030s – not just as a way to increase energy access, but as a clear and timely opportunity for African economies to benefit from the global green transition. It illustrates how certain drivers enable some countries to move faster than others and argues that a 'just energy transition' needs to start from African countries' own economic development agendas, assets and priorities.

While overall renewable energy deployment in Africa is slower than in most parts of the world, several African economies are catching up. They seek to leverage their renewable energy potential and believe that clean energy is a trigger for their socioeconomic and industrial development. At the same time, Africa as a whole accounts for just a fraction of worldwide investment in renewable energy. The costs of a delayed African renewable energy shift will increase over time, creating new fossil fuel lock-ins and missed opportunities.

Unlocking the renewable energy potential across the continent requires major coordinated changes across the infrastructure, finance and policy domains. International climate diplomacy and renewable energy finance need to address context-specific constraints, including existing and emerging fossil fuel dependencies and create long-term perspectives for sustainable economic development and industrialisation.

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Acronyms

ACEC	African Clean Energy Corridor
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AfSEM	African Single Electricity Market
AU	African Union
AU-EU	African Union-European Union
BMBF	German Federal Ministry of Education and Research
CBAM	Carbon Border Adjustment Mechanism
CIF	Climate Investment Funds
CO_2	Carbon dioxide
COP	United Nations Climate Change Conference or Conference of the Parties of the UNFCCC
DFI	Development finance institution
DRC	Democratic Republic of Congo
DRI	Direct reduced iron
EAPP	Eastern Africa Power Pool
EC	European Commission
ECDPM	European Centre for Development Policy Management
EGD	European Green Deal
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
GDP	Gross domestic product
GOI	Government of the Republic of Indonesia
GW	Gigawatt
IEA	International Energy Agency
IFI	International financial institution
IPG	International Partners Group
IPP	Independent power producer
IRENA	International Renewable Energy Agency
JETP	Just Energy Transition Partnership
LCOE	Levelised cost of electricity
LEAF	Leveraging Energy Access Finance Framework
LIC	Low-income country
LNG	Liquified natural gas
LPG	Liquified petroleum gas
MASEN	Moroccan Agency of Sustainable Energy

MDB	Multilateral development bank
Med-TSO	Mediterranean Transmission System Operators
MENA	Middle East and North Africa region
MW	Megawatt
NDC	Nationally Determined Contribution
PPA	Power Purchase Agreement
PV	Photovoltaics
R&D	Research and Development
RE	Renewable energy
SAPP	Southern Africa Power Pool
SEFA	Sustainable Energy Fund for Africa
SSA	Sub-Saharan Africa
UK	United Kingdom
UN	United Nations
UNCTAD	United Nation Conference on Trade and Development
UNECA	United Nations Economic Commission for Africa
US	United States (of America)
WB	World Bank

1. Introduction

The discussions on energy transition in African countries at COP27 in November 2022 reflect two seemingly conflicting narratives: (1) Africa as a potential renewable energy powerhouse, which can play a leading role in decarbonising energy systems and industries in and well beyond the continent; and (2) African countries seeing their growth and industrialisation objectives stifled by an ever more carbon constrained international environment, being left out as the other parts of the world transition to a new model.

This paper looks at opportunities for scaling renewable energy deployment in African countries in the 2020s and 2030s, not just as a development or energy access problem,[1] but as a clear and timely opportunity for African economies to benefit from the global green transition. It illustrates some of the drivers of renewable energy transition in African countries, and what enables some countries to move faster than others, and looks at current and future opportunities for scaling up clean energy on the continent. It argues that a 'just energy transition' needs to start from African countries' own economic development agendas, assets and priorities.

Renewable energy (RE) investment across the continent has multiplied over the past two decades. This is led by the continued dropping costs of renewable energy, especially solar and wind power compared to fossil fuels[2]. Between 2000 and 2020, Africa attracted almost $60 billion in investment in renewables (excluding large hydropower). From 2010-2020, the annual average investment increased ten-fold, from $0.5 billion to $5 billion, showing a growth rate that is higher than any other region in the world (IRENA 2022a)[3]. The cumulative sum of these investments, however, accounts for just 2% of worldwide renewable energy investment, and remains far below the $25 billion per year the International Energy Agency (IEA) estimates is needed to deliver universal clean energy access within this decade (IEA 2022).[4]

Further unlocking the renewable energy potential across the continent, while it may appear straightforward on paper, is more difficult in practice, and requires major coordinated changes across the infrastructure, finance and policy domains. Even if many African countries are at a distinct geographical advantage when it comes to renewable energy, there is not one recipe for energy transition that can be applied to the entire continent. This calls for a context-driven approach to just energy transition, but also a shift in how external financiers look at Africa's energy priorities.

[1] Currently, 600 million or 43% of Africa's overall population live without electricity and 900 million lack access to clean cooking facilities making the urgent case for universal energy access (AU 2022a) with liquified petroleum gas (LPG) being a leading solution in urban areas (IEA 2022).

[2] The global weighted average levelised cost of electricity (LCOE) of new onshore wind projects in 2021 dropped by 15% year on year, and the costs of utility-scale solar fell by 13%. Given the current fuel price crisis the advantage of renewables in 2022, is set to be significant (IRENA 2022d).

[3] RE investment in Africa grew at an average growth rate of 96% per year (starting from a relatively low base) – compared to 15% in Asia-Oceania (excluding China and India) and 7% globally (IRENA 2022a).

[4] To fully implement Africa's Nationally Determined Contributions (NDCs), the African Development Bank (AfDB) estimates financing needs could be up to $ 145 billion per year (AfDB 2022a).

2. Energy and just transition in Africa: in search of common ground

The energy debate ahead of COP27 in Sharm-El-Sheikh emphasises the fault lines between developed and developing countries. Tensions between Europe and Africa are especially stark, revealing different interpretations of what a fair and just energy transition entails. This is exacerbated by the EU's own problems since the start of the Russian war in Ukraine, its oscillating position on fossil fuels and nuclear energy (Hernandez 2022), and most of all its search for alternative sources of natural gas to compensate for the weaponisation of energy supply by Russia.

For the EU and EU member states' the idea of a 'just transition' is rooted in their own experience and the imperative of providing additional support for a comprehensive economic transition in the less developed and more fossil fuel dependent regions of the European continent. At its core, the European Green Deal's 'just transition' concept is driven by both a moral imperative of leaving no-one behind, and a more pragmatic, political one, of reducing the resistance to change among potential 'losers' of decarbonisation in Europe (Strambo 2020). The notion of a European 'just transition' was grafted onto the EU's existing cohesion policy with the launch of the EU's just transition mechanism and fund. The integration of 'just transition' objectives in European foreign policy followed later. At COP 26, the UK, US, Germany, France, and the EU first backed a 'Just Energy Transition Partnership with South Africa' meant to provide broad and cross-sectoral support to assist South Africa to phase out coal. The deal has since become a model for future Just Energy Transition Partnerships (JETPs) supported by members of the G7[5]. The 2022 AU-EU summit also introduced a specific objective of a "fair, just and equitable" energy transition.

For most African countries, however, 'just transition' relates less to the transition away from coal, and more to Africa's right to develop. The notion of an African just energy transition is centred around the question whether African economies will be able and supported to develop mature energy systems in an increasingly carbon constrained environment. This is especially important because while African economies have limited emissions to cut, avoiding future emissions can be very costly leaving African countries at a disadvantage (Adow 2022).

While many African governments are committed to expanding renewable energy as an affordable way to provide access and electrify the continent, they also see the use of new and existing natural gas supplies as a critical condition for achieving functioning energy systems, providing baseload and flexibility[6] that will enable them to scale up the use of renewables in the coming decades. Africa is home to a number of established oil and natural gas producers, like Nigeria, Algeria, Egypt, Angola and Equatorial Guinea. Discoveries in the past decades, have led to an emerging natural gas sector in Southern (Mozambique, South Africa, Namibia), West (Mauritania, Senegal) and East Africa (Tanzania, Ethiopia) (Anwar et al. 2022). At the same time, most of these countries, like South Africa, Namibia, Egypt, and Ethiopia have also seen strong growth in renewables, or are aiming for ambitious net-zero targets (Nigeria). This shows that most see the development of their natural gas reserves as a key driver of economic development in the coming decades, in addition to the benefits of renewable energy sources. External pressure to phase out fossil fuel finance is perceived as a direct risk to these ambitions.

This has made for a difficult conversation in international fora. At the 2022 EU-AU summit, tensions were somewhat glossed over, with announcements of new prospective investments, including in green hydrogen. Ahead of COP27,

[5] In November, Indonesia announced a $20 billion JETP backed by the US and Japan along with Canada, Denmark, the EU, France, Germany, Italy, Norway, and the UK (GOI and IPG 2022), while several other countries, including India, Vietnam, and Senegal are in talks for future JETPs.

[6] New gas-fired power plants can operate as baseload or load-following power plants, giving countries much-needed flexibility. They can also help displace heavy oil and coal-fired power generation, drastically improving air quality for example in West Africa, and use different blends of gaseous fuels, including biomethane and low-carbon hydrogen (IEA 2022: 127).

the AU presented its common position on energy access and just transition, which calls "to deploy all forms of [Africa's] abundant energy resources" and stresses that "natural gas, nuclear energy and other non-renewable energy resources are expected to play an important role [...] in the short to medium term [...]" (AU 2022a). This position, however, is far from shared by all stakeholders. African climate groups in particular firmly rejected the AU position, calling it "a betrayal of African people" (Kibochi 2022; African Coal Network et al. 2022). Some African negotiators at COP27 also reportedly preferred a less explicit pro-gas stance to avoid distracting from key priorities like adaptation and climate finance (Farand 2022). At the same time, the call from African leaders to finance natural gas exploration and exploitation was very present at COP27, illustrated by recent statements by leaders and negotiators from *i.a.* Uganda, Nigeria, and DRC, calling out what they see as Western hypocrisy on fossil fuels (Museveni 2022; Buhari 2022; Kavanagh 2022).

The question on Africa's natural gas reserves will continue to fuel tensions both within Africa and globally. What is clear, however, is that **as late industrialisers, many African countries see Western pressure to phase out fossil fuels and adopt carbon pricing (e.g. through the upcoming Carbon Border Adjustment Mechanism (CBAM) as an unwelcome and fundamentally unfair - and therefore 'unjust'- threat to their economic development** objectives, and call for a more balanced and differentiated approach to climate policy in the multilateral system.[7]

This does not mean, however, that African countries see no future in decarbonised energy systems. In fact, the continent is home to a wide range of initiatives that seek to leverage its clean energy potential and specific African assets in a global green transition.

3. African clean energy trends

3.1. Renewable energy champions: what enables first movers?

Variable renewables, mostly solar and wind[8], account for about 3% of total generation capacity on the continent (IEA 2022), however this masks the high variation in adoption between African countries. Kenya and Morocco, for example, both have a solar PV and wind share of more than 10%, surpassing the US, China and several European countries. A closer look at these 'transition champions' illustrates some of the strategic choices these countries have made. But it also shows the need to look beyond 'depoliticised' statistics, and understand the structural and economic conditions that enable these economies to prioritise solar and wind ahead of others.

Baseload renewables and sector reform: Kenya

Kenya produces nearly 80% of its energy from renewable sources, 36% of which comes from hydropower and another 36% from geothermal[9], which it intends to double by 2030 (Burkhardt and Herbling 2021). This provides it with a fairly strong baseload capacity to which variable energy can be added (IRENA n.d.; Kibugu and Gathuni 2022;

[7] According to the United Nations Conference on Trade and Development (UNCTAD) (2021) estimates, a $44 per ton carbon price would raise developed country incomes by $2.5 billion while incomes in developing countries would fall by $5.9 billion. This is also highlighted by Pleeck et al. (2022) who argue that even if African countries account for only a fraction of the overall EU imports in the five products initially targeted for the CBAM, it accounts for a high share of the economy and exports of some African countries (in excess of 2% of the gross domestic product (GDP) in several cases.

[8] This section focuses on variable renewables because they hold the biggest scaling potential. Hydropower, however, is by far the largest existing form of installed renewable energy capacity in Africa, accounting for an estimated 6.8% of total capacity (PwC 2021).

[9] Kenya holds roughly 10GW of geothermal potential, putting it in a unique lead position on the continent. Kenya commissioned its first geothermal plant in 1981, and has significantly increased its capacity in the 2000s and 2010s, with new sites in active development (EPRA n.d.).

Takouleu 2022). Kenya only has a fairly nascent oil and gas sector, and heavily relies on imported oil and gas (Kwame 2020; Nevell 2014; Takase et al. 2021). This makes dependence on fossil fuel (whether through generation or imports) an expensive and less secure option. To tap into cheaper energy resources, Kenya is also looking to its neighbours. In 2022 it signed a Power Purchasing Agreement (PPA) to purchase an initial 200 MW from Ethiopia, where the Grand Ethiopian Renaissance Dam has recently come online (FANABC 2022a; FANABC 2022b).

While these factors help enable a relatively smooth integration of variable capacity into the country's energy system, the importance of policy choices should not be underestimated. As one of the biggest and fast-growing African economies, Kenya's energy investment needs are enormous. Kenya enacted several power sector reforms since the 1990s, making it a prime African destination for private energy investment (Godinho and Eberhard 2019; Eberhard et al. 2018).[10] Moreover, Kenyan officials are increasing their ambitions in policy statements. The country's most recent draft Energy Sector Roadmap aims for 100 GW of installed capacity by 2040, setting out a highly ambitious approach to scale up energy production and take advantage of the global clean economy transition (Kenya Ministry of Energy 2022).[11] Kenya's newly elected president also recently announced an ambition to move towards 100% renewables by 2030 (Ruto 2022).

Commercial and industrial incentives: Morocco

Morocco, in turn, illustrates the importance of industrial incentives as a driver of renewable energy transition. Just like Kenya, Morocco still relies heavily on fossil fuel imports, including coal for its electricity generation, making it highly vulnerable to global price fluctuations.[12] Since the 2000s, Morocco has made consistent progress, primarily with utility scale solar, earning itself a reputation as a promising destination for solar and wind energy investment (Vidican Auktor 2017). It built the world's largest concentrated solar power complex, the Noor Ouarzazate Solar Power Station (a 580 MW facility commissioned between 2016 and 2019), and is positioning itself as a future renewable energy hub and hydrogen exporter (Alami 2021; Okpanachi et al. 2022).

Contrary to the unbundling and liberalisation reforms promoted by international financial institutions (IFIs) in the 1990s, Morocco's experience involved a highly selective integration of private sector participation, maintaining a vertically integrated utility as a single buyer (Usman and Amegroud 2019). To attract and channel foreign investment, the government relies on a highly effective project development and implementation agency.

What also sets Morocco apart is that it seeks to use renewable energy to harness a green industrial development. In addition to mandating a significant degree of local content[13] in renewable energy projects (Vidican Auktor 2017; AfDB 2022b), it invests heavily in research and skills development (Vidican Auktor 2017), and proactively promotes the country as a "future-proof industrial platform" an attractive destination for low-carbon manufacturing (Smouh et al 2022; Morocco Now n.d.). Morocco also seeks to lead in green hydrogen and ammonia production, both for export and to decarbonise its phosphate mining and fertiliser industry.[14] Beyond reducing costs, greening its

[10] Kenya is a hybrid market. KenGen and Kenya Power and Lighting Company (now Kenya Power) are both state-owned entities with significant private participation (Eberhard et al. 2018). The country also has more experience with independent power producers (IPPs) than any other sub-Saharan African (SSA) country, and introduced a Feed-in-Tariff for renewable energy in 2008 (Godinho and Eberhard 2019).

[11] This is a seven-fold increase from the current 'Least Cost Power Development Plan' (2021-2030) (Kenya Ministry of Energy 2021).

[12] In the first half of 2022 the cost of the country's energy imports more than doubled due to inflated energy prices (Eljechtimi 2022).

[13] Phase III of the Noor Ouarzazate project reached a 42% 'industrial integration rate', measured in the procurement of local services in its development (AfDB 2022b).

[14] Morocco's state-owned phosphate group OCP is investing heavily in locally produced green ammonia to displace its highly expensive imports of natural gas-based ammonia. See also section 4.2.

production of (finished) fertilisers industry may also facilitate future access to the EU market, given that fertilisers are covered by the EU's carbon border adjustment mechanism (CBAM) (Berahab and Dadush 2021).

Kenya and Morocco's experience show that some African economies are betting on a rapid increase in renewable energy capacity to power a greener, and ultimately more economic development pathway. They also show that the drivers of renewable energy transition pathways are highly context-specific, and that the defining factors are often far beyond the energy sector itself. These factors also explain why many other countries take a less decisive position on renewable energy, and given the risks involved, rely on hybrid pathways using both fossil fuels and renewables.

Figure 1 below shows the importance of looking beyond the apolitical and more technocratic ingredients of a successful renewable energy transition, to also focus on the highly political enablers (or disablers) of renewable energy transition, not least the industrial (dis)incentives and commercial opportunities that can trigger a renewable energy investments and vice-versa.

Figure 1: Understanding the complexity of renewable energy adoption

Ingredients of an apolitical / technocratic view on renewable energy	**Natural resource endowments:** e.g. solar irradiation, wind forecasting, hydropower potential, etc.
	Policy targets and regulatory environment: e.g. national targets; power market liberalisation and market mechanisms (IPP schemes, etc.)
	External finance: e.g. JETPs, IFIs (incl. AfDB)
	International climate regimes: e.g. paris agreement commitments, NDCs.
Other (political) enablers or disablers of renewable energy adoption	**Power sector dynamics:** e.g. current energy mix; grid infrastructure and electrification objectives; existing baseload sources, fossil fuel reserves and exploration, etc.
	Industrial incentives or disincentives: - existing carbon intensive industries (cement, steel, aluminium…); - short-to medium opportunities (electrifying existing industries incl. H2, low-carbon manufacturing, greening for export markets); - longer-term prospects (e.g. hydrogen economy for export markets)
	Regional factors: - PPAs, existing and future regional infrastructure (incl. pipelines and interconnections) - State of regional power markets and power pools
	Domestic energy market dynamics (who pays for power and how much)**:** - Energy subsidies and sectoral arrangements - Market and integration of Commercial & Industrial (captive solar) and decentralised solutions - Formal and informal sector governance - Utility management and performance

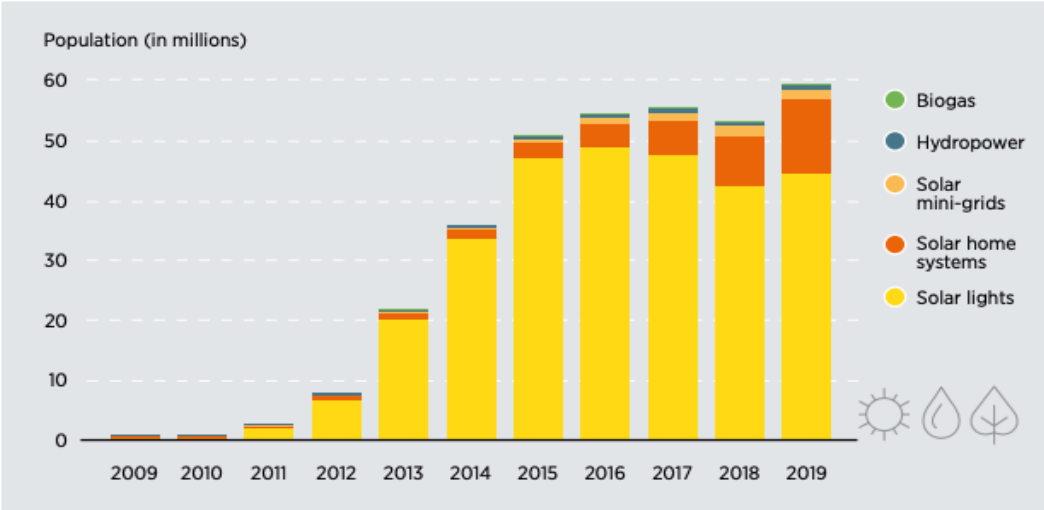
Source: Authors

3.2. Africa's decentralised (off-grid) solar markets: leapfrogging in action

In parallel to utility-scale developments, African economies have seen a major increase in decentralised renewable energy[15], primarily solar, in both rural and (peri-)urban areas (Le Picard and Toulemont 2022; Lighting Global et al. 2022). In some areas, decentralised renewable energy is emerging as an alternative to highly ineffective (rural) electrification programmes, reaching underserved areas in a cost-effective way, replacing often expensive diesel back-up power.

Off-grid solar power generation in Africa took off rapidly in the 2010s (see figure 2). Between 2016 and 2019, 8.5 million people in Sub-Saharan Africa gained access to electricity through solar home systems, the majority in East Africa (IRENA 2022b), while the World Bank estimates that between 2010 and 2019, access to mini-grid systems more than doubled from 5 to 11 million people (WB 2021).

Figure 2: African population served by off-grid renewable power (2009-2019)



Source: IRENA 2022a

Off-grid solar power is very much an African-grown dynamic. 70% of global investments in the off-grid sector between 2010 and 2020 took place in Africa, with Kenya, Uganda, Tanzania, and Nigeria being the lead markets today (Lighting Global et al. 2022; IRENA 2022a).[16] Annual commitments to off-grid renewables in Africa grew from around $ 0.5 million in 2010 to more than $ 380 million in 2020 (IRENA 2022a). Governments are increasingly adapting policy frameworks to better integrate decentralised solar in their energy systems, introducing mini-grid regulations, tariff-setting policies, standards, and planning mechanisms, using it as an intermediary step towards full grid integration (Power for All 2022; 2021; Meier 2019; Mekwunye 2022).

African off-grid solar power markets are developing in parallel to, and in some cases compete with or substitute access to national energy systems. Remote sensing recently also revealed that while adoption started in rural, disconnected areas, access to off-grid solar power in cities is also rapidly growing (Le Picard and Toulemond 2022). Researchers identified an estimated 184-231 MW of solar capacity in just 14 sub-Saharan African cities, which (excluding South Africa) would equal 10% of the centralised solar capacity of the region. This shows that

[15] Decentralised or off-grid renewable energy covers many different applications, ranging from solar lighting to mini hydropower, full-blown mini-grid systems and in some cases captive power plants powering major businesses and industries.

[16] From a total worth of $ 2.5 billion off-grid investments, $ 1.7 billion went to Africa over the time period (IRENA 2022a).

decentralised solar is not only seen as a way to leapfrog expensive grid expansion efforts in rural and remote areas, but that it is also used by urban populations to increase the reliability and lower the costs of their electricity supply (Le Picard and Toulemond 2022)[17].

Decentralised solar power is a major growth market for African economies with the potential to reach up to $ 9.9 billion in investments and funding by 2030 in total (WB 2022). It is also one that is largely driven by consumer demand, and has shown a remarkable resilience throughout the COVID-19 pandemic (Lewis 2021). While the 'revolution' started in East Africa, off-grid providers rapidly moved into West Africa, led by Nigeria's enormous potential (IRENA 2022a; Lighting Global et al. 2022). Much of the technology is sourced from China, although Europe-based companies have also played a key role in developing and supplying African markets in the past decade (Medinilla, Sergejeff and Domingo 2022). Yet off-grid solar markets also offer significant opportunities for new African companies, especially in service provision, installation and maintenance, because it is less capital intensive, than utility-scale renewables, and allows for a highly scalable business model. More recently, however, global supply chain disruptions and resulting shortages reportedly are also creating some demand for locally manufactured or assembled off-grid technology, including battery storage (Kukeera and Brophy 2022).

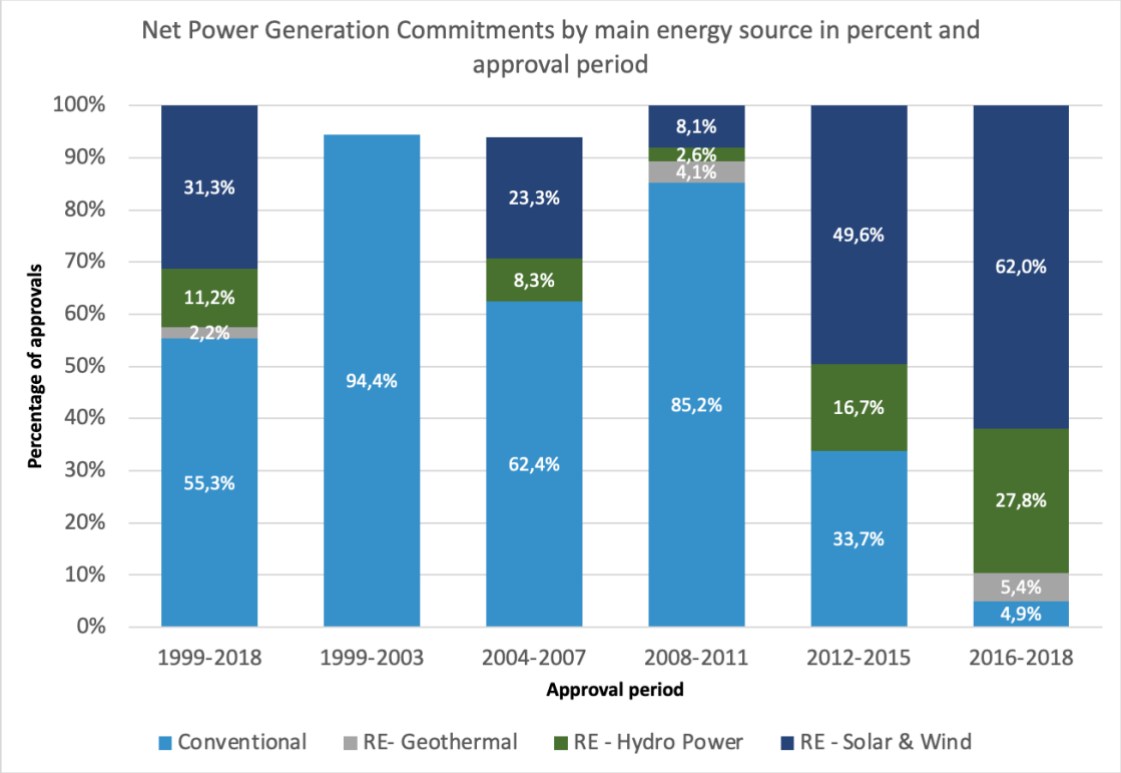
3.3. African continental policies and development finance for renewable energy

The continental narrative is somewhat dominated by the debate around fossil fuels and natural gas (AU 2022a), but a number of notable policy developments signal support for a more sustainable, and lower-carbon energy system. In an effort to create a stronger, more integrated continental power system, the African Union recently launched the African Single Electricity Market (AU 2021). Initiatives like the AfSEM may not be driven by renewable energy objectives, but could help optimise the use of African renewable energy sources, further strengthening the business case for utility-scale solar and wind power. This is also the idea behind the African Clean Energy Corridor framework (ACEC), an intergovernmental partnership with IRENA for developing a North–South power transmission chain across the 21 countries in the Eastern Africa (EAPP) and Southern Africa Power Pools (SAPP) (IRENA 2021). While still very far from a reality, these initiatives help develop more granular clean energy policy scenarios, even if the political and financial conditions for their success are not yet fully in place. More recently, the AU's 2022-2032 climate strategy also shows a clear commitment to clean energy as a key driver of climate resilient development (AU 2022b).

The eventual reach of these policy frameworks remains uncertain, but on the finance side, a shift towards renewables is clearly underway. Energy finance commitments from the African Development Bank (AfDB) in particular show a clear trend from large-scale fossil fuel projects (including coal) in the early 2000s to predominantly solar, wind and hydropower since 2016. (See figure 3).

[17] Private adoption of solar -by households as well as companies- has a strong demonstration effect, yet also has a knock-on effect on grid development, by taking paying customers away from centralised systems.

Figure 3: Net power generation commitments by energy source (1999-2018)



Source: AfDB 2020, calculated by IDEV based on an internal AfDB database. Graph reproduced by ECDPM.

The main driver for this shift at the AfDB is the Climate Investment Funds (CIF), which enabled the AfDB to support major clean energy projects in Morocco, South Africa, and Kenya (AfDB 2020). The AfDB also manages several other multi-donor initiatives, like the Sustainable Energy Fund for Africa (SEFA), established in partnership with Denmark, and promotes decentralised renewables in several countries through the Leveraging Energy Access Finance Framework (LEAF) (AfDB 2022b; AfDB 2022b). While this represents just a fraction of African energy finance, the AfDB's decisions are directly linked to continental development agendas and therefore significant weight. Beyond the AfDB's commitment to no longer finance coal (AfDB 2019), it can also play a key role in helping define the scope of the transitional role of natural gas in Africa's transition.

4. African clean energy going forward

4.1. Leveraging renewables for African development: a difficult balancing act

The preceding sections illustrate how African policy-makers, private sector and consumers see significant opportunities in clean energy, not only as a means to lower emissions, but as a trigger for a sustainable socioeconomic and industrial development, and as a way to accelerate and democratise access to affordable electricity. This forward-looking 'vision' co-exists and overlaps with a more pragmatic one, prioritising fossil fuel development, particularly natural gas, as a safer bet to jump start its economic recovery and industrial development in the coming decades.

While several African economies are increasingly moving into position to take advantage of the global clean energy transition, it is clear that the conditions that enable African economies to benefit from a clean energy transition are unevenly distributed. This makes a fully renewable pathway a much riskier choice for some than for others. Private investment in renewables, much like any other investments, tends to flow towards the lower risk environments, leading to a further concentration of renewable energy investment in a limited number of markets.

Going forward, the AfCFTA provides an institutional framework for greater intra-African trade and industrialisation.[18] Increasingly, Africa's potential, be it in industrial development or in opportunities for energy investments, needs to be approached from a regional and continental, and not just national perspective. Regional power markets and power pools can play a major role in balancing the intermittency of variable renewable energy sources. Cross-border trade can be an important enabler of variable renewable energy adoption, especially if combined with other innovations, including (battery) storage, advanced forecasting, and market design choices such as time-of-use tariffs (IRENA 2021: 95)

Between now and 2030 some African countries will come out ahead of others in the global green transition. For these countries their first mover status may become a competitive advantage, potentially bringing new opportunities and finance for their private sector, and possibly even creating a form of privileged access to European and global markets for both energy and sustainably produced goods. However, these examples are few and far between, with most countries just starting the switch to renewables.

A new generation of frontrunners

At the same time, a new generation of frontrunners is starting to take advantage of both domestic opportunities and international finance for renewable energy infrastructure, joining existing leaders in renewable energy adoption. Egypt for example, while a major natural gas and liquified natural gas (LNG) hub and the continent's largest consumer of oil and gas (Moharram et al. 2022), is now also making rapid progress in attracting large-scale investment in renewable energy and green hydrogen[19] around the Suez Canal Special Economic Zone (IRENA 2018; Egypt today 2022; O'Farrell 2022a). Five African countries increased their renewable energy capacity by more than 10% in 2021, including Senegal, Malawi, and Togo (IRENA 2022b). Senegal, while strongly committed to valorising its natural gas reserves for electricity production, also increased its renewable energy capacity more than tenfold between 2012 and 2021, from 31MW to 421 MW[20] (IRENA 2022b), showing no intention to slow down its renewable energy ambitions (Adé 2022). These cases highlight the prerogative of African countries to balance meeting their energy needs through increasing investments in renewables on the one hand, and the need to leverage their vast natural resources to forge a way towards prosperity on the other. In many African countries, rather than a zero-sum game, fossil fuel and renewable energy sources are seen as complementary measures to meet African development needs.

While some of these countries can present impressive renewable energy commitments, on a continental scale these are often still marginal developments. Africa's global share of renewable energy capacity is just 2% and its share,

[18] The UN Economic Commission for Africa (UNECA) estimates that implementing the AfCFTA will increase intra-African trade by 15-40% by 2040 (Signé and van der Ven 2021). Creating a single continental market for goods and services is also projected to nearly double African manufacturing from $ 500bn in 2015 to $ 1 trillion by 2025 (Signé 2018). The AfCFTA thus promises a virtuous circle of greater market opportunities, triggering more trade and investment, and allowing greater value addition and productivity growth – leading to more and better jobs including for the youth and women with social inclusion, and thus further enlarged markets (Byiers et al. 2020).

[19] The country is using its host role of COP27 to establish itself as a new leader in this space and has reportedly attracted no less than $ 100 billion in green hydrogen pledges (O'Farrell 2022a).

[20] Most of this increase came from large-scale projects, including the 158 MW Taiba N'Diaye wind power station that was commissioned in 2021 (Lekela n.d.).

and the continent continues to be outpaced in its renewable energy deployment by most other regions in the world (IRENA 2022c).[21]

The challenge for the coming decades therefore is going beyond the support to promising African-driven initiatives to actually enable a rapid scaling up of renewable energy deployment which requires significant investments. While MDBs and DFIs have increased their renewable energy investments, most of these do not focus on Africa and even less in low income countries (LICs). This is partly explained by both factual and perceived risks, which are today strengthened by a growing debt issue and inflation (which affects the credit worthiness of project's promoters). Multilateral development banks (MDBs) and development finance institutions (DFIs) also tend to operate on a project basis, with less focus on the contribution and impact of their investments on systemic change, including industrial development and economic transformation.

Future investments must go hand-in-hand with the scaling-up of productive *use* of electricity, both for utility-scale and decentralised electricity. There are many promising clean energy initiatives underway in the agricultural sector (Shirley 2020; Kamadi 2022), and existing industries like mining[22] (Cudennec and Kiwelu 2021; Njini 2021), generally driven by both cost savings, and emissions reductions. However, in order for the benefits of African clean energy to be enjoyed more widely, it will be essential that these renewable energy investments not only also trigger a rapid growth in new industrial applications but also provide solutions to greening or decarbonising existing production, thereby contributing to a mutually reinforcing dynamic between affordable clean energy, increased productivity and higher value addition (Tikri and Said 2021; Medinilla et al. 2022). While the energy transition can create winners, there are also significant potential losers which need to be brought on board to make such a transition successful.

From carbon leakage to a renewables pull

From a European perspective, a lot of attention has been paid to limiting 'carbon leakage', meaning that industrial production shifts from one jurisdiction with strict climate protection policies and high CO_2 costs, to a more lenient jurisdiction with a lower CO_2 costs. In theory, however, the opposite could also occur, when industries relocate from one jurisdiction to another with similar climate protection policies, but also a much greater renewable electricity generation potential (Samadi et al. 2021).[23] The concept of a so-called 'renewables pull' remains largely untested, but could potentially apply to industries that are especially energy intensive, including the sectors that are covered by the EU's CBAM: steel, fertilisers, cement, aluminium and energy.

African institutions and governments recognise the need to prepare their economies to take advantage of a low-emission and resource-efficient industrialisation pathway. The 2022-2032 AU climate strategy, for example, puts great emphasis on the need for a "new path of industrialisation", and takes into account Africa's "unique leapfrogging opportunity" in order to avoid a further "marginalisation from the global economy" (AU 2022b). African governments like those of Kenya, Morocco, Namibia, and Rwanda are also working to promote their countries as prime investment destinations for green economy projects, offering (future) low-cost clean energy (e.g. Kenya, Morocco), but also investing in a skilled labour force (e.g. Morocco), and a range of fiscal and non-fiscal incentives to facilitate investment in clean economy projects, especially green energy (Rwanda, Kenya).

[21] In 2021, only Central America and the Caribbean had a slower renewable energy growth rate than Africa.

[22] Primarily through the use of captive power plants.

[23] At least with existing infrastructure, renewable electricity and hydrogen is more expensive to transport than oil and gas (Saadi, Lewis and McFarland 2018). This means that in a scenario in which the cost of energy is a decisive factor, transport premiums can play a role.

4.2. Redrawing energy geographies: African power exports and green hydrogen

For African economies to fully leverage their renewable energy potential, they will need to become net suppliers of green energy, and related products like hydrogen and low-carbon industrial products. African economies have the potential to supply the continent and its neighbours with some of the most affordable renewable electricity in the world, yet on average, the continent has the highest levelised cost of renewable electricity (IRENA 2022d)[24].

Some of the seeds of a new energy geography - in which Africa becomes a net exporter of clean electricity - are being planted today. Plans exist for multiple new energy transmission lines in the Mediterranean Sea (Med-TSO 2020). New interconnections between Tunisia and Italy (2000 MW), and Egypt and Greece (3000 MW) for example are planned to come online in 2028 (ENTSO-E 2022; Bellini 2022), supplementing existing infrastructure between Spain and Morocco.

Beyond direct exports, projected hydrogen and ammonia demand has the potential to significantly redraw the energy field. African countries hold some of the most promising locations for green hydrogen production, primarily from solar energy, and some are rapidly moving into position to be part of this new intercontinental value chain.[25] Europe's energy crisis since the war in Ukraine has also led the EU to frontload plans for using green hydrogen and ammonia to transition hard to abate industrial sectors and the shipping sector, including plans to import 10 million tonnes of renewable hydrogen by 2030 (EC 2022).

Namibia is a net importer of electricity today, but it has partnered with Germany[26] to become the continent's first green hydrogen hub, supplying domestic, regional and international markets (BMBF 2022). It is moving ahead with plans for a $ 10 billion project to deliver 350,000 tones of green H2 by 2030 (Biogradlija 2022; Hyphen 2022), and is on course to deliver the continent's first green hydrogen plant in 2024 (Roelf 2022; Biogradlija 2022b).[27] At the same time, less than 60% of the Namibian population currently has access to electricity (WB n.d.). This shows the critical need for investments in expanding energy access domestically and developing local industries, and avoiding an 'extractive' approach to clean energy investment, which could be perceived as neo-colonial (Williams 2021). This risk is particularly high in economies that already heavily rely on the export of raw materials, such as Namibia, Angola, and Nigeria.

North and West Africa's green hydrogen potential is particularly strong with plans to use this energy source for the development of local industries as well (Nweke-Eze and Quitzow 2022). Morocco's leading phosphate and fertiliser industry is moving ahead with plans for a green ammonia production to reach net-zero by 2040 (Latrech 2022). Mauritania is taking steps to develop a 30GW wind and solar green hydrogen project (O'Farrell 2022b; CWP 2022), while Egypt intends to use its unique geographical position to become a regional hydrogen and ammonia hub for shipping and export (Español 2022; Habibic 2022). Ahead of COP27 these countries, along with South Africa and Kenya also launched the African Green Hydrogen alliance to help position the continent as a frontrunner (Climate Champions 2022).

[24] Africa also has among the highest prevalence of diesel backup power worldwide, which relies on expensive fuel imports (Ghandi 2019).

[25] Several African flagship projects that were announced at COP26 are moving forward (Hollands 2022; Biogradlija 2022a).

[26] Germany, which accounts for 27% of the EU's industrial production (EuroStat 2022) is leading the search for new hydrogen partnerships and is in talks with several other African countries, including fossil fuel producers Angola and Nigeria (Nweke-Eze and Quitzow 2022). It focuses on Western and Southern Africa with targeted diplomacy, early investment and the prospect of technology transfer.

[27] The project will produce hydrogen from 85 MW of solar panels for storage.

While African countries are geographically well placed to compete with the Middle East, Australia and the United States, key challenges will be to ensure that hydrogen production contributes to energy access locally and most of all the development of an African hydrogen economy. Beyond fertilisers (Morocco), a critical future opportunity exists in hydrogen for decarbonising iron and steel production. Analysts argue that the MENA region is particularly well placed to lead the steel decarbonisation globally (Basirat 2022). However, while Mauritania is currently exploring the feasibility for direct reduced iron (DRI) using green hydrogen (ArcelorMittal 2022), R&D and investment, however, remains largely concentrated in advanced economies.[28]

5. Conclusions

While overall, renewable energy deployment in Africa is slower than in most parts of the world, several African economies are catching up, and seek to leverage their renewable energy potential as a competitive advantage, and means to meet universal access and foster industrial development. Yet there is not one recipe for scaling up renewable energy deployment for the entire continent. First movers on the continent are able to leverage highly context-specific factors, including baseload renewables and existing industries while others face structural constraints and disincentives, particularly linked to fossil fuel dependence.

African governments' interests in developing their natural gas reserves are often presented as a moral argument of Africa's right to develop, but they are also linked to the absence of an immediate alternative. Gas-to-power infrastructure can offer scale and flexibility with limited power sector reforms. Countries also hope to develop fossil fuel exports for much-needed revenue and to feed into economic development back home without relying much on external (climate) finance, which has not lived up to commitments. This can make a 'renewables only' strategy a rather risky endeavour.

There will be opportunities in the coming decade to move African economies from being deeply energy impoverished to using renewable energy to trigger the future of industrialisation, creating quality jobs for millions of people, while improving household access to affordable and clean energy. Yet scaling up renewable energy transition and deployment will fail if it is addressed as a mere sectoral, or universal access issue, without focussing on broader socio-economic challenges of productivity gains, job creation and (green) industrialisation.

International climate diplomacy and finance initiatives need to better address context-specific constraints. They also need to help create the conditions for African economies to not only leverage their renewable energy assets for exports, but also create long-term perspectives for sustainable economic development and industrialisation.

Any major initiative targeting renewable energy development in African countries will need to factor in the following:

1) **African countries have an interest in renewable energy to trigger (industrial) productive capacity.** For several countries, the main objective of energy development is to reduce energy poverty and spur economic growth and development. Therefore, scaling up renewable energy deployment will not be driven by a mitigation imperative, but an industrial development one. Early successes and future prospects are linked to industrial demand and commercial incentives. To turn the tide of energy poverty, energy projects need to enable increasing productivity and a viable clean economy transition. This applies at all levels, ranging from decentralised solar for household access and agri-voltaics to utility-scale renewables to power new green industrial corridors.

[28] The European Commission is investing several billions in research and development for green steel in order to meet its self-imposed timeline.

2) **Even though natural gas remains a priority for African countries, its economic viability will reduce over time.** Given the strong commitment of African institutions and governments to develop their reserves, natural gas will likely play a role in Africa's energy transition to cleaner sources. Yet there is a risk of countries being left with stranded assets and high debt burden, as first oil and then gas become increasingly uneconomical. Both existing and emerging producers will face increasing 'transition risk' (Anwar et al. 2022). While European demand has temporarily shifted from Russia towards other parts of the world, including Africa, the long-term prospects for gas are still of a significant reduction in demand in the coming decades. This has important implications for African gas since domestic consumption is unlikely to be a viable substitute to attract investments, and will continue to face competition from lower-cost renewables (Anwar et al. 2022). The timelines for major natural gas infrastructure projects such as pipelines, LNG terminals and gas-to-power plants often span over multiple decades and make them increasingly high-risk for the producing countries.

3) The risks and costs of lagging behind will increase over time. The costs of a delayed renewable energy transition in (some) African countries will increase over time. A stumped transition pathway can lead to missed opportunities and finance as other parts of the world move forward, reducing their costs and attracting new investments. Within Africa, the absence of working correction mechanisms may lead to further concentration of renewable energy investment in selected countries, while others are locked into expensive and increasingly obsolete energy systems. For some countries, a slow energy transition may also reduce their commercial competitiveness, gradually pricing their goods out of global markets, especially if Europe (and others) pursue an increasingly aggressive externalisation of carbon pricing building on the Carbon Border Adjustment Mechanism's initial experience.

4) Success will require stronger regional cooperation. A maximalist approach to African clean energy cannot be achieved on a country-by-country basis, as segmented energy systems will always be less efficient and more expensive to maintain. Making (more) optimal use of Africa's renewable energy potential in a way that is also reliable and scalable requires a deep regionalisation of power markets through power pools, as building blocks of an eventual African Single Electricity Market (AfSEM). Similarly, in order for energy investments to trigger green industrialisation, increased productivity, and sustainable job creation, the focus should be on developing regional industrial value chains, and clean economy corridors across borders.

5) The finance gap can severely stifle ambitions. The timeline for a global energy transition does not allow for a business-as-usual approach, yet the investment gap remains enormous, especially in Low Income Countries suffering from risk perception premiums. The 2020s are an extremely difficult time for African countries to invest in major infrastructure projects and long-term agendas, as many face a growing public debt crisis, exacerbated by rising interest rates and the strength of the US dollar. This will (1) make development finance even more important as a source of funding for renewable energy projects, and (2) require extra efforts to ensure private investments do not taper off. Failure to address this gap will create further disincentives and slow down renewable energy adoption.

6) MDBs and DFIs are only half prepared. Some countries (including the United States and Germany) are pressuring MDBs to lend more and boost spending on climate action. Mobilising capital for renewable energy in Africa -especially in higher-risk but strategically important countries-, however requires a significant change in the business model of development finance. Stronger cooperation between MDBs and DFIs and risk sharing (e.g. using risk-sharing facilities) will be key. De-risking instruments -while not a silver bullet- can help improve the credit profile of projects, and attract private finance in the African RE sector. Finally, MDBs and DFIs need to look beyond individual project transactions, using renewable energy investment strategically and supporting clean industrial development and economic transformation more broadly.

Key recommendations for EU institutions and member states in the African renewable energy space include:

Focus on green economy transitions	Better coordinate commercial interests and partnerships
Reframe renewable energy investments under a broader 'just economic transition' objective, linking projects to a context-driven vision of clean economic development. This means supporting the development of regional green corridors, but also supporting innovation and technology transfer for green industrial applications.	Ensure that the commercial interests of EU demand for African energy and hydrogen supports a clean economy transition locally, and avoids creating new dependencies.
Make MDBs and DFIs up to the task	**Develop 'just energy transition partnerships' with emerging gas producers and exporters**
As shareholders, create incentives to prioritise clean energy investment in Africa, including earmarked portfolios, a segmented balance sheet, and build capacity and a reward structure for higher risk, but strategic clean energy projects.	The idea of a just energy transition should be applied to both existing fossil fuel dependencies and emerging ones. Partners should work with emerging African producers on a new generation of JETPs in order to manage future transition risks, and create viable alternative pathways in the short term. They should also work with African institutions and DFIs on an African definition of a 'transition fuel', in order to minimise the future risks and environmental harm.

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