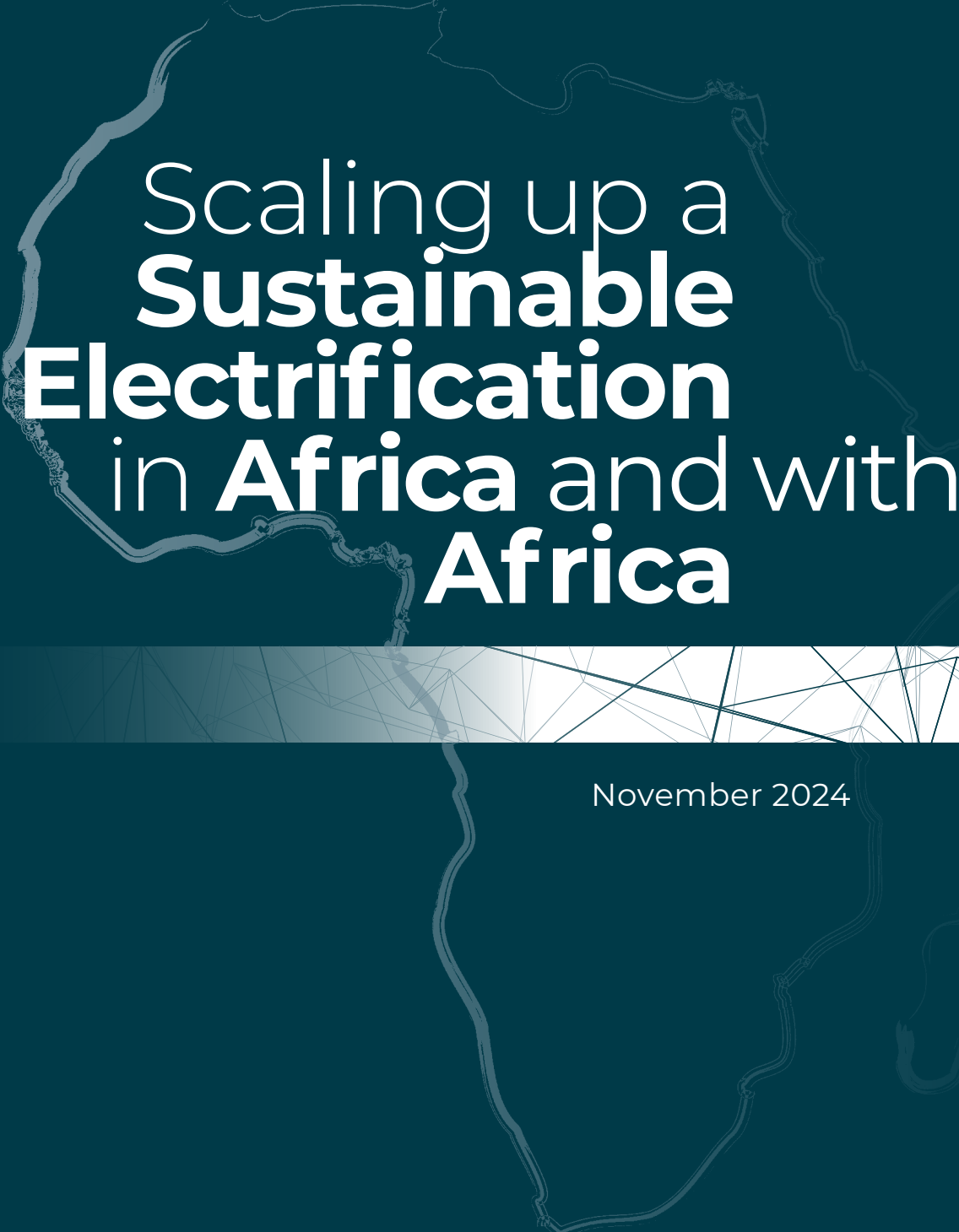




Scaling up a **Sustainable Electrification** in **Africa** and with **Africa**

November 2024

Table of Contents

Foreword	5
Executive Summary	6
1. Setting the Scene: Key Macrotrends in Africa	9
2. Energy's Role in Africa's Sustainable Transformation	15
3. Key Components of Sustainable Electrification	23
3.1. Define Optimal Electrification Plans (Centralised and Decentralised Solutions)	23
3.2. Expand the Electricity Generation Fleet with Renewable Energy Technologies	24
3.3. Reinforce and Develop Reliable Electric Grids	29
3.4. Expand Digitalisation and Smart Grids	31
3.5. Support Green Industrialisation	33
3.6. Electrify End Use of Energy	36
4. Recommendation for Leaders and Policy Makers	39
4.1. Setting Ambitious Targets and Goals, Coordinate and Harmonise Policies	39
4.2. Implementing Regulatory Reforms and Focused Incentives	40
4.3. Developing Partnerships and Collaboration	41
4.4. Breaking the Investment Ceiling	43
4.5. Raising Awareness and Building Capacity	44
Conclusion	48
Case Studies	49
Bibliography	68
Acknowledgments	69

Table of Figures

Figure 1: Change in population between urban and rural areas by region	9
Figure 2: Key macro-trends driving Africa's socio-economic transformation	10
Figure 3: Share and absolute size of population without access to electricity, 2022	11
Figure 4: The strong relationship between electricity consumption and income	12
Figure 5: Africa's role in global energy systems	13
Figure 6: Key context for the African power sector	15
Figure 7: Urban and peri-urban areas in Johannesburg and Nairobi	17
Figure 8: Electricity demand by sector and region (2020-2030)	18
Figure 9: Annual energy investments in Africa (2016-2030)	18
Figure 10: Key Africa development indicators, 2023-30	19
Figure 11: Women's participation in the energy sector	21
Figure 12: Barriers hampering start-up growth in Africa	22
Figure 13: Key components of sustainable electrification	23
Figure 14: People gaining access to electricity by technology by 2030 in the SAS	24
Figure 15: Levelised cost of electricity and power generation growth in Africa	25
Figure 16: Electricity generation by region and source in the IEA Sustainable Africa Scenario	26
Figure 17: Renewable capacity growth disparities	27
Figure 18: The great solar acceleration	28
Figure 19: Power generation capacity addition and retirement by source in Africa	28
Figure 20: Jobs created in clean energy and related sectors up to 2030	29
Figure 21: Utility vicious cycle	30
Figure 22: Annual grid investment to 2030 based on recent growth rates in Africa (2022-2030)	30
Figure 23: Ageing grids challenges	32
Figure 24: The new dynamic paradigm of distribution operator	32
Figure 25: Manufacturing value added per capita by world region, 2020	34
Figure 26: The challenges in the full value chain for green hydrogen	35
Figure 27: Share of African global production of selected minerals, 2020	36
Figure 28: Energy efficiency in electrification of end uses	37
Figure 29: Improved, and increased access to electricity domestic consumption in the best Africa Scenario	37
Figure 30: People gaining access to clean cooking in the Access for All Scenario by 2030 in Sub-Saharan Africa	38
Figure 31: Africa's clean energy challenge	43

Table of Boxes

Box 1. Geopolitics and Energy Security	20
Box 2. Making the Case for Women	20
Box 3. Making the Case for Youth	21
Box 4. Making the Case for Renewables	27
Box 6. Critical Materials	35
Box 5. Scaling-up Africa's Access to Clean Cooking	37
Box 7. Partnership Agreements EU – Africa	41
Box 8. RES4Africa's Capacity Building Program	45

Table of Case Studies

Shoring up Sustainable Energy Distribution in the City of Cape Town, ABB	50
Advancing Africa's Electricity Reform Agenda: Towards Increased Private Sector Participation in Clean Energy Infrastructure, AFRY	51
RES Integration in South Africa, CESI	53
The Case of South Africa, ENEL GREEN POWER	55
Energy Plans and Policies & the Energy Poverty Index: the Case of Colombia, GME	57
Energy Poverty and the Role of Productive Uses of Energy – The Case of Haiti, GME	58
The Digital Revolution of Distribution Grids, GRIDSPERTISE	61
BESS – South Africa Project, NIDEC	63
Deploying Battery Energy Storage Solutions in Tunisia, RINA	64
Replacement of Diesel Generators for Pumped Water Station, RINA	65
Sustainable Electrification Projects Empowering Communities in Menoufia Governorate, SCHNEIDER ELECTRIC	66

Foreword

For Africa, electrification emerges as one of the most cost-effective and efficient strategy not only for decarbonising energy final uses, in transport, buildings, and across industry and agriculture, but also in supporting continued socio-economic development. Governments will need to drive this energy transition by developing and implementing consistent long-term plans, policies and electricity roadmaps. Transmission and distribution networks will play a critical part in facilitating widespread electrification and require substantial investments alongside regulatory frameworks that promote and support the development of zero and low-emission technologies. Electrification technologies are mature, but a range of existing policy and economic barriers still currently hinder their full potential.

Switching final uses of energy (transports, buildings, industry etc.) from fossil fuels to electricity can offer numerous direct and indirect benefits for customers, the environment, and society at large. These include increased energy security and efficiency, economic savings, reduced greenhouse gas emissions, improved air quality, and enhanced safety. Most significantly for Africa, electrification can help to improve energy access as well as human health and wellbeing, particularly for vulnerable households, by transitioning from inefficient and polluting energy sources to more reliable, cost effective and clean electricity. New markets, potential clients, and business models can also be identified and unlocked by increasing reliance on electricity as the primary energy carrier. This in turn fosters both innovation and economic growth, and also contributes to the circularity of consumption patterns, thereby promoting and encouraging more sustainable community and business practices.

This paper has been developed to help policymakers and other stakeholders improve their understanding of how existing electrification technologies might be rolled out at scale across Africa. It highlights the key barriers and challenges that are currently holding back the implementation of these solutions, a proposed structure for how they might be addressed, and the potential benefits that these steps, when applied at scale, could deliver. African policymakers have an opportunity to prioritise and deliver on these actions to enable a real and lasting improvement in socio-economic development. By doing so, they will at the same time be equipping the Continent in the best way that they can for the consequences of climate change and other global developments that are already challenging the robustness and resilience of current infrastructure, business operations, societies and communities today.

RES4Africa Foundation

Executive Summary

Africa has historically often been considered a marginal continent in terms of global geopolitics and economic influence on the world stage, despite its size and population. This perception has now changed largely as a result of the **exponential levels of growth** being witnessed across multiple areas. Population levels continue to increase, urbanisation trends are accelerating, and there continues to be a transition in many rural and traditional economies, with the help of digitisation and new technologies, to greater levels of industrialisation. These changes are sadly not uniform across the Continent and severe contradictions remain with more than 600 million people lacking access to electricity and almost 1 billion people without clean cooking systems. This results in difficult life conditions for many and persistently high levels of premature deaths.

A key enabler to support Africa's continued socio-economic development lies within the **energy sector**: it can provide many of the solutions, and also unlock new opportunities. To access this, substantial decisions need to be made by relevant stakeholders to identify and promote the right energy sources that can make this development **just**, in terms of social equality, and **sustainable**, from an economical and environmental point of view. One credible solution that can deliver these outcomes, based on experience elsewhere in the world, is to scale up the **electrification of the energy system** along the entire value chain, investing in clean energy generating plants, in new grid infrastructure and in the electrification of final uses.

RES4Africa has identified six essential and linked components that can drive the sustainable electrification of Africa.

Firstly, there is a need to define new country and regional **electric development plans** or reshape the existing ones. These will help to identify the size and location of generation facilities and grid infrastructures needed.

Secondly, it will be vital to deploy at scale, a range of **renewable energy generation systems** that can support the decarbonisation of power sector. These projects should consider the most competitive technologies currently available. These include solar PV, both at utility scale and in decentralised forms, onshore and offshore wind, hydro, geothermal power plants and bioenergy. Energy storage systems should also be considered as a necessary complement to these technologies to ensure electrical system flexibility and stability.

Thirdly, it will be necessary to make large investments in **grid extension and reinforcement**. Both national and regional transmission grids, and the more local distribution grids will need to be considered. In that way it will be possible to impact rural areas that are partially served at the moment by off-grid solutions (mini/micro grids and Solar Home Systems) and cover the fast-growing peri-urban areas in the big mega-cities.

Fourthly, the enormous potential of **digital technologies** should also be considered and applied across the energy sector. IoT, Big data, AI, Apps for users etc. can provide particularly

big results – at relatively low cost – in terms of production efficiency, grid resilience and power transfer capacity, quality of service to end customers and innovative commercial approaches.

Fifthly, sustainable electrification can also provide significant support for the **development of the wider African industrial system**. This is currently often inefficient, polluting, unfair on labour practices, exploitative and wasteful of raw materials. If followed through, electrification in hard-to-abate sectors and the exploration of new opportunities e.g. green hydrogen production, can and will boost local manufacturing capacity.

The final step is to look closely at the **electrification of final uses**, in particular the ones that are currently based on fossil fuels. Electrification in buildings should be considered first, looking to decarbonise heating, cooling and cooking, whilst simultaneously improving cost-effectiveness. Mobility is then another important sector where the competitiveness of e-solutions is key, and the introduction of electrification in agriculture can also play a significant role.

To deliver these changes in short term will not be easy, but the best time to act remains now. RES4Africa hopes to support greater awareness and progress at this important juncture by identifying the key components, and the policy actions that stakeholders should focus on. **National and regional policies and regulations** will be the initial trigger to unlock local and international investments both from the public and private sector. The high existing cost of capital constraints can then be addressed in parallel with appropriate and **innovative financial tools**. The **creation of a local workforce** skilled in the new energy technologies will require a long-term view and sustained support from various actors across the economy, but then also deliver lasting results and benefits.

With the development of this policy paper, RES4Africa aims to provide an objective perspective for policy makers, public entities, financing entities, utilities, manufacturers of components, small entrepreneurs and communities regarding the role of **sustainable electrification as a necessary prerequisite to eradicate poverty and inequalities in Africa**, and provide practical and actionable insights and suggestions to support next steps. Doing so will enable continued progress on socio-economic development and equip the continent with the resilience that it needs to cope with the consequences of climate change.

RES4Africa remains focused, engaged and committed to supporting African stakeholders, and deploying the resources and services at its disposal to enable the electrification transition in the coming years.

As can be noted, in this document Africa is often depicted as a uniform entity and for which the recipes are applicable univocally and regardless of region or Country. RES4Africa acknowledges that Africa is the largest Continent on the globe and presents enormous variety in geo-morphological, cultural and socio-economic terms. The attempt here expressed to outline objectives and recommendations for the sustainable development of the energy sector through a univocal and non-differentiated description leads to inevitable inaccuracies and approximations. This approach is solely for the efficiency of the paper and does not intend to diminish the rich variety and individual characteristics of each African nation.

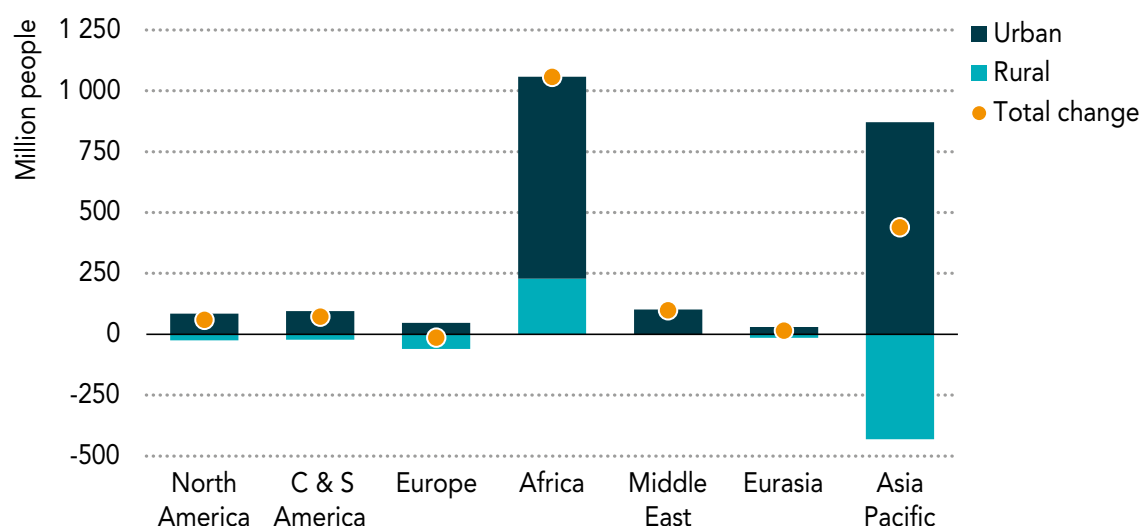
The background of the entire page is a dark blue gradient. Overlaid on this is a complex, abstract geometric pattern. It consists of numerous thin, light blue lines that connect various points. These points are represented by small circles and squares of different sizes, some of which are also light blue, while others are white. The pattern is dense and somewhat chaotic, resembling a network or a molecular structure. It covers most of the page, with a slight fade towards the left edge.

Chapters

1. Setting the Scene: Key Macrotrends in Africa

For many years, Africa has been experiencing exceptional economic growth. While the economic exploitation of the continent's natural resources has been the main driver behind this, in the past decade something has changed. There has been a growing recognition of the importance and urgency of considering not only economic growth, but also social inclusion, environmental protection and equitable distribution of resources. The realisation that in the coming decades the Continent will see rapidly expanding **urbanisation and population growth** has changed local and global mindsets (Figure 1).

Figure 1: Change in population between urban and rural areas by region

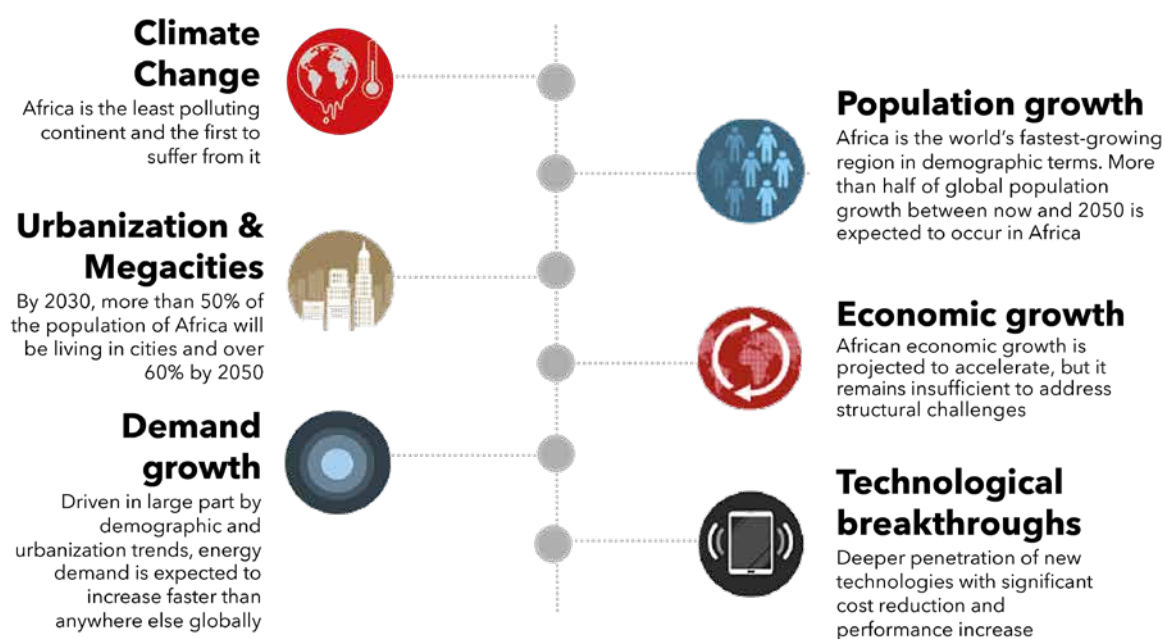


Source: IEA World Energy Outlook 2023

By 2050¹, Africa's population is expected to reach 2.5 billion people – 56% of which will live in urban areas – while tens of millions of young people will join the labour market every year. This will result in a growing expectation for demand for food, water, jobs, etc. and access to services such as healthcare, education, transportation (Figure 2).

¹ Statista – Forecast of the total population of Africa from 2020 to 2050

Figure 2: Key macro-trends driving Africa's socio-economic transformation



Source: RES4Africa

In addition to challenging levels of growth, **inadequate levels of existing infrastructure, weak governance, and conflicts** are also undermining countries' attempts to improve general living standards and economic growth. On top of this, despite accounting for the smallest and historically negligible share of global greenhouse gas emissions, **vulnerability to climate change** is also becoming a more major factor. Recent examples include extreme droughts, floods, and ongoing desertification, which threaten livelihoods and wellbeing for hundreds of millions of individuals. Statista's² recently published study shows that Africa has been suffering from more frequent floods, storms and droughts, with recorded events jumping from 85 events in 1970s (1970-1979) to over 540 events between 2010 and 2019. The impact of these has been devastating, with over 730,000 deaths since 1970 due to climate change, and an economic toll amounting to \$38.5 billion.

With **severe climate events now happening more frequently**, challenges faced by initiatives to improve the healthcare system, food security, access to clean water, resilience of the energy sector are multiplied. The end result is that Africa continues to have some of the world's most fragile countries and communities with more than 400 million people in Sub-Saharan Africa living below the poverty line, and worryingly, this number continues to increase³. Making headway against these challenges will require concerted efforts from governments, civil society, the private sector, and the international community to implement sustainable development strategies that reflect the needs and aspirations of African societies.

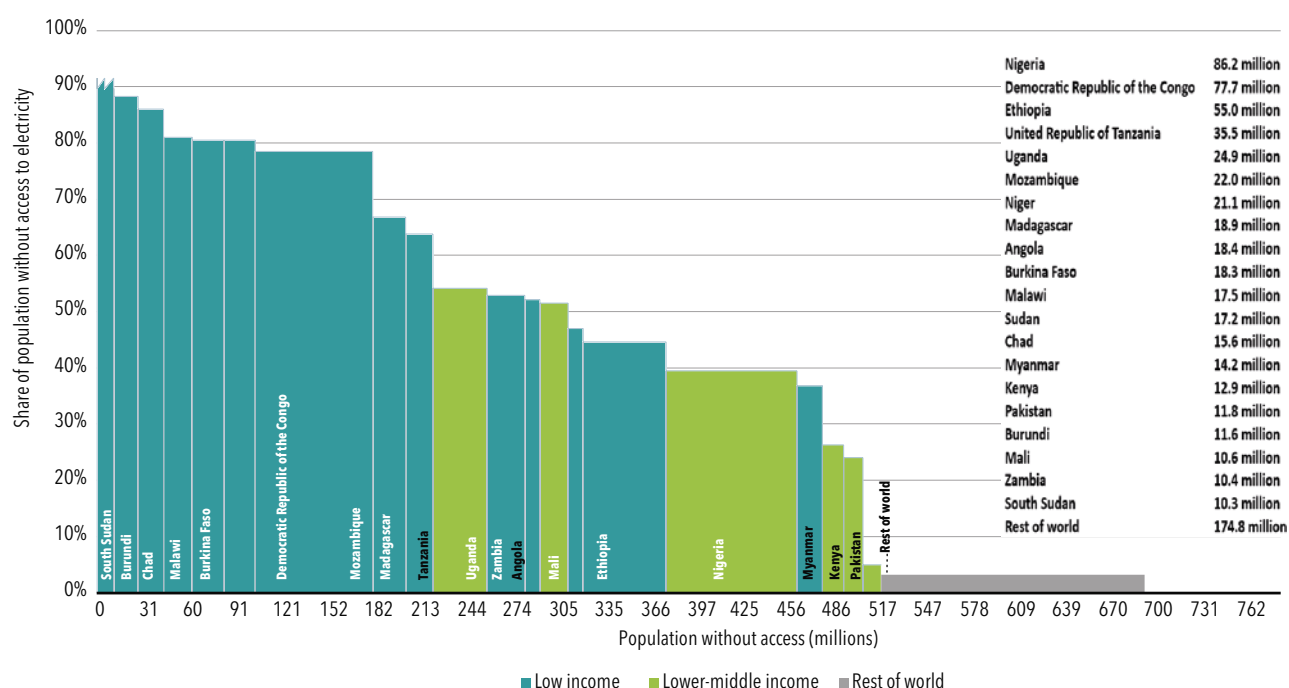
² Statista – Climate change in Africa – statistics & facts

³ World Bank – The number of poor people continues to rise in Sub-Saharan Africa, despite a slow decline in the poverty rate

Ensuring a stable, affordable, and reliable energy supply for economic growth is an urgent imperative, and if left unaddressed in the short term, will have regional repercussions. Many of these existing factors are significant drivers behind current migration flows, security threats, and political instability. Well-designed collaborative decisions and actions taken today will significantly influence Africa's trajectory, and that of its neighbours in the coming decades.

Compounding the challenge is that **notable advancements made in recent years across various socio-economic areas are currently at risk of being eroded**, including reductions in poverty levels and inequality, and improvements in access to essential services such as electricity (Figure 3, 4). The data highlights that progress remains both too slow and insufficient to align with the 2030 targets outlined in the UN Sustainable Development Goals (SDGs) (IEA, IRENA, UNSD, World Bank, WHO. 2024). Partly this has been a consequence of recent global developments, which have hindered and, in some cases, reversed previous progress. The COVID-19 pandemic, compounded by the ripple effects stemming from other geopolitical events such as the Ukraine and Middle East crises, have exacerbated existing vulnerabilities within Africa's health, energy and socio-economic systems. The aftermath of the pandemic, coupled with sluggish economic growth, escalating debt levels, and high interest rates, have also increased levels of debt distress across a growing number of African countries all contributing to the erosion of previous achievements.

Figure 3: Share and absolute size of population without access to electricity, 2022



Source: IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024

While the problems are clear, the solutions still need to be designed in detail. Africa's long-term energy and electricity systems can be made future-proof, inclusive, sustainable, and equitable if the right decisions and action are taken today. Governments, development partners, and the private sector need to grasp the current opportunity to work together to set this in motion and, with continued commitment, see it through. They will need to resist the pressures of current geopolitical developments that are leading to a more fragmented world and ensure that the erosion of trust in bilateral and multilateral engagements does not distract them. They will need to also accept that maintaining the status quo is no longer a viable option; instead, Africa should embrace innovative and forward-thinking strategies on energy and in other sectors that reflect individual country circumstances.

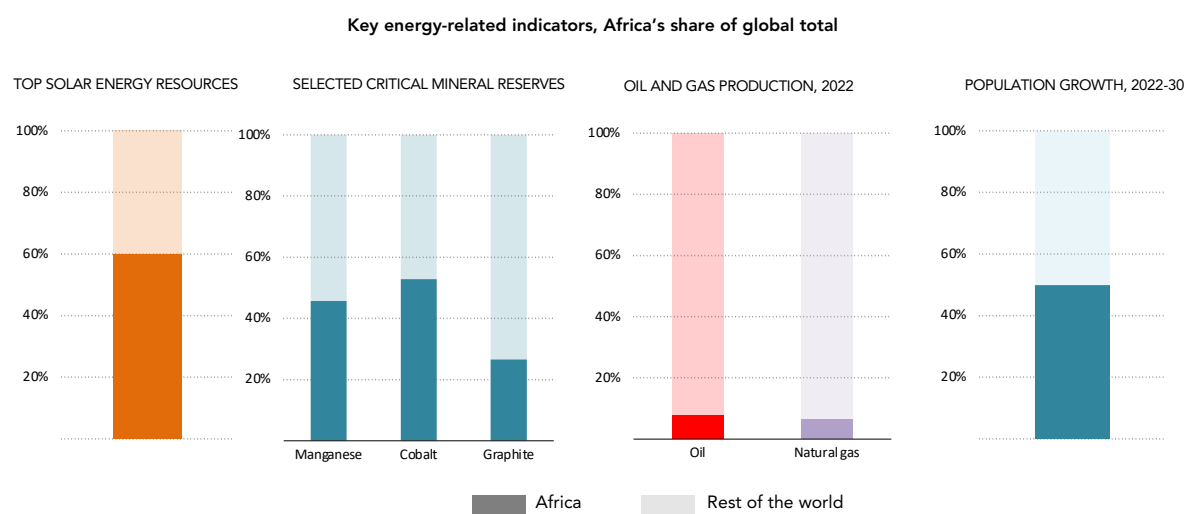
Figure 4: The strong relationship between electricity consumption and income



Source: GEAPP, *Powering People and Planet*, 2022

To ensure that its local communities and businesses can continue to thrive, Africa can and should ensure that its **plans include a significant role in the global energy system**. It has abundant natural resources, including solar radiation and other renewables, minerals and fossil fuels (Figure 5). The Sustainable African Scenario developed by IEA provides a comprehensive understanding of Africa's possibilities and challenges by 2030, and their impact on both African and global energy transitions. The Continent is not there yet, mainly due to fossil fuels having historically played a primary role driving economic growth and income through exports. Currently only 1% of the global installed solar PV capacity is located in Africa (IEA, 2022). However, studies by IRENA have indicated that the continent's installed renewable capacity could grow from 54 GW in 2020 to more than 530 GW by 2040, with solar PV capacity soaring to 340 GW and wind energy rising to 90 GW.

Figure 5: Africa's role in global energy systems



Source: IEA presentation to the G7 Leaders for the Energy for Growth in Africa Initiative

The issues highlighted above need to remain at the centre of international debates such as Conferences of Parties and G20 to enable meaningful progress to be made in the Continent. **International stakeholders will also need to re-establish themselves as a reliable and long-term partner to Africa.** Trust will need to be rebuilt, as to date, many individual African countries have grown increasingly wary and vocal about external interference in their internal affairs, including in economic development strategies and governance. Recent geopolitical shifts have led to increased scepticism towards foreign economic policies in Africa, prompting dissent from civil society and others. Past crises have also strained relations among partners, necessitating a focus on efforts to rebuild them.

As a precursor to engaging in an open dialogue with African stakeholders, **EU countries must firstly acknowledge Africa's development imperative** and commit to advancing it within the framework of the broader UN Sustainable Development Goals (SDGs) and plans that individual countries may have. Aligning with the EU-AU Joint Vision for 2030, future cooperation will need to be committed to "consolidating a renewed partnership focused on solidarity, security, peace, sustainable economic development, and prosperity for citizens and future generations of both continents"⁴.

In return, to prepare for meaningful discussions with the EU new Commission and G20, the **African Union and African countries could prepare by considering three key areas**, and engaging on each of these through a series of preliminary discussions.

1. **Robust business case and data:** Ensure that complete and up-to-date data on resource availability, energy access requirements, project development opportunities, and success stories is available to support the development of local business cases. Clearly outline the financial requirements for

⁴ 6th European Union – African Union Summit: A Joint Vision for 2030, 2022

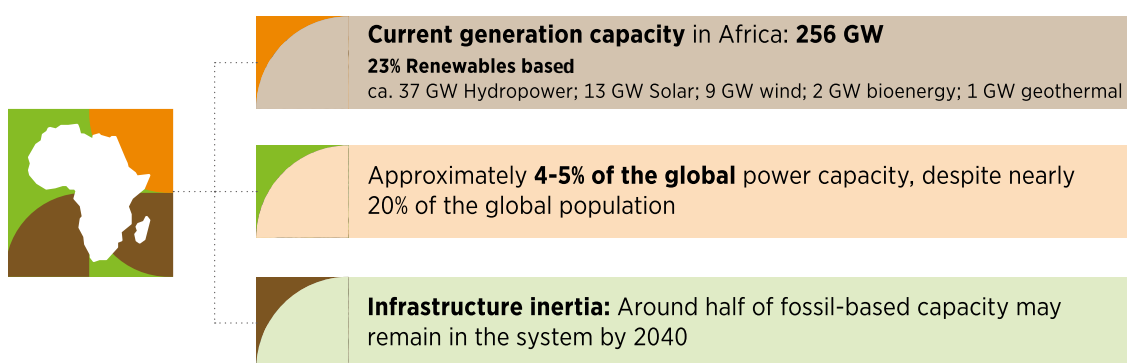
achieving energy goals, that includes grid extension, renewable energy projects, and technology upgrades, and suggest opportunities for more innovative financing models.

2. **Aligned policies and priorities:** Coordinate among regional African nations to develop a more unified strategy that represents the Continent's collective energy and development interests and goals. Ensure that there is a greater alignment of energy policies and objectives that together clearly highlight the key priority areas: sustainable electrification, greater development of renewable energy projects, and value addition for critical raw materials.
3. **Greater action on institutional reform and climate change:** Show that they are developing and improving the regulatory frameworks needed to support energy investments, that transparency and stability is improving, and that they are investing in building the capacity of local institutions and the workforce. Alongside this reiterate their commitment to climate goals, adaptation, resilience and sustainable development, and how their efforts are aligned with global efforts to combat climate change.

2. Energy's Role in Africa's Sustainable Transformation

Historically the link between energy and socio-economic development in Africa has been based on and driven by fossil fuels. **The region's long-standing and heavy reliance on fossil fuels**, particularly coal and oil, presents a significant legacy challenge to any proposed change in the energy sector. Given their ease of use, fossil fuels remain the dominant energy sources of choice in many African countries, even though their use contributes to continued environmental degradation, air pollution, and climate change. Ongoing reliance on these sources will continue to expose African economies to volatile global energy markets and price fluctuations, making energy access and affordability unpredictable for consumers and hindering long-term energy security and sustained socio-economic development efforts.

Figure 6: Key context for the African power sector



Source: IRENA contribution to G7: The energy transition in Africa, 2024

International experience has shown that **sustainable energy sources have the potential**, and are a much better fit, **to support a just and lasting approach to socio-economic development**. The introduction of clean energy sources and improved electric systems in Africa can promote wider and faster regional economic growth that is inclusive, environmentally sustainable, and that addresses the shortcomings and failings of legacy approaches.

By this approach, African countries can stimulate **economic growth**. Access to reliable and affordable energy remains essential for **powering industries, businesses**, and in supporting the **development of wider infrastructures**. Energy-intensive sectors such as manufacturing, mining, and agriculture will require significant amounts of power to operate efficiently. By attracting investments to develop these sectors there is the opportunity to **create jobs, enhance productivity, and increase poverty alleviation efforts**.

More reliable **access at a household level** enables them to engage in income-generating activities, such as small-scale enterprises and agricultural production, thereby lifting people

out of poverty. It will also improve living conditions, as well as the general health and wellbeing of individuals simply by enabling greater and more reliable access to modern amenities such as lighting, cooking facilities, refrigeration, and communication technologies.

Energy is also vital for supporting essential services such as **healthcare and education**. Reliable electricity enables the operation of healthcare facilities, including hospitals, clinics, and mobile medical equipment, ensuring access to critical healthcare services and improving health outcomes. Likewise, access to energy is crucial for educational institutions, powering schools, computer labs, and educational materials, facilitating learning opportunities and enhancing educational opportunities and outcomes for individuals. Better health and education contribute to an overall enhanced quality of life and to a reduction in poverty and premature deaths.

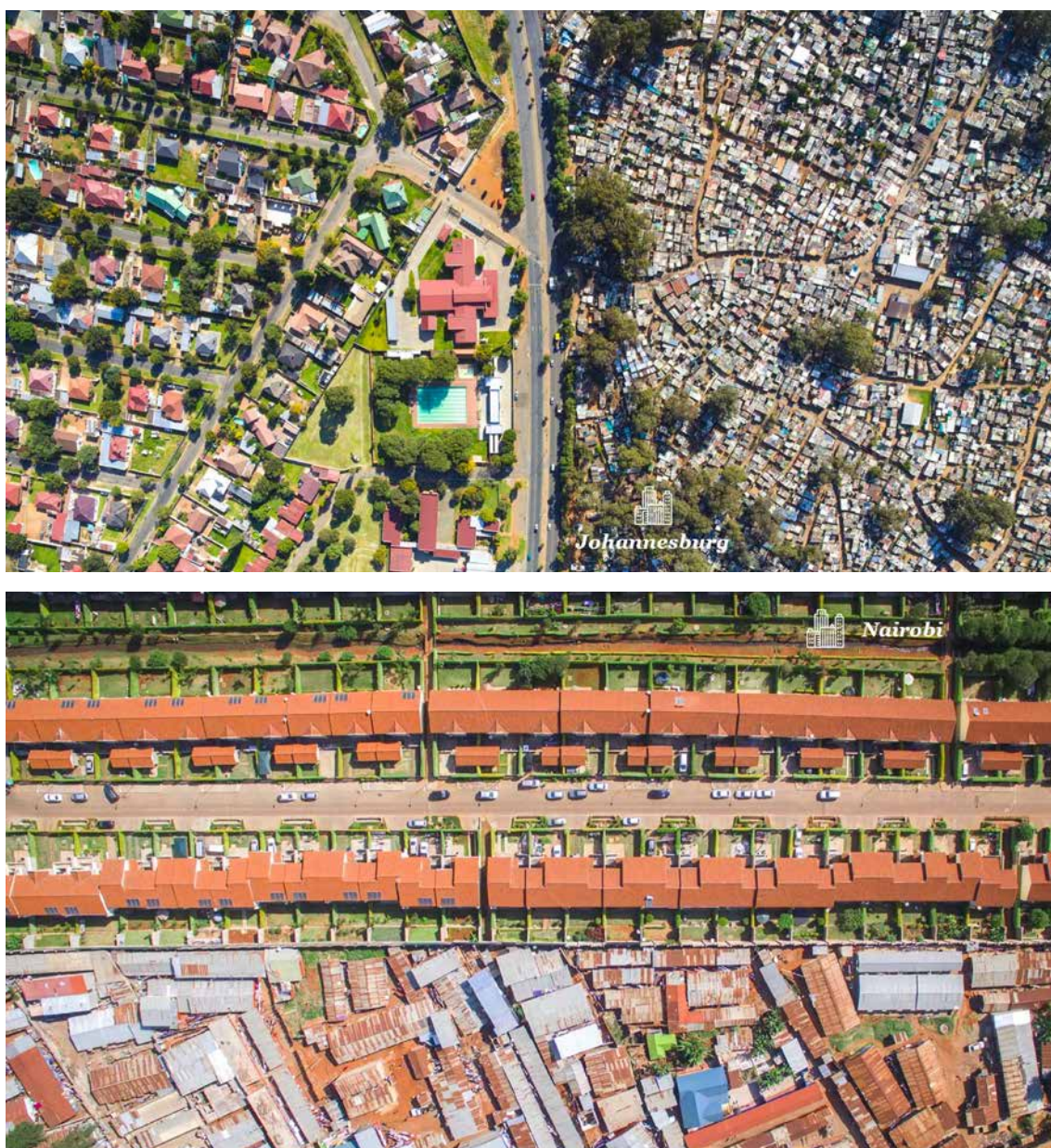
In many African countries, a significant portion of the population resides in **rural areas**, where access to energy infrastructure is often limited. Extending energy services to rural communities can improve general access to clean water and sanitation for individuals. It can also catalyse rural development by enabling agricultural mechanisation, processing, and value addition, and supporting the development of rural industries and businesses, taken together they help to reduce rural-urban disparities and promote more inclusive development. The availability of energy for shared services can also foster greater security, safety, and cohesion within communities.

With more and more people being attracted from the regions to the **big mega-cities**, one consequence is the rapid growth of informal townships or slums. These usually do not have any formal housing or public services available, including water, electricity or sewage systems. Guaranteeing access to energy in those areas as a minimum will become as important if not more crucial. Figure 7 provides a visual example of the disparities that can arise if **peri-urban areas development** is left unplanned and unmanaged.

While energy is critical for development, the **environmental impact** of current means of energy production and consumption should not be overlooked. Making a decision to phase out fossil fuels will have immediate and welcome environmental and cost benefits, and lead to positive economic consequences at a local and national level. With ample renewable energy resources that can be brought to bear, and proven technologies, investing in renewable energy technologies will not only expand energy access but also help to significantly mitigate greenhouse gas emissions and reduce local environmental and health impacts. A focus in parallel on improving energy efficiency in buildings, industries, and transportation sectors can provide further benefits. These developments will need to be accompanied by **climate-resilient electrification strategies** to ensure that existing and new infrastructure and services are able to withstand upcoming climate-related risks and disasters.

If adopted across countries, this approach could support improved **regional responses**, such as alignment on energy and market planning, on policies, standards and approaches, the opportunity for cross-border electricity trade, and collaboration on shared infrastructure development. Acting regionally can enable countries to reduce both costs of new infrastructure and mitigate risks, but more importantly harness their comparative advantages, optimise resource utilisation, enhance energy security, reliability and affordability for all.

Figure 7: Urban and peri-urban areas in Johannesburg and Nairobi



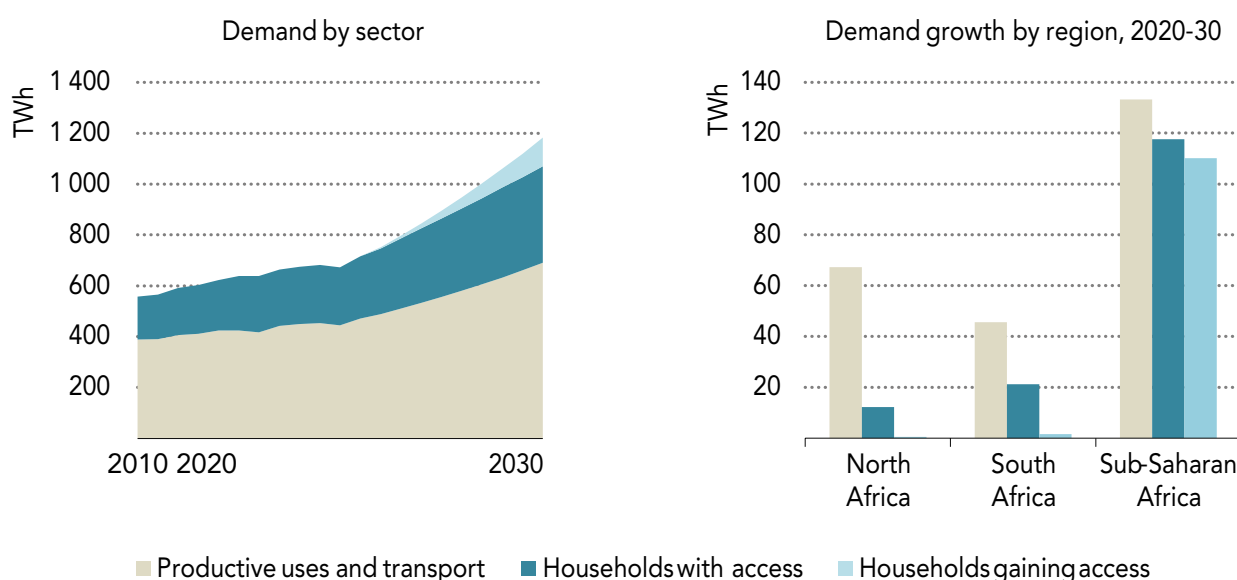
In looking to implement and realise the potential of renewable energy sources, it will be important to identify and take into account the peculiarities of the current energy systems, the original underlying needs that drove these outcomes, and the demand profile and other requirements that will shape how the wider energy across Africa should evolve in the future.

Based on projections of population and wider economic growth, **Africa's demand for energy will increase rapidly in the near future.** It can easily be seen that the current energy set up and approach will struggle to meet the expected levels of final electricity demand (Figure 8). Many energy scenarios foresee a sharp increase in Africa's final energy consumption across all economic sectors: IEA's Sustainable Africa Scenario (SAS) estimates an increase in TFC⁵ of

⁵ TFC: Total Final Consumption of Energy

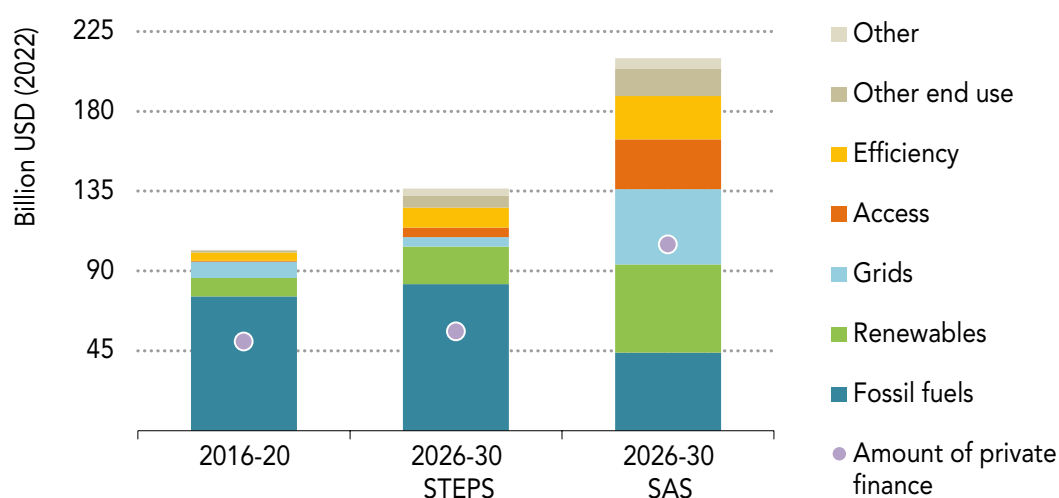
modern fuels in Africa of about 5% in average per year between 2020 and 2030, compared with 2% over the previous decade. All energy scenarios also show that the decade to 2030 will see a surge in electricity consumption with African electricity demand increasing by around 75% from 680 TWh to 1,180 TWh in the IEA's SAS (IEA, 2022).

Figure 8: Electricity demand by sector and region (2020-2030)



Source: IEA Africa Energy Outlook 2022

Figure 9: Annual energy investments in Africa (2016-2030)



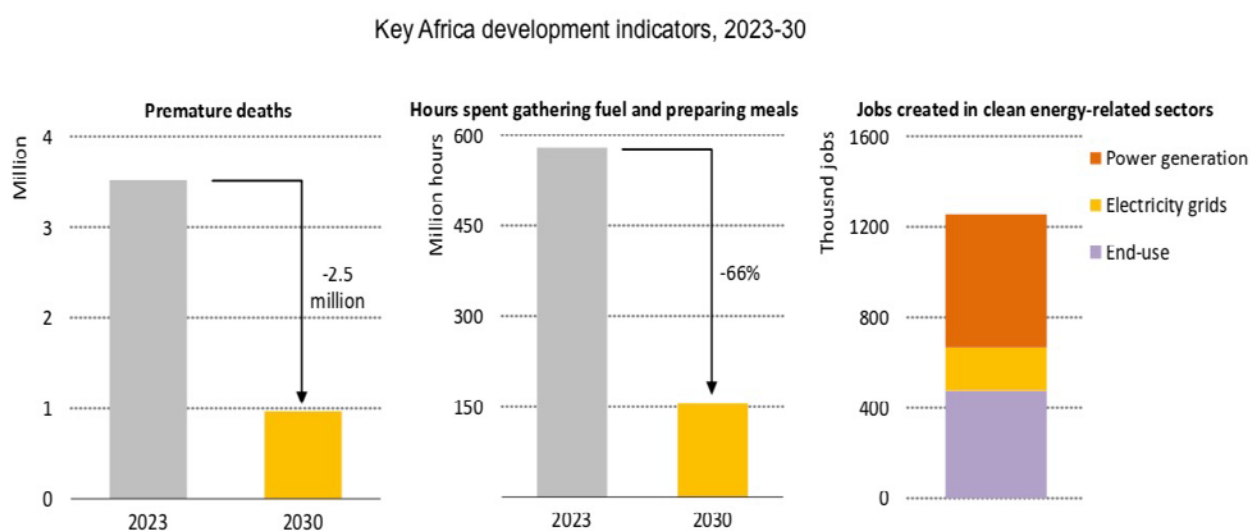
Source: IEA Financing Clean Energy in Africa

Delivering energy access at scale needs to remain a key priority. Despite advancements in recent years, existing national grids continue to fail most Africans, and as a result, a considerable portion of the continent's citizens still lack access to reliable and affordable electricity. Population growth continues to outstrip the expansion of access to electricity, leaving an estimated 600 million Africans without energy, a figure higher than pre-pandemic levels. This lack of access inhibits economic growth and restricts opportunities for education and healthcare. It also perpetuates cycles of poverty, particularly in rural areas where electrification rates lag behind urban centres, further deepening socio-economic disparities. It is crucial to recognise that historically, no country has achieved improved living standards and societal prosperity without a corresponding increase in energy consumption.

Existing socio-economic disparities need to be acknowledged, with wealthier urban areas often having better access to electricity and modern energy services compared to peri-urban areas and rural communities. This merely serves to deliver an endless cycle that perpetuates disparities in income, education, and healthcare outcomes. Additionally, marginalised groups are increasingly and disproportionately affected by energy poverty, lacking access to clean cooking facilities, lighting, and other basic energy services. Bridging these socio-economic gaps will require targeted policies and investments aimed at ensuring equitable distribution of energy resources across all segments of society.

Having discussed the pivotal role of energy sector in all segments of society and its impact on Africa's socio-economic development, the concept of **sustainable electrification** assumes a fundamental role especially for younger generations that more and more base their activities on electrical and digital devices. RES4Africa has formulated a comprehensive framework delineating the essential elements needed in order to solve the energy equation for Africa.

Figure 10: Key Africa development indicators, 2023-30



Source: IEA presentation to the G7 Leaders for the Energy for Growth in Africa Initiative

BOX 1. GEOPOLITICS AND ENERGY SECURITY

Energy security has long been crucial for global and national stability given our society's and economy's growing dependence on uninterrupted access to affordable energy sources. As policymakers begin to realise the consequences of, and the need to urgently address population growth, climate change and geopolitical shifts, more attention is now also being paid to finding scalable, affordable and reliable solutions to enable a just transition. At the heart of this remains energy security, however the way in which this can be addressed has become more complicated given current geopolitical and economic uncertainties.

Recent years have seen the world slowly beginning to recover from the COVID-19 pandemic. The Ukraine war then induced an unprecedented global energy crisis, impacting trade, transports, and food security and reshaping regional and international dynamics. This is now also continuing with the ongoing conflict in the Middle East. The EU's REPowerEU Plan was an earlier response to halt the reliance on Russian fossil fuels. This contributed to the emergence of a new energy landscape especially for North African countries that see an encouraging trend for sustainable energy cooperation both with Europe and new partnerships with countries such as China and India.

In this regard, RES4Africa developed the policy paper **"Navigating the transition in times of uncertainty: from a paradigm of energy security to electricity security in North Africa"**. This delves deep into the criticalities faced by North Africa's energy transition amidst global uncertainty and shifting international energy dynamics. The paper provides recommendations on how to integrate energy security and energy transition within a regional understanding to ensure the right balance in the energy trilemma i.e. security, equity and sustainability. It includes identification of key enablers for the development of renewable energies (e.g. prioritise the clean energy production for domestic needs and incentivise the related self-consumption as well as support green industrialisation and green hydrogen) and for fostering regional integration through the promotion of public to private dialogue between energy stakeholders from the region. The focus is also on the reinforcement and development of reliable electricity grids as well as energy efficiency and safeguarding of vulnerable segments. Clean energy can help to lower the risks for African economies by reducing the impact of volatility in global energy markets. This in turn contributes to a more resilient national energy system that is also less impacted by external events such as pandemics, natural emergencies, conflicts, and economic recessions.

See more

BOX 2. MAKING THE CASE FOR WOMEN

Any discussion and activity to arrive at a sustainable energy transformation that can support economic growth and prosperity in the coming decades, will need to consider and build in the topic of inclusion and gender equality. Recent data shows that women still represent less than 20% of the energy workforce compared to 40% in the worldwide economy average (IEA, 2023a). More worryingly, women working in the energy sector also still tend to earn 20% less than their male counterparts⁶.

The energy sector thus seems to be exacerbating the challenges that women already face in other economy sectors. Changing the status quo, and supporting the steps needed to enable greater inclusion

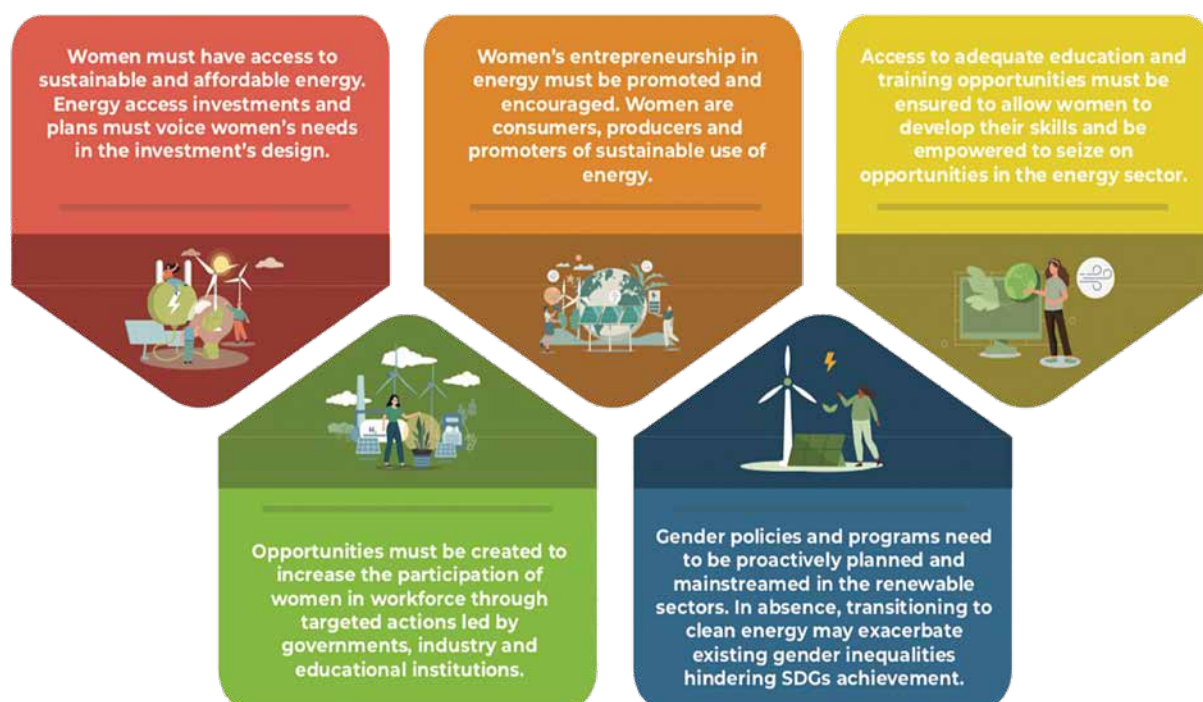
⁶ IEA, Energy and Gender

of women in the energy sector will require both multi-stakeholder engagement, and concerted action by these across the following five dimensions:

1. Energy access
2. Energy-related education
3. Employment and leadership
4. Entrepreneurship
5. Policy-enabling environment.

On International Women's Day, RES4Africa presented "**A just transition or just a transition: making the case for women in energy**". The report analyses the results of online surveys addressed to women working in the energy sector in North Africa, and provides key recommendations on how to ensure that the benefits from the energy transition are equitable and accessible for all (Figure 11).

Figure 11: Women's participation in the energy sector



Source: *A just transition or just a transition: making the case for women in energy*, RES4Africa

[See more](#)

BOX 3. MAKING THE CASE FOR YOUTH

The key to a thriving and sustainable future for Africa also lies in the innovative thinking of its youth. When considering the key macro-trends driving Africa's socio-economic transformation – population growth, urbanisation, demand growth – a future where universal access to energy is a reality can be achieved by empowering young people, innovators, entrepreneurs, and start-ups with opportunities and a platform to voice their ideas.

In recent years, the African start-up ecosystem has been growing rapidly with an increasing number of entrepreneurs launching innovative businesses in a variety of sectors. In the timeframe between 2015 and 2023, there has been a remarkable surge in annual investments for startups, witnessing a growth of 1,195%. In 2023, investments in the energy sector increase by 335.2% compared to 2022, with specific countries emerging as regional leaders of the continent i.e. Nigeria, Egypt, Kenya, and South Africa (Disrupt Africa, 2023).

Energy and Agri-Tech sectors present opportunities for investment and growth, but African start-ups still face significant challenges, including limited access to funding and know-how, inadequate infrastructure, and regulatory barriers (Figure 12). Fintech dominates the start-up ecosystem, followed by e-commerce and e-health. This discrepancy is also reflected in the support space, with less accelerators focused on renewable energy enterprises. Thus, there is a need and space for new players to support start-ups both in terms of technical assistance and access to finance in this area.

These findings have encouraged RES4Africa to introduce **RAISEAfrica – Renewables Accelerators for Innovative Start-ups and Entrepreneurs in Africa** – in partnership with Enel Green Power, EDP, CSIR, and SAICA ED, and support from EIB. This initiative, encompassing pre-acceleration and acceleration programs, is specifically designed for the renewable energy sector in Africa to support and scale up renewable energy-focused businesses in the start-up ecosystem. The pre-accelerator is aimed at aspiring entrepreneurs and start-ups in the early stages of developing a business idea, while the accelerator is tailored for entrepreneurs and start-ups looking for market validation and business expansion. The program includes a comprehensive package of services, encompassing Mentoring & Coaching, Networking & Visibility, Fundraising, and various other activities.

After the launch of this initiative during COP28, the open call lasted for three months. Following a thorough screening and evaluation of over 250 applications, six participants were selected: three for the pre-accelerator program and three for the accelerator program. These activities and actions will hopefully make a meaningful difference by supporting and fostering the development and success of these entrepreneurial ventures, empowering them to thrive and make a lasting impact in the energy sector.

Figure 12: Barriers hampering start-up growth in Africa

African incubator and accelerator hubs

Limited access to finance to better run programmes



Lack of gender balance in hub management



Lack of managerial know-how for hubs' implementation



Lack of specialized and sector focused know how



African startups

Limited access to finance, including for R&D



Limited business network and access to markets



Limited legal, admin and accounting capacities



Lack of working digital tools and business spaces



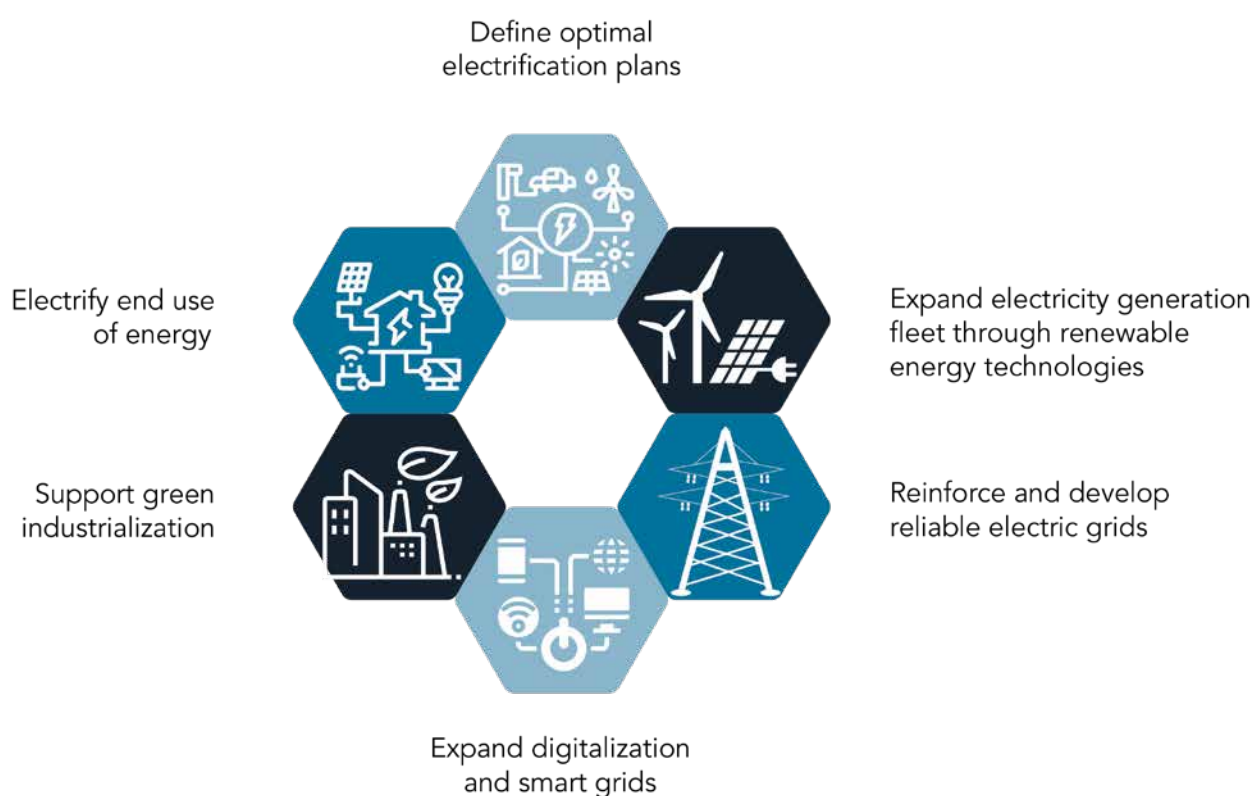
Challenges in geographic scale up of business



3. Key Components of Sustainable Electrification

The transition to a new energy system will be complex and will take time. A coherent, structured and holistic approach will be needed to enable the sustainable electrification of the Continent. An increase in power supply capacity on its own will not be enough to deliver the outcomes needed. In this regard, RES4Africa has identified the key areas of intervention: (1) electrification plans, (2) renewable energy technologies, (3) reliable electric grids, (4) digitalisation and smart grids, (5) green industrialisation and (6) electrification of end uses (Figure 13).

Figure 13: Key components of sustainable electrification



Source: RES4Africa

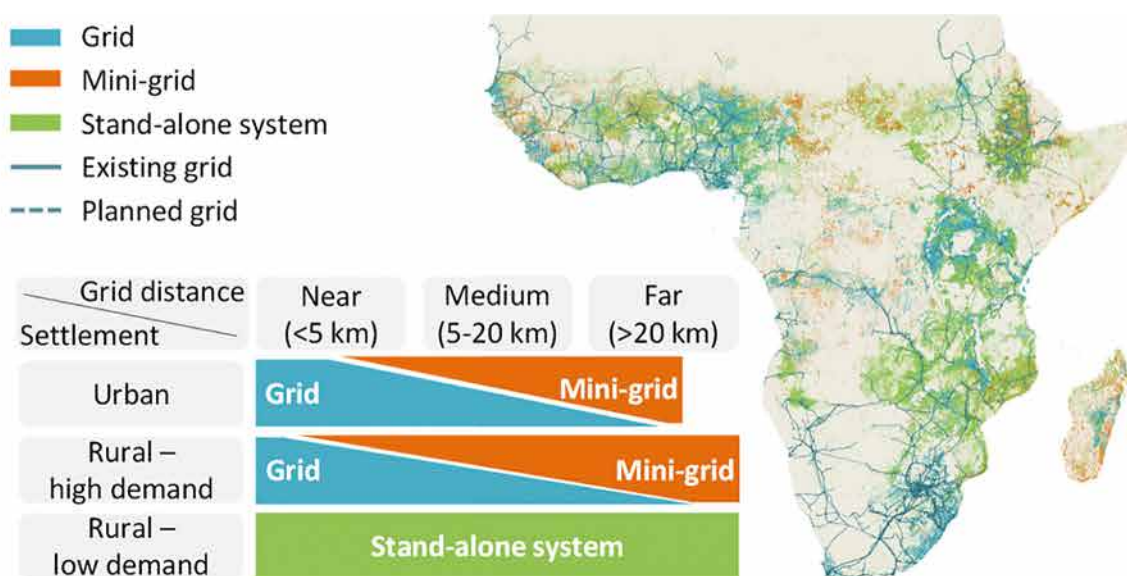
3.1. Define Optimal Electrification Plans (Centralised and Decentralised Solutions)

To meet the urgent need across much of Africa for universal access to reliable electricity for its communities, businesses, and energy systems, new electrification plans will require meticulous planning, prioritisation, and resource allocation. Available and planned resources can be utilised more efficiently by identifying and targeting areas with the greatest need

and potential for impact and by bringing to bear the appropriate insight, knowledge and experience. This can help to accelerate both the gap in electricity access and effectively support wider socio-economic development.

A cost competitive approach could involve a combination of centralised solutions, such as large-scale power plants coupled with grid extension, and decentralised approaches including mini-grids and stand-alone systems utilising renewable energy resources (Figure 14).

Figure 14: People gaining access to electricity by technology by 2030 in the SAS



Source: IEA Africa Energy Outlook 2022

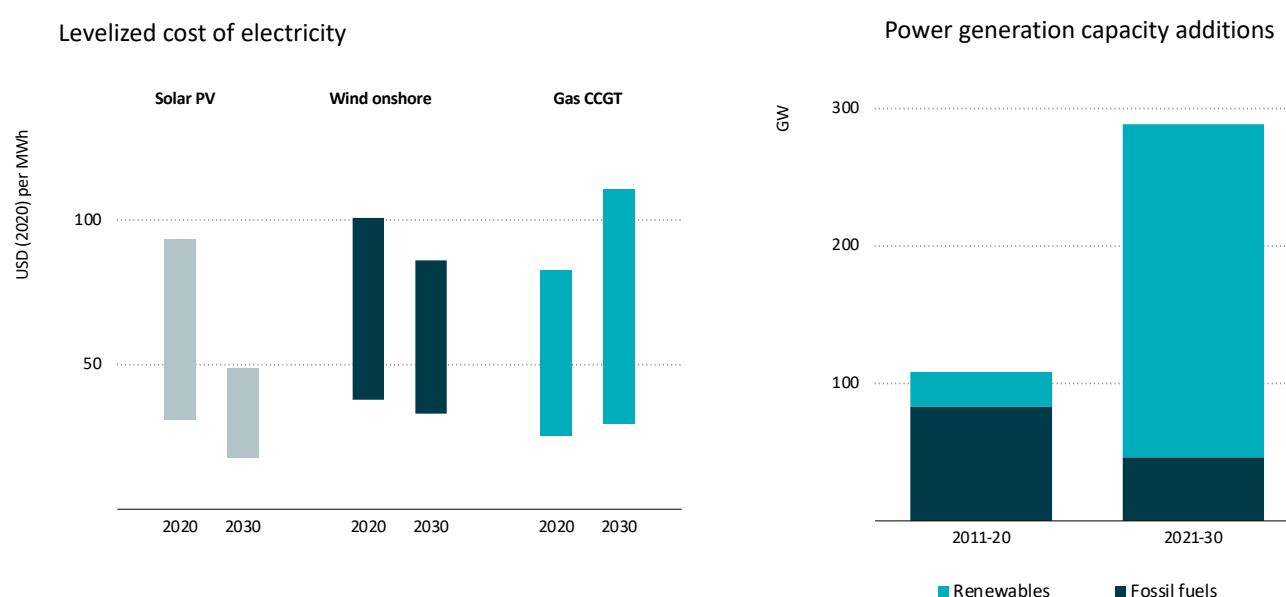
Grid connected systems are therefore only one of a number of appropriate solutions. Off-grid and more decentralised energy solutions offer a viable, affordable and reliable approach to electrify underserved communities who are currently without power, and can also be progressively integrated into national grids. Digital technologies such as novel mapping systems based on GIS and drones, IoT, AI and other emerging offerings can add further precision and detail. By increasing levels of community engagement, technical training, and local ownership among stakeholders, there are also opportunities in the short and medium term, to further optimise costs, to support greater levels of social equity, and enhance livelihoods.

3.2. Expand the Electricity Generation Fleet with Renewable Energy Technologies

The expected rapid, and continued, growth in power demand means that Africa's electricity generation infrastructure must be expanded and modernised at pace. The focus here should be on the inclusion of renewable energy technologies, given that the underlying technologies are proven and local renewable resources such as solar, wind, hydro, and biomass are available in abundance.

Once massively in place, they can be relied upon to deliver a viable, efficient, and sustainable solution that will also help to reduce reliance on local and imported fossil fuels, mitigate environmental impacts, enhance overall national energy security, and contribute to greater resilience of local electricity systems. Building on decades of project experience internationally, it is well proven they can be deployed rapidly, are scalable, climate resilient, and most importantly, are cost-competitive (Figure 15). What they will need from governments are supportive policies and regulations, and in some cases, technology support and subsidies for electrification programs.

Figure 15: Levelised cost of electricity and power generation growth in Africa



Source: IEA Africa Energy Outlook 2022

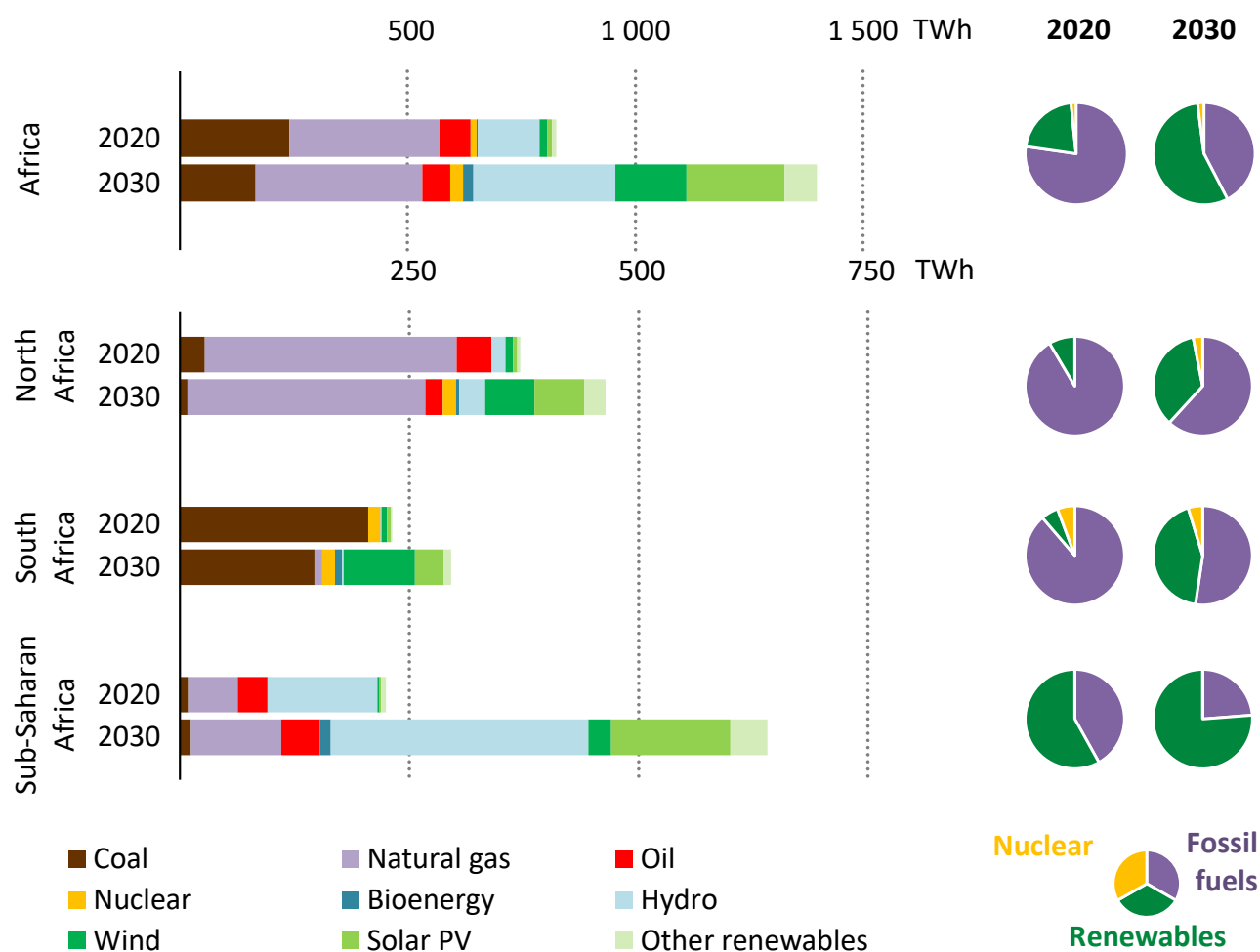
Accessing financing for new renewable energy projects in Africa remains a significant obstacle. Despite abundant global pools of funding, studies have shown that the cost of capital in many African countries can be up to seven times higher than in industrialised countries due to a perception that these are high-risk environments (IEA, 2022). Overcoming this barrier, so that greater amounts of finance can be mobilised and applied, will require the implementation of a range of de-risking measures and the adoption of mitigation strategies, such as regulatory support mechanisms, concessionary finance, and blending mechanisms.

Once the necessary measures are implemented, various energy scenarios project that renewables could dominate new capacity additions in Africa's power sector in the coming years, in the same way as they have historically done so elsewhere in the world. The International Energy Agency's (IEA) ambitious scenarios anticipate an eightfold increase in solar and wind energy capacity in Africa by 2030. With Africa's primary energy demand expected to surge by over 30% by 2030 there is the opportunity with the appropriate

planning, for renewable energy to deliver over 80% of this rise. Within this, solar photovoltaic (PV) is expected to lead capacity growth, outcompeting other power sources continent-wide by 2030 (IEA, 2022).

The other renewable technologies will continue to play a significant role in the energy mix but the incremental growth will be lower respect to solar PV and Wind. In particular hydro power, that at the date represents the first renewable source in terms of energy produced, is facing several challenges. Those are both limiting the operability of existing plants (e.g. recurrent draught seasons and in general climate modifications due to increasing GHE) and the development of new projects (e.g. profitability of existing sites, environmental and social backlashes), favouring small scale solutions (Figure 16).

Figure 16: Electricity generation by region and source in the IEA Sustainable Africa Scenario



Source: IEA Africa Energy Outlook 2022

BOX 4. MAKING THE CASE FOR RENEWABLES

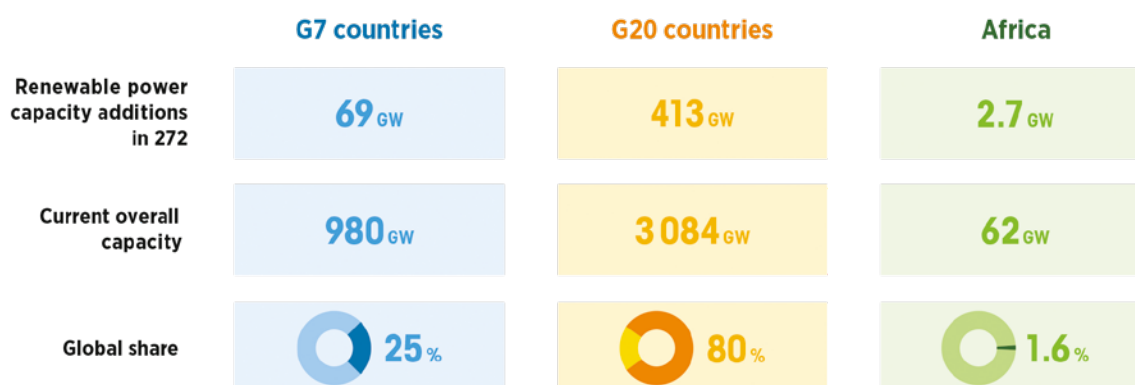
The potential **benefits of adopting clean energy technologies** in Africa are many and wide ranging. If governments are serious about delivering broader and all-encompassing socio-economic development, it is incumbent on them to use them at scale. They offer compelling advantages across a number of dimensions including being **rapidly deployable, cost-effective**, they possess **vast geographical potential**, demonstrate **resilience to climate impacts**, and offer **multiple co-benefits**.

Recent years have seen renewable energy technologies becoming increasingly competitive in terms of affordability, even amidst today's energy challenges. The costs of generating power from renewable sources, such as wind and solar, have been declining consistently for over a decade, making them more cost-effective options than traditional fossil fuel power plants. Moreover, the levelised cost of electricity (LCOE) for solar PV and wind technologies in Africa now competes favourably with natural gas and coal. Solar PV in particular, due to modularity, fits perfectly both with large scale plants and distributed generation in households and Commercial and Industrial (C&I) segments.

Secondly, clean energy technologies can contribute to **reliable electricity supply** by enhancing the resilience of energy infrastructure to extreme weather events. Solar PV, wind, hydro, geothermal, and biomass technologies can serve as base-load power sources, particularly when coupled with energy storage solutions.

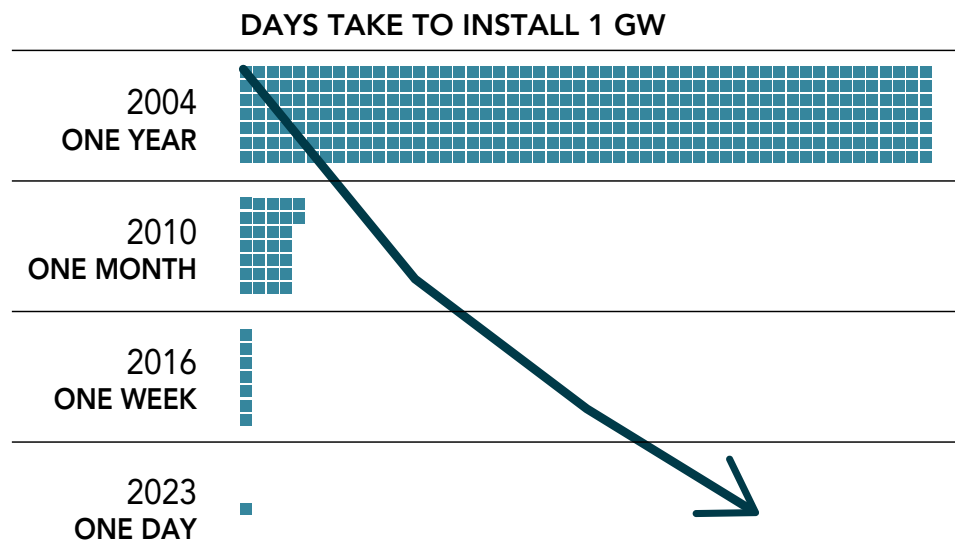
Renewable energy sources can also enhance **energy security** by reducing reliance on volatile fossil fuels thereby minimising exposure to international market price fluctuations. The adaptability and short time-to-market of renewable energy technologies, especially solar PV and wind can also help to contribute to energy security.

Figure 17: Renewable capacity growth disparities



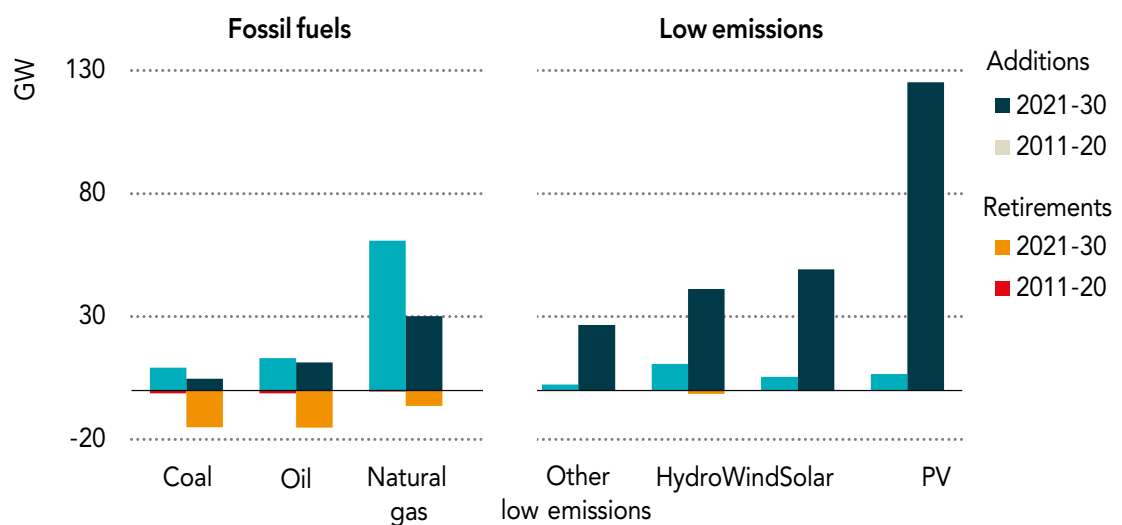
Source: IRENA, *The energy transition in Africa: Opportunities for international collaboration with a focus on the G7*, International Renewable Energy Agency, Abu Dhabi, 2024

Fourthly, renewables offer **modularity, scalability, reliability, and market readiness**, making them suitable for addressing energy access challenges in remote areas. These technologies can be deployed close to consumption points, including rural and remote regions where a significant portion of the population lacks access to electricity. Moreover, renewable energy systems can be adjusted to match varying levels of consumption and integrated into mini-grids or standalone systems, which can later be connected to the main grid as demand grows.

Figure 18: The great solar acceleration

Source: Liebreich Associates

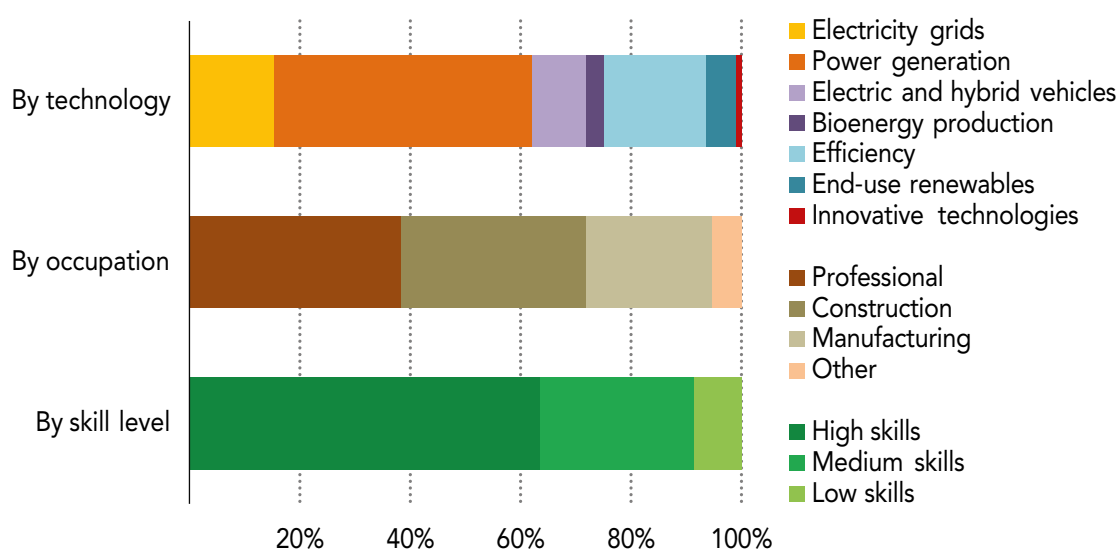
And finally, socio-economic advantages. Recent analysis conducted by IRENA, featured in a collaborative publication by R4A, IRENA, and UNECA, indicates that Africa stands to gain significantly across various dimensions by pursuing an economic development path aligned with the 1.5°C Paris Agreement climate target (1.5-S) that involves greater use of renewable energy technologies, compared to a less ambitious Planned Energy Scenario (PES). In the 1.5°C Scenario, Africa's gross domestic product (GDP) in 2050 is projected to be on average 6.4% higher than in the Planned Energy Scenario. Employment across the economy is anticipated to be 3.5% higher by 2050 in the 1.5°C Scenario compared to the Planned Energy Scenario

Figure 19: Power generation capacity addition and retirement by source in Africa

Source: IEA African Energy Outlook 2022

The energy sector is forecast to generate at least 28 million jobs by 2050, with renewable energy employment expanding from over 0.3 million presently to 8 million by 2050. On the other hand, the fossil fuel industry and related value chains, will be affected from job losses. According to IRENA's Scenarios, the job loss from PES to 1.5-S will result in 2.1 million people less in 2030 and 4.2 million less in 2050, but these reductions will be largely offset by the creation of alternative jobs related to the transition-related sectors. The general welfare index, encompassing environmental, health, energy access, social, and economic indicators, is expected to improve by 25% by 2050 in comparison to the Planned Energy Scenario (IRENA, 2022).

Figure 20: Jobs created in clean energy and related sectors up to 2030



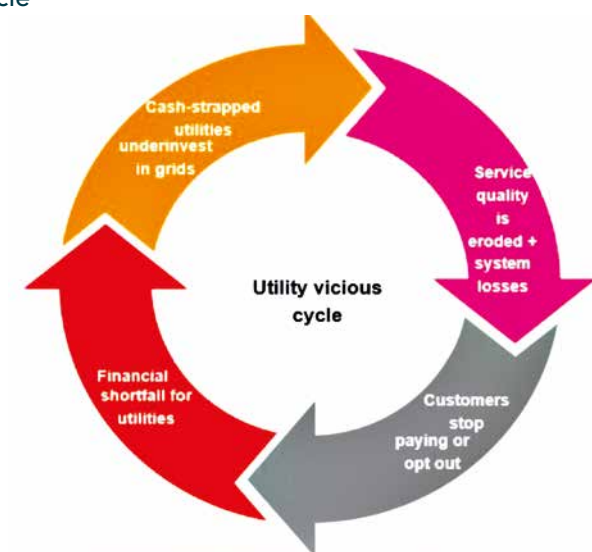
Source: IEA African energy outlook 2022

3.3. Reinforce and Develop Reliable Electric Grids

A reliable electric grid remains a critical prerequisite for any country that is looking to provide a stable and resilient supply of electricity for their communities and businesses. **Grids serve as the backbone of power systems**, acting as essential conduits that also enable the inclusion of new intermittent sources of supply.

Most African infrastructure suffers from inefficiencies, congestion, experiences high levels of both technical and non-technical losses, regularly has outages and blackouts, delivers poor power quality, and only has limited hosting capacity for new renewable energy projects. Underinvestment has been the main reason behind this. Many African utilities have not yet made the additional investment needed in grids. On top of this, climate change has, and will continue to, exacerbate these challenges by damaging assets and compromising reliability (Figure 21).

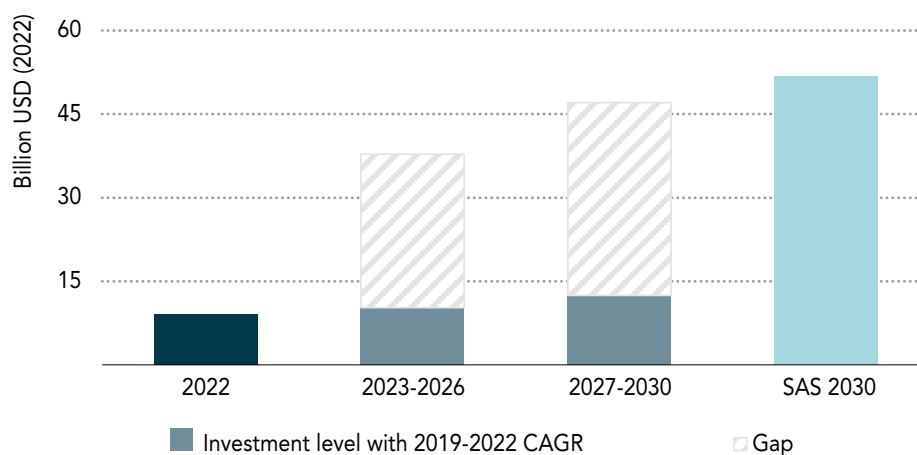
Figure 21: Utility vicious cycle



Source: PwC Private sector participation presentation at Grids4Africa launch November 2021

According to IEA, African countries need to redouble their investments in transmission and distribution grids. The huge network losses and the need to expand grid coverage require investments to the tune of US\$800 billion through 2040 (Figure 22).

Figure 22: Annual grid investment to 2030 based on recent growth rates in Africa (2022-2030)



Source: IEA Financing Clean Energy in Africa, 2023

A major challenge for utilities will be Africa's high transmission and distribution losses, well above the world's average. These are typically incurred because of physical and technological deficiencies, known as technical losses, and because of non-technical losses, mostly in the form of electricity theft. Combining policy measures and technological solutions can be the recipe to address these long-standing issues. These in turn can improve revenue-collection systems and protecting power-supply infrastructure.

The widespread adoption of renewable energy in Africa in the coming years will also need to be accompanied by concurrent **investments in transmission and distribution grids, modernisation and maintenance, digitalisation as well as storage infrastructure**. These stationary storage systems will provide the balance between generation (especially when this is done with variable and not dispatchable sources), and demand, and provide ancillary services that can help to defer larger investments on grids.

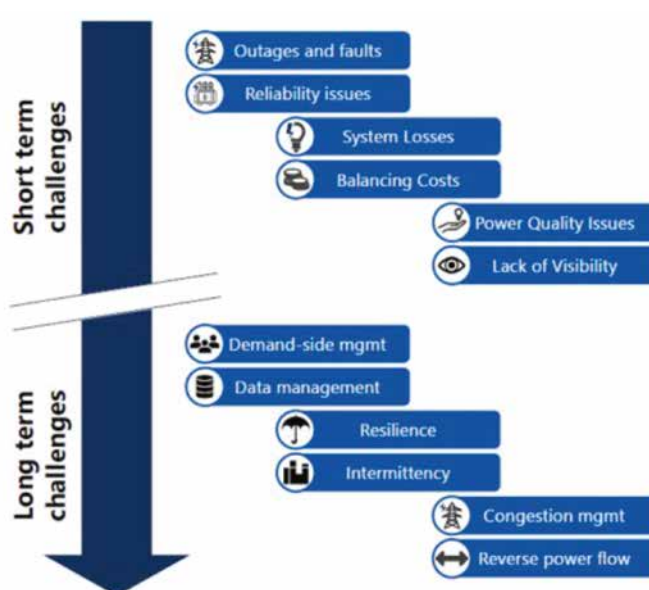
In this regard, Battery Energy Storage Systems (BESS) should be deployed both in Front-of-Meter (FTM) and Behind-the-Meter (BTM) applications. Both of them can provide services to network operators such as ancillary services (frequency control, frequency stability of weak grids, voltage support and black start), network load relief and energy shifting.

Public-private partnership can play a crucial role in this area, helping to unlock additional economical resources that local utilities, frequently suffering of negative balance sheets, will need to act on this agenda. The payback on this sort of investment should be attractive for international partners. With increasingly reliable grids will come reduced downtimes, improved quality of supply, and enhanced energy access for industry and society, that in turn will result in wider and positive socio-economic development.

3.4. Expand Digitalisation and Smart Grids

On average, most electrical grids in Africa date back to the electro-mechanical era (Figure 23). The introduction of digitalisation in planning, designing, building, operating and maintaining electrical grids has not been massively deployed in the Continent. This should represent a priority in shaping African energy agenda.

Figure 23: Ageing grids challenges

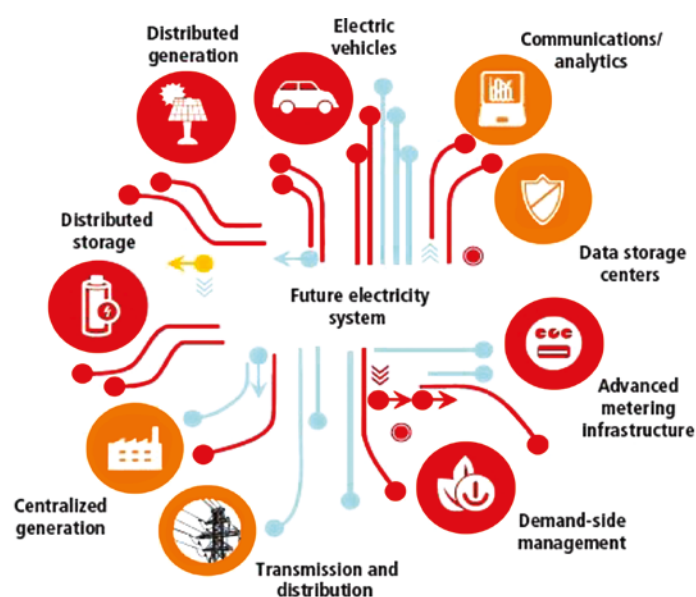


Source: Gridspertise input to RES4Africa Executive School November 2024 from Statista, IEA

A great focus on **digital technologies and smart grids** would provide utilities with the means to better plan, monitor, manage, and optimise their electricity systems. These approaches have been proven at scale in other countries where the integration of digital technologies has delivered enhanced grid efficiency, resilience, and flexibility. With the introduction of appropriate digital solutions there is an opportunity to have real-time monitoring, data analytics, and predictive maintenance. It will also be possible to further improve consumer engagement and demand response, allowing greater integration of distributed energy resources. The support and operation of these systems can then also stimulate a growing jobs market with exciting career opportunities for younger generations.

More practically, digitalisation will be indispensable in helping to extend decentralised energy solutions to communities residing in remote or low-income areas (IEA, 2023). They will prevent overinvestment in grid expansion, enhance the operation of existing grids, and improve the quality of supply. Digitalisation will also allow the introduction of innovative commercial approaches to energy trading and selling, such as smart meters and pay-per-use meters, enable more effective demand management, and facilitate the seamless integration by grids of greater amounts of variable renewable energy sources (Figure 24).

Figure 24: The new dynamic paradigm of distribution operator



The successful deployment of digital technologies will also need to consider a number of underlying factors such as:

- Originally developed for European and American electricity systems, the existing technologies are not well suited for ageing and low-meshed African grids. Specific and

customised lean solutions should be developed and adopted to best fit to the necessities of the energy system in the short and medium-term.

- Concurrently, there should be a focus on overcoming existing challenges in limited ICT infrastructure in certain countries and related security concerns. Efforts to advance energy development will be heavily dependent on efforts to improve digital development and investment in digital infrastructure.
- It will be very important to ensure that there is the necessary focus on the development of training programs that take into account the increasing digitalisation of the grid. A skills gap will result if individuals entering the energy sector workforce at all levels do not have the necessary skills to navigate the newly digitised energy landscape.

3.5. Support Green Industrialisation

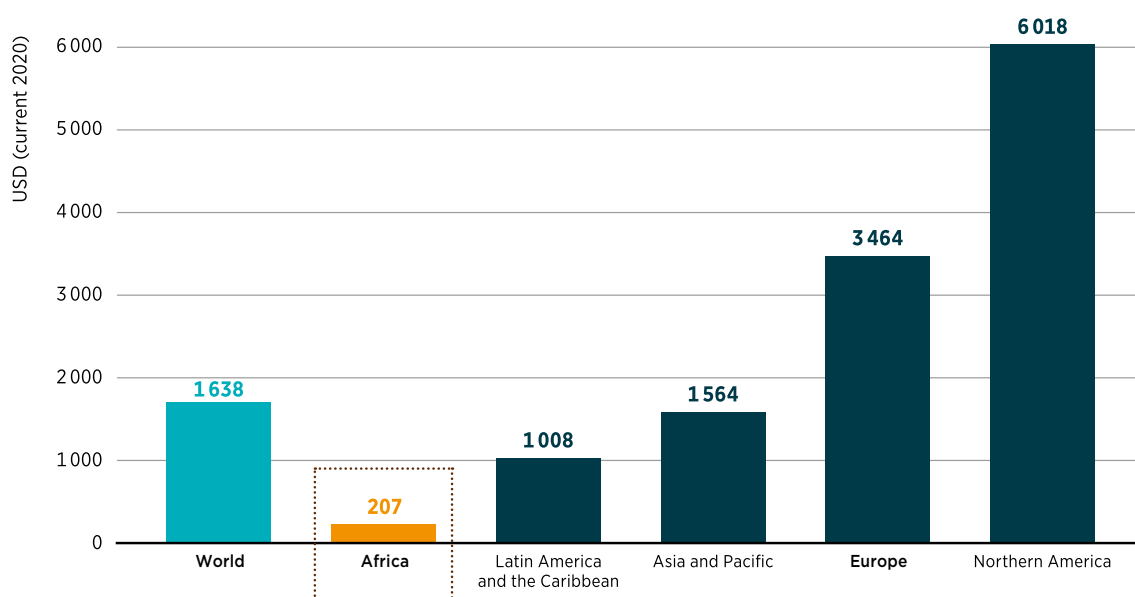
Africa historically has suffered from a very low level of industrialisation compared with the huge potential related to the abundance of raw materials, including critical materials needed to the energy transition. Passing from the pure exploitation and export to the creation of the entire value chain up to the end product is a no longer a deferrable ambition.

Almost **unlimited renewable energy sources and electrification are at the core of Africa's new industrialisation strategies**. There is in particular the opportunity to tackle hard-to-abate sectors with novel technologies that would allow not only to decarbonise the existing industrial fabric but also to advance industrialisation agendas including the development of new local, regional and international supply chains.

Decarbonising hard-to-abate existing and newly established industrial sectors in Africa present a complex, but not impossible, challenge. This is due to a combination of factors such as current reliance on fossil fuels, limited access to advanced technologies and rapid industrialisation. Industries like cement production, steel manufacturing, and chemicals face significant hurdles in transitioning to low-carbon alternatives. This is true at worldwide level and in particular for Africa. Cement production, a cornerstone of construction, is particularly challenging due to its high energy intensity and reliance on limestone calcination, emitting large amounts of CO₂. Similarly, steel manufacturing, essential for infrastructure development, struggles with emissions from coke ovens and blast furnaces. Chemical production, vital for various sectors including agriculture and manufacturing, often relies on energy-intensive processes and fossil fuel feedstocks. Addressing these hard-to-abate sectors will require a multifaceted and long-term approach encompassing close ties with international efforts on technological innovation, local policy incentives, and industry wide collaboration to enable emission reductions to be achieved.

For other industry sectors, the development and delivery of renewable energy and energy efficiency technologies can help drive more sustainable manufacturing practices, efficient resource management and lower carbon products. Africa is strategically well positioned to harness the benefits of these developments, embedding technological advancements and private-sector investment flows as practices are modernised. All of these actions will help Africa to overcome the fact that it currently has the lowest manufacturing value-added per capita of any world region (Figure 25).

Figure 25: Manufacturing value added per capita by world region, 2020



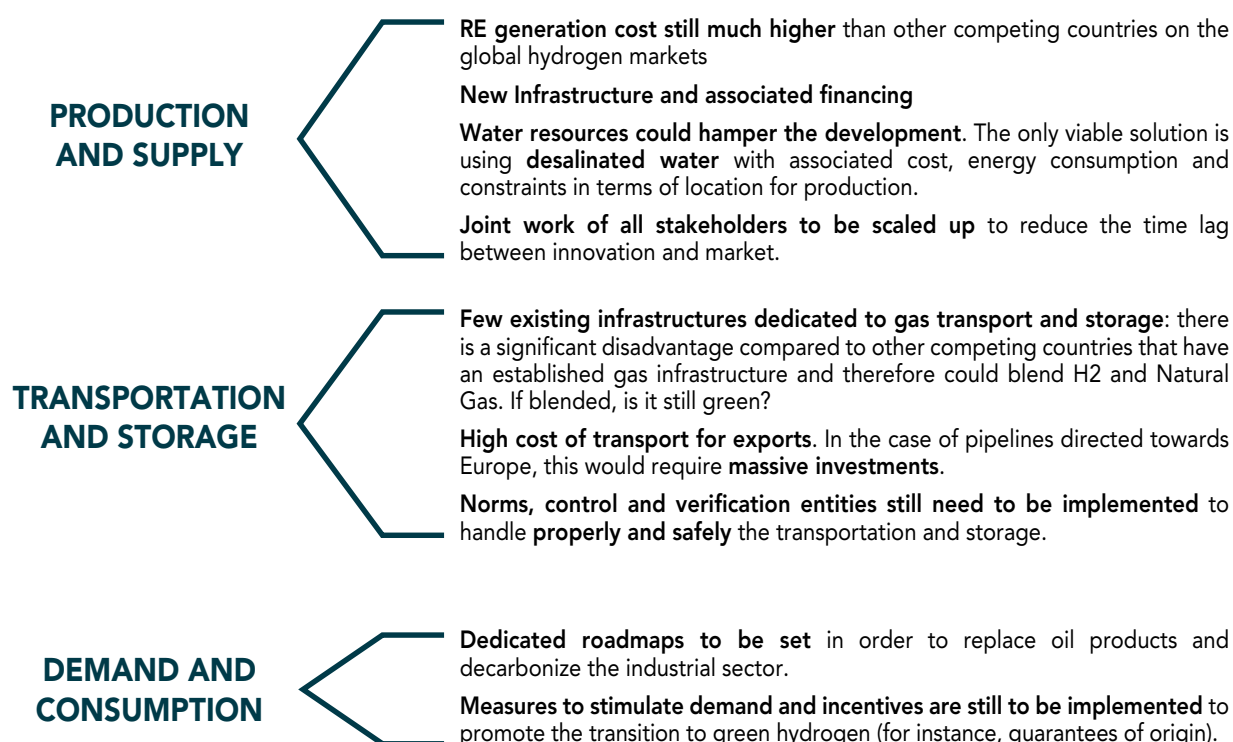
Source: IRENA, *The energy transition in Africa: Opportunities for international collaboration with a focus on the G7*, International Renewable Energy Agency, Abu Dhabi, 2024

At a global level, there is the opportunity for Africa to play a larger part in all of the emerging project areas such as clean energy, power markets, grid infrastructure, and green hydrogen for its economic growth.

Clean hydrogen could, in the future, be a critical element for the green industrialisation but there remain existing technological and economical challenges that will need to be addressed for this to happen (Figure 26). It is clear that costs are not yet competitive and there is no real open market at this time for trading as most production is still consumed locally. The cost of infrastructure, and the complexity of hydrogen storage and transportation also poses challenges in terms of economic feasibility. If these constraints can be adequately addressed, and costs of production continue to decline, Africa has the potential to become a major regional player in the green hydrogen market assuming increasing future demand in Europe⁷.

⁷ See more: <https://res4africa.org/wp-content/uploads/2023/12/R4A-GH2-paper-final-24.11.23.pdf>

Figure 26: The challenges in the full value chain for green hydrogen



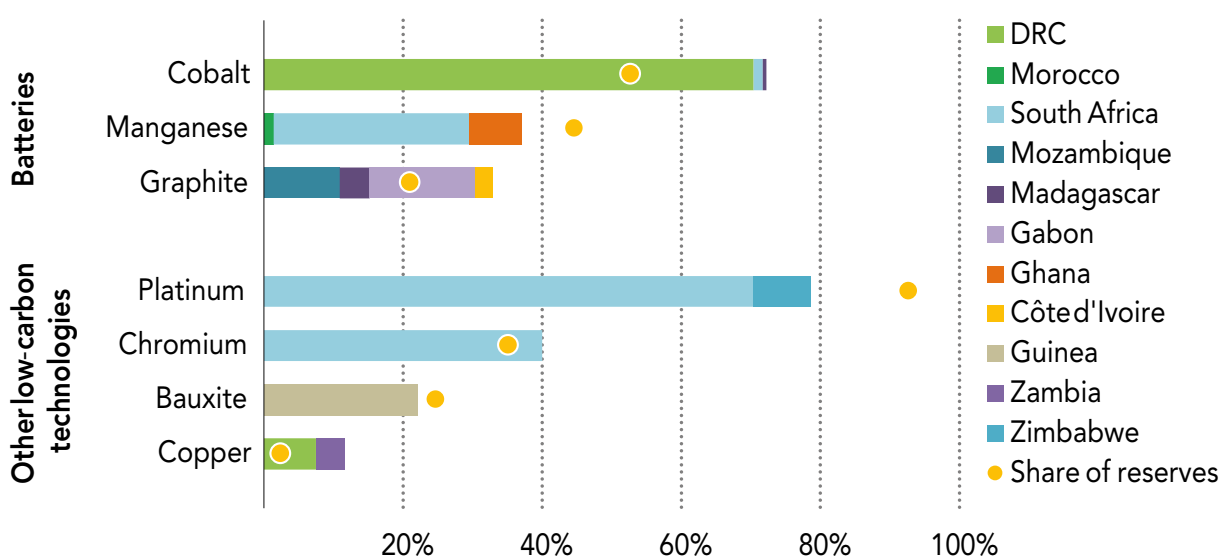
Source: RES4Africa and PwC

Enabling green industrialisation and a greater role in global green economy transition supply chains will require the development and implementation of integrated and longer-term energy and socio-economic strategies. Only then will we see sustainable economic growth, the creation of meaningful green jobs, and a reduction in the environmental impacts typically associated with these industries.

BOX 6. CRITICAL MATERIALS

The energy transition relies on renewable sources like solar, wind, and hydrogen, along with electric vehicles. Critical raw materials (CRMs) such as cobalt, copper, lithium, and nickel are essential for these technologies. The supply chains for these metals and minerals, integral to everything from smart appliances to electric aircraft, are becoming strategically important, especially in light of rising geopolitical tensions worldwide. As a result, these supply chains are now a focal point of strategic competition.

As global demand for critical minerals is predicted to rise, Africa has the potential to play a unique role in the international supply chains. The Continent, endowed with vast reserves of these CRMs, stands at a pivotal juncture where it can leverage its natural resource to foster a sustainable energy transition and also to finally industrialise its economy (Figure 27). Historically, African nations have relied on exporting raw materials hindering value addition and local involvement in processing these materials. Africa has a chance to change this paradigm by leveraging the energy transition to industrialise and achieve economic sovereignty.

Figure 27: Share of African global production of selected minerals, 2020

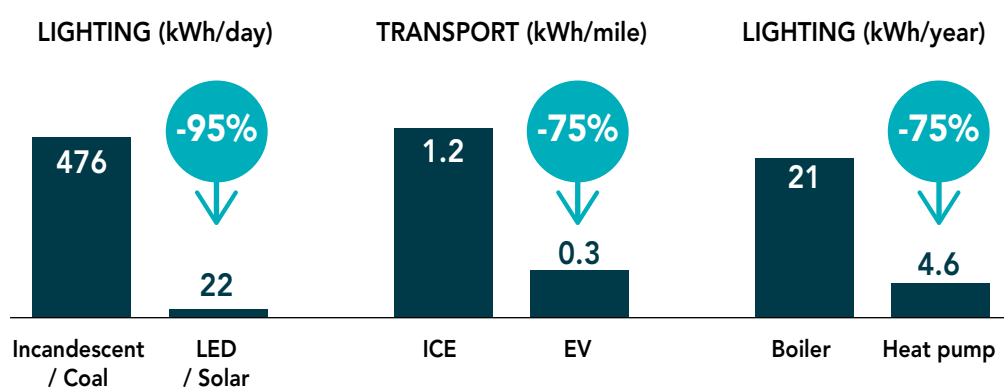
Source: IEA Africa Energy Outlook, 2022

Furthermore, the energy transition offers a fertile ground for fostering stronger partnerships between Africa and the EU. There is the need to create a common ground for cooperation to enable investments in projects to ensure local content, participation, and services. In light of the EU's need for diversification of supplies, several agreements have been finalised in the last few years with African countries to secure access to CRMs for European markets. In March 2023, The EU enacted the Critical Raw Materials Act, whose goal is to develop sustainable and secure supplies of CRMs. In order to do so, EU will establish strategic partnership with those African countries such as the Democratic Republic of Congo, Zambia, Rwanda and Namibia endowed with natural resources (Acheampong, 2024).

3.6. Electrify End Use of Energy

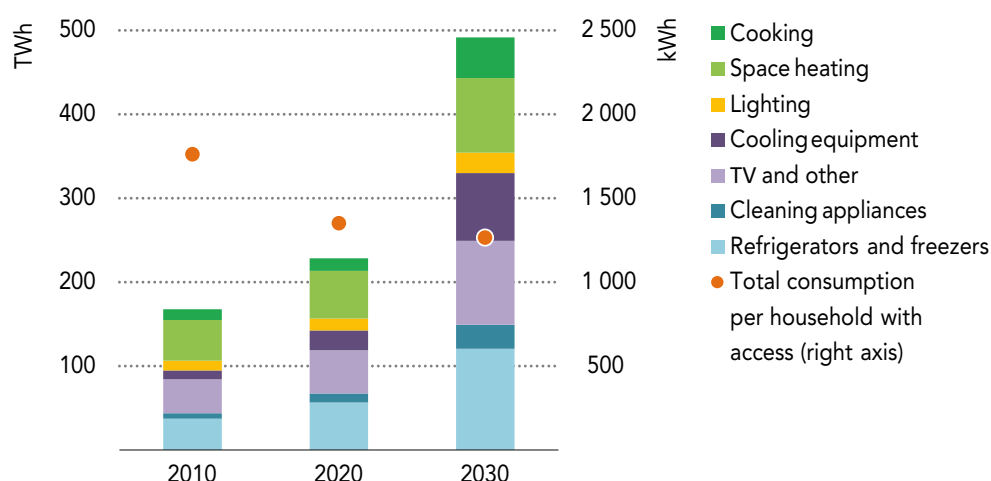
Africa still has the lowest per capita utilisation of modern energy globally (IEA, 2022). Expanding electrification for various end-uses presents a significant opportunity across the Continent. Immediate focus areas should include sectors such as mobility, heating, cooling and cooking. These can deliver immediate benefits due to improved efficiency of electrical appliances than fossil fuel-based ones (Figure 28). Another relevant area is agriculture taking into account the well-known water, energy and food relationship (WEF Nexus). If done comprehensively, electrifying energy consumption can help achieve significant emission reductions, reduce national and local dependence on volatile imported fuels, and raise both social and economic well-being (Figure 29).

Figure 28: Energy efficiency in electrification of end uses



Source: Liebreich Associates

Figure 29: Improved, and increased access to electricity domestic consumption in the best Africa Scenario



Source: IEA Africa Energy Outlook 2022

BOX 5. SCALING-UP AFRICA'S ACCESS TO CLEAN COOKING

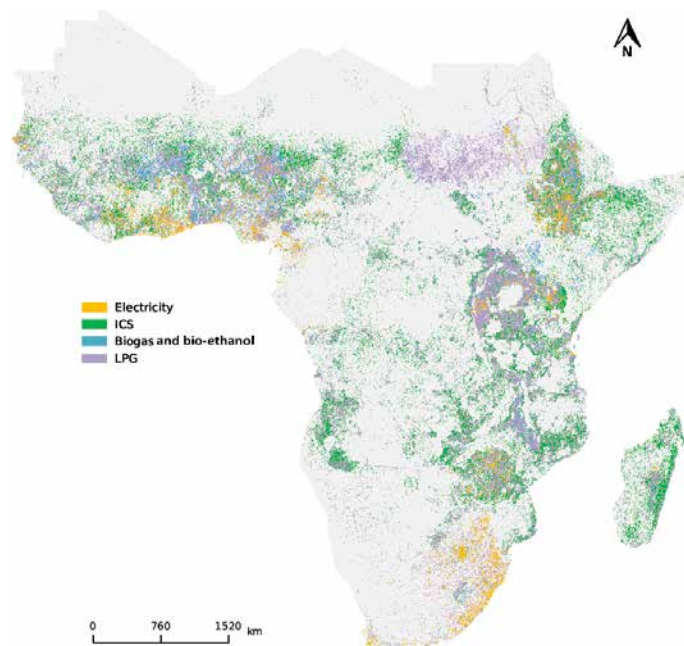
When it comes to global development agenda and energy sustainable transition, clean cooking must become a priority, in particular for Africa. The Continent accounts for approximately 1 billion people out of the 2.3 billion people worldwide without access to clean cooking (IEA, 2023c). The reliance on basic and polluting cooking fuels such as charcoal, wood, coal, and animal waste, has severe health, socio-economic, and environmental repercussions.

Respiratory and cardiovascular diseases are among the most dramatic consequences of smoke inhalation from traditional indoors cooking practices. They lead to approximately 3.7 million deaths worldwide, representing the second leading cause for premature deaths in Africa. Household air pollution affects especially children and women, with the latter being severely impacted due to their responsibility of carrying out the intense and risky activity of collecting fuel and gathering firewood. Having access to clean cooking would give women more time for education and opportunity to work and increase their chances to be financially secure and independent. Moreover, it would represent clear benefits for the environment as the adoption of clean cooking methods are expected to reduce greenhouse gas emissions and deforestation.

Asia and Latin America have adopted successful initiatives to encourage clean cooking, however, the same cannot be said of Africa. There is a chance that Africa may end this decade without any significant improvements in the number of people without access to clean cooking, if changes are not made to improve the quality of life. To achieve similar in Africa and potentially have complete access to clean cooking by 2050, significant changes are vital and should be made in policy and investment. It is clear that the ongoing crisis necessitates urgent attention and action. Considering the availability of solutions and successful practices of other countries such as China, India, and Indonesia, the issue stands in lack of resources and investments.

IEA's Access for All Scenario, described inside the recent publication "A Vision for Clean Cooking Access for All" provides a practical and comprehensive framework that considers the necessary investments and the available clean cooking solutions. Electricity, liquified petroleum gasses (LPG), bioenergy, improved cookstoves (ICS) are among the solutions that can be adopted depending on the needs and characteristics of each country and area (Figure 30). Electric cooking is expected to be the solution for one in eight people raising once again the crucial need for access to electricity and reliable grids. Governments will play a pivotal role in shaping e-cooking programmes and education campaigns to support the adoption of these technologies and raise awareness regarding the benefits related to modern electric cooking.

Figure 30: People gaining access to clean cooking in the Access for All Scenario by 2030 in Sub-Saharan Africa



Source: IEA, *A Vision for Clean Cooking Access for All*, 2023

On 14 May 2024, RES4Africa signed the "Clean Cooking Declaration: Making 2024 The Pivotal Year for Clean Cooking" at the Summit on Clean Cooking organised by the IEA. The Declaration has been endorsed by governments, international organisations, and civil society.

4. Recommendation for Leaders and Policy Makers

This report has outlined that there are a number of ways in which meaningful progress on the sustainable electrification of Africa can be achieved. All of them will require strong leadership and coordinated action on the components outlined in the previous chapter. Leaders and policymakers will be expected to support and drive these changes through the channels over which they have control, and their ongoing, and visible, commitment will have a significant impact on the speed, depth and breadth of actions, and to what extent it will become a sustainable transition. Suggested areas for prioritisation by leaders have been set out below.

4.1. Setting Ambitious Targets and Goals, Coordinate and Harmonise Policies

The first step needs to be the **establishment of clear, ambitious and longer-term targets at national level**, such as timelines to achieve 100% access to energy, to reach a given percentage of total energy consumption sourced from (clean) electricity or for phasing out fossil fuel-powered generation. This statement of intent, if projected at regional level, will allow for increasing coordination and collaboration amongst relevant government agencies, who can then work on creating harmonised and appropriate policies, standards, and regulations, and ensure that administrative processes are streamlined.

By having key government stakeholders assuming a stronger, more central and coordinated role, a clear signal can be sent to the market that there is long-term intent and aligned political support. The introduction of a shared digitalised platform collecting country and regional status on energy systems can help in shaping new policies and regulations and can avoid duplication of efforts and creating common ground for discussion.

By building on the national policy frameworks, it will be possible to create a wider enabling environment for electrification across Africa. Lessons learned from today's collection of national market policies and regulations that have not met the expectations of international investors will need to be taken into account. However, with the right changes, African countries have the potential to become as appealing as other global locations for investment and project development from a market openness, attractiveness, and readiness perspective.

A crucial element that can be used to reach this goal is to **leverage Public-Private collaboration** experience (e.g. auctions/PPA based energy procurement) and regional agreements (e.g. power pools) that can take more pragmatic and stable approaches.

A good example is India, that in a short period of times has dramatically improved access to energy from 56% in 2000 to over 97% in 2020 (CEEW India). Learnings from this period are that action on this agenda should start with the setting of clear strategies and targets. These

can then enable greater policy coherence and coordination across various sectors and levels of governance. This in turn facilitates alignment of objectives, helps to streamline regulatory frameworks, and promotes synergies among stakeholders, enhancing the effectiveness and efficiency of electrification initiatives. By doing so, the governments could clearly communicate how they intended to prioritise electrification goals, promote renewable energy deployment and how all departments and organisations were aligned to support these outcomes. The result was greater and more sustained private sector participation.

4.2. Implementing Regulatory Reforms and Focused Incentives

Conducive signals for the energy sector and in particular for private investors could be sent through the implementation of the necessary regulatory reforms and incentives needed to promote sustainable electrification.

Part of this should focus on **the simplification and removal of existing structures and processes that currently hinder the progress** of sustainable energy projects. What is no longer relevant or appropriate should be removed. In the same way that the necessary supporting structures were set up over the last few decades to support oil and gas penetration of local markets and economies, it is perfectly possible to put in place new and appropriate measures that create a more favourable environment for the new energy investments proposed in this paper.

Reforms will need to take in consideration feed-in tariffs, tax incentives, competitive auctions and other forms of market drivers. Grid integration standards and codes and streamlined permitting processes will help to attract investment, foster innovation, and promote market competition as well. In this context, the role of Regional Power Pools can definitively make the difference to create a “fertile regulatory ground” for a harmonised development and operation of interconnected power systems. Long term off take agreements for renewable energy projects could also be used to encourage the deployment private investments in solar PV, wind, hydro, geothermal and biomass plants, especially in remote and rural areas where grid extensions might be costly.

Implementing correctly designed and supportive policies, regulations, and incentives can also help to create a more supportive environment for local electrification, favour the establishment of new local manufacturing capabilities and, if sustained, provide a showcase for other regional countries to follow.

Taken together it remains a complex set of actions. It will require a **collective willingness to invest time, effort, resources, and be open to both dismantling existing practices and structures, and drawing on insights from experiences across diverse countries, technologies, and case studies**. Regular reviews and updates of these updated and new policies and regulations will also be necessary to ensure best fit, and to adapt to evolving local, technological and market trends. The outcome will be a clear plan for what and when will be rolled out, a potential de-risking of local projects, and increased private sector interest.

4.3. Developing Partnerships and Collaboration

The enhancement of existing, and the development of new, partnerships and collaboration arrangements among African government agencies, the private sector, civil society organisations, and international partners will be fundamental to the success of efforts to improve sustainable electrification across Africa. With effective partnerships in place, all stakeholders can more easily keep the energy transition dialogue focused on the realities and benefits of renewable energy for Africa, share data, best practices and insights, and coordinate efforts to maximise the impact of electrification initiatives across the continent.

On a national basis this could most immediately be used to improve access to single sources of reliable data on energy demand, resource availability, and market dynamics. This information will need to be collected from a variety of sources, and one version of the truth that all stakeholders are bought into, can support more evidence-based decision-making, enhance planning efforts, and optimise resource allocation for electrification projects. Different stakeholders could look to drive different initiatives, not all need to be government or private sector led: it could be a mixture depending on the specifics, the organisational skills and role that they could play in the longer-term electrification agenda.

Across African countries there are also opportunities for closer working arrangements and collaboration. National resources to support the electrification agenda will always have constraints. With the appropriate trust and supporting arrangements in place, there is the opportunity to better leverage on pool resources, access expertise, and information, and share in research and delivery networks. This could enable participants to access, much more practically and immediately, tried and tested approaches on how to best address barriers and risks such as economic uncertainty, technological challenges, and social resistance as well as understand lessons learned and avoid repeating costly mistakes. Over time, these increased levels of regional cooperation and coordination among African countries might also be able to facilitate the development of more longer-term arrangements, such as interconnected regional power markets, power sharing, the promotion of energy trading, all of which could lead to more efficient and resilient electricity systems at a lower cost.

BOX 7. PARTNERSHIP AGREEMENTS EU – AFRICA

The suggestion to forge stronger ties with other national governments, especially with those that are regional neighbours that have already gone through some or all of this journey, could help to speed up the electrification transition across Africa. The European Union (EU) for example, has several partnership agreements with African countries and regional organisations aimed at promoting renewable energy and electrification in Africa. Some of the main agreements currently in place include the following.

1. **Global Gateway Investment Package:** Launched in 2021, the Global Gateway initiative is a counterforce to Chinese One Belt and One Road (OBOR) with the aim of fostering partnerships and connectivity between Europe and Africa. The total investment of the initiative is €300 billion and package for Africa is valued at € 150 billion. It represents a unique and comprehensive commitment by the EU to support Africa's transformation in energy and transport sector, green and digital

- transition, job growth, health systems, and education, combining resources from the EU's own budget with additional sources from public and private funding. This includes up to €135 billion worth of investments made possible by the EU and €145 billion of planned investment volumes by European financial and development finance institutions, complemented by grant financing.
2. **The EU-Africa Green Energy Initiative:** Launched in 2020, this initiative aims to mobilise €1 billion in public and private investments to support the deployment of renewable energy and energy efficiency solutions in Africa. It focuses on areas such as off-grid electrification, grid integration of renewable energy, and the development of green hydrogen production.
 3. **The EU-Africa Renewable Energy Cooperation Programme (RECP):** Launched in 2010, the RECP is a multi-stakeholder initiative that facilitates investments and partnerships in the renewable energy sector in Africa. It provides technical assistance, project preparation support, and matchmaking between European and African renewable energy stakeholders. The RECP has helped to develop several renewable energy projects across Africa, particularly in the solar, wind, and hydropower sectors.
 4. **The Africa-EU Energy Partnership (AEEP):** Launched in 2007, the AEEP is a long-term strategic partnership that aims to improve access to reliable, secure, affordable, and sustainable energy services. It focuses on increasing the use of renewable energy sources and supporting energy efficiency measures across Africa. Key initiatives under the AEEP include the Africa Renewable Energy Initiative (AREI) and the EU-Africa
 5. **EU-Africa Infrastructure Trust Fund (ITF):** The ITF was launched in 2007 to support infrastructure projects in Africa, including those related to energy. It provides grants to help leverage additional financing from other sources, including public and private sector investments, to support the development of energy infrastructure, including renewable energy projects.
 6. **European Investment Bank (EIB) Investments:** The EIB, the EU's financing institution, provides funding and technical assistance for renewable energy and electrification projects in Africa. The bank finances a wide range of projects, including renewable energy generation, energy efficiency improvements, and energy infrastructure development.

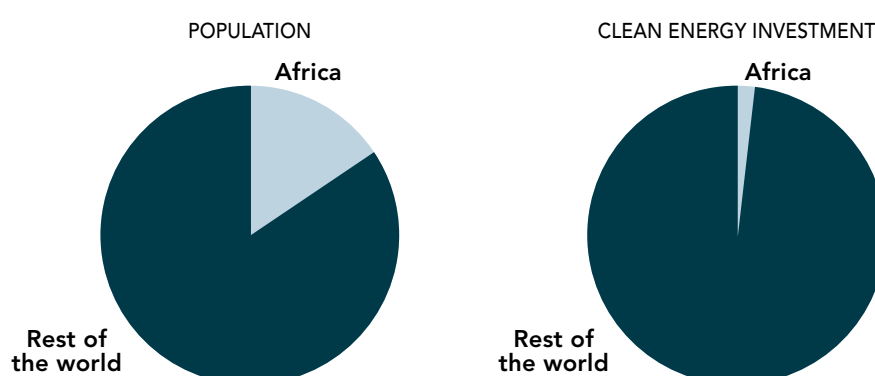
These partnership agreements reflect the EU's commitment to supporting Africa's efforts to transition to a more sustainable energy future and to promote economic development and prosperity across the continent. Implicit in these is also the message that it remains important to heed the ambitions of the UN SDGs. Infrastructural expansion (including an increase in electrification) can be an important mechanism for alleviating poverty and delivering economic growth as set out in this paper, but when unaccompanied by strong environmental safeguards it is also a key global driver of biodiversity and ecosystem service loss. As policymakers look to accelerate the pace of electrification in Africa, it would be wise to also ensure that these are increasingly designed as "no net loss" (NNL) policies, that they assess country-level overlaps between planned infrastructure expansion, infrastructure-threatened biodiversity, national biodiversity compensation policies and other measures to ensure that there is limited negative impact on species and ecosystems, else the electrification activities will be the undoing of the environment and associated socio-economic development ambitions.

4.4. Breaking the Investment Ceiling

Successfully overcoming existing and entrenched investment hurdles and mindsets for African projects have already been identified as a priority focus area if sustainable electrification efforts across Africa are to increase. Much has been attempted over the last few decades to attract both public and private investments to finance a range of renewable energy and electrification projects, from grid expansion to renewable energy project development and the deployment of off-grid solutions. Historic attempts to increase the level of investment, especially those from international sources, have involved innovative financing mechanisms, such as blended finance, public-private partnerships, and investment incentives. None has really yielded the levels of investment that were hoped for.

At this point in time, it remains clear that **significant barriers remain, hindering investment flows** that could support the development of renewable energy and electrification projects. Africa has only secured a meagre 2% share of global investment in renewable energy over the past decade, despite being home to 17% of the world's population (Figure 31) (IEA, 2022). In 2021, the continent received a mere 0.6% of the total global investment in renewable energy, marking an 11-year low and underscoring the pressing need for corrective measures. This glaring discrepancy also underscores a substantial gap between the investment flows associated with the global energy transition and Africa's capacity to harness them for sustainable development.

Figure 31: Africa's clean energy challenge



Source: Liebreich Associates from IEA, 2022

At times the explanation put forward has been linked to the cost or reliability of the technologies, but this is not the case. Most often it is related to the **cost of capital**. Hindered by various finance, country-specific, policy-related, and other risk factors, accessing finance remains a daunting task for most African nations and local project developers. Studies have identified that the cost of capital can be as much as seven times higher than in the US or Europe in certain instances for similar projects (IEA, 2022). More needs to be done by the **international financial institutions and rating agencies to implement innovative strategies at scale**, such as further country and project level de-risking mechanisms, blending

instruments, public-private partnerships, international cooperation, and other interventions at scale. Building on experience from other developing countries that are now further along their transition, there is significant knowledge and insight available to governments and project developers to help mitigate some of the actual and perceived risks, and to tell the investment story more accurately. By engaging with the wider international financial stakeholder community on this area, there is also the opportunity to learn from them what is missing, their perceptions of project risks and how these can best be addressed to enable a more conducive environment for investors.

In parallel, **governments should look to provide more anchor investment and access to affordable financing mechanisms**, including grants and concessional loans to facilitate investment in electrification projects, especially for underserved communities and small-scale renewable energy entrepreneurs. Alongside these actions, there is a need to agree long term, and regionally appropriate, electrification plans. With these in place, it will be possible to prioritise the necessary investment in electricity infrastructure to support electrification, including transmission and distribution networks, to expand access to underserved areas and improve reliability of supply. A key focus area for this activity should be technological integration. Harmonising technical standards and interoperability will help to reduce overall costs, enabling local manufacturing capacity to be set up at scale.

It is perhaps time to also consider newer and more innovative approaches. Examples could include pay-as-you-go (PAG) schemes, crowdfunding and micro-credit, with each of these perhaps also combined with other locally developed African models. The design of these could be informed that the knowledge that the enablement of greater financial inclusion and participation, particularly for underserved communities and small-scale renewable energy entrepreneurs can often help to reshape those communities.

Another element that increases the risk perception and consequently the cost of capital is the average low quality of renewable plants and grid infrastructure projects pipeline. This is also related, in some cases, to the shortage of local high skilled professionals hence highlighting the crucial role of capacity building as addressed hereafter.

4.5. Raising Awareness and Building Capacity

There will be a need to significantly scale up the education of communities, policymakers, and industry professionals on the basics of renewable energy, as well as on the profound benefits of electrification for socio-economic development. Efforts should begin by focusing on concerted action to raise awareness, dispel myths and build capacity for the change amongst all stakeholders in society prioritising decision-makers (ministries, regulators, utilities) that will be in charge to introduce favourable reforms. Common myths include that renewables are more expensive, unreliable, or take up too much land, are energy negative and result in job losses.

Electrification will work better, happen more quickly, deliver wider and longer lasting sustainable and resilient socio-economic growth if society at large is engaged, understands what is being planned and required of it, and is supportive of the transition.

With the prioritisation of marginalised communities, and by addressing affordability challenges and fostering participatory decision-making processes, individual communities and countries can use this agenda to bolster social cohesion, diminish existing disparities and foster greater numbers of sustainable development outcomes. This could then lead to communities more actively engaging with, and supporting, the development of local electrification projects.

With that in place, the design, development, delivery and operation of sustainable electrification projects will then necessitate a skilled, educated and committed **local workforce at all levels**. Long-term plans at country and regional level are needed in order to have a global harmonised capacity building path that involves all the players in the energy sector, including key managerial roles in public and private institutions, medium and small entrepreneurs, white and blue collars. A special area of focus is related to **vocational and institutional training programs**. These can play a crucial role in preparing individuals for these future employment opportunities. A variety of organisations from schools, universities, technical colleges, apprentice programs from across Africa and internationally should be encouraged to play a key role in supporting this outcome.

As with raising societal awareness, attention will need to be paid to ensure that these initiatives also continue to promote diversity, equity and inclusivity in the energy sector. This will help to ensure that diverse perspectives and talents contribute to greater engagement, which will then lead to a larger pool of talented resources, and perhaps also more technological innovation.

At a national level, governments can send a clear signal about the importance of this transition by investing in capacity building programs and technical assistance to strengthen local institutions, train workforces, and enhance technical skills for the planning, implementation, and maintenance of electrification projects with a special focus on emerging technologies and digitalisation. This can then be linked to collaborative R&D efforts, by supporting research and development efforts and partnerships to advance electrification technologies, improve energy efficiency, and reduce the costs associated with renewable energy generation and storage. Aligning this with a campaign that is focused on educating the public about the benefits of electrification, such as reduced greenhouse gas emissions, improved air quality, and energy security, to build support for policy initiatives and encourage adoption of electrified technologies will then ensure both market demand for these solutions, and supply of interested and committed individuals that can deliver them.

BOX 8. RES4AFRICA'S CAPACITY BUILDING PROGRAM

RES4Africa Foundation has a long track of experience in training and capacity-building with several well-recognised and established initiatives. RES4Africa Academy is the environment in which all those initiatives converge and grow pursuing a wide set of goals, including the promotion of open access to content and inclusivity, the empowerment of women and youth, and the provision of various levels of capacity-building, from vocational to managerial. An overview of the main initiatives is provided below: **Executive School**: formerly Advanced Training Course (ATC), the Executive School is the RES4Africa Foundation's flagship capacity-building initiative addressed to institutional and high-level professionals,

managers and profiles operating in the RE sector in Africa. It is organised every year in partnership with Enel Foundation, Politecnico University Graduate School of Management of Milan and SDA Bocconi, and in collaboration with RES4Africa members.

Technical-Vocational School: formerly Micro-Grid Academy (MGA), it is a Technical and Vocational Capacity Building Programme born in 2018 in Nairobi with the aim to create a skilled and conscious African workforce to deploy decentralised renewable energy solutions (micro and mini-grids) within the East-Africa region in order to enhance the access to energy in urban, peri-urban and rural communities while promoting youth empowerment by strengthening local enterprises and job creation.

Re-skilling Lab: the Re-skilling Lab is an initiative aimed at reskilling and upskilling workers employed in the fossil fuel sector and preparing a new generation of workers required for the energy transition. The programme has already been tested by RES4Africa with a one-year pilot following an intensive design process in collaboration with relevant local stakeholders, and is still successfully running in the Mpumalanga province, South Africa's coal district but also home to the majority of the country's coal-fired power plants undergoing decommissioning. The programme offers: support in curriculum development, assistance in the formal accreditation process, provision of technical equipment, teacher training and internships for students.



Conclusion

Supporting socio-economic development and access to energy remain the highest priorities for Africa. The view of this report is that one of the core ways in which all of these areas could be addressed is by **increasing the penetration of sustainable electrification**. It is, on all counts, the **most cost-effective and efficient strategy** for decarbonising energy consumption in transport, buildings, and across industry and agriculture, preparing for the effects of climate change and further geopolitical instabilities, and for delivering enduring socio-economic benefits for African customers, the environment, and society at scale.

It is well known that **underinvestment in electricity systems** historically has caused the inefficiencies, losses, congestion, and outages that we see more and more frequently today. African nations know that they need **more investment in grid extensions, interconnections, and digitalisation** to improve electricity access. However, that investment has been held back as a result of national monopolies, limited investment capacity of public utilities, non-cost-reflective tariffs, technical losses, and perceived risk premiums for African projects. Private sector participation needs to be a major part of the solution, but current efforts remain insufficient, especially international ones.

This policy paper has identified the major barriers that currently hinder full engagement and uptake of these technologies across the continent. It has proposed a six-pillar framework, that explains the key components that RES4Africa feels are needed to support the design and delivery of sustainable electrification at scale. These areas include: (1) **updated electrification plans**, (2) **greater use of renewable energy technologies**, (3) **reliable electric grids**, (4) **increased digitalisation and smart grids**, (5) **development of green industrialisation supply chains** and (6) **greater electrification of end uses**. Policymakers have also been provided with a list of areas where their influence could make a difference. Together, these activities could turn this ambition into reality.

RES4Africa recognises that once the decision to embark on this journey at scale has been made, **it will be challenging, and it will take time**. It will require a **rethinking of the current status quo**, especially in terms of the economy, infrastructure, operations, engagement with the private sector and local communities, and with international stakeholders. A **long-term view** will need to be taken with regular evaluations of progress and outcomes. It will also require that some long-standing economic areas of focus and activities stop, and support is provided for legacy as well as replacement areas of the economy. This may often need to span electoral cycles. However, this journey need not be made by national governments alone. **Greater regional collaboration** on what are ultimately shared and common agendas, and hoped for outcomes, can reduce the financial requirements, streamline approaches and speed up the achievement of key changes. Delivering on the socio-economic benefits outlined in this report and managing the consequences of climate change and continuing other global developments will deliver a positive and lasting legacy for generations to come.

With this work, RES4Africa Foundation hopes to have provided **African policy makers with valuable insights** that will enable them to **prioritise the steps that are needed to make this happen** within a generation, and remains excited about the opportunity to continue to play an active supporting role as this journey unfolds.

Case Studies



Shoring up Sustainable Energy Distribution in the City of Cape Town

ABB's electrification service experts design, install and commission switchgear upgrade solution to support safer, more sustainable power supply. New devices replace oil and SF₆ insulated products, reducing reliance on fossil fuels and release of potent greenhouse gas.

The City of Cape Town awarded ABB a three-year contract for a phased retrofit of legacy medium voltage (MV) switchgear within its electrical infrastructure. Following the success of an initial project in 2020, this initiative aims to further enhance the reliability and sustainability of the power supply for the 4.8 million residents of the Western Cape. The past project saw more than 400, 11kV oil filled circuit breakers and over 100 SF₆ insulated circuit breakers replaced with next generation ABB VD4 vacuum circuit breakers, safely disposing of 160kg of potent SF₆ gas. By only replacing older legacy circuit breakers, and not the entire feeder board and substation, the upgrades were executed with minimal downtime, while avoiding the costs and emissions associated with replacing the entire switchgear.

Now the aim is to install additional 12kV VD4 circuit breakers and ancillary equipment to replace their ageing LMX installations. The devices will clear potentially harmful short-circuit faults in tens of milliseconds, preventing severe damage to electrical infrastructure and minimising the risk of downtime, particularly critical for the Western Cape during planned loadshedding.

Frans Bouwer, ABB Regional Manager for the Western Cape, said: "Improving the reliability of the power supply is crucial for the Western Cape but this project goes much further. The City not only invested in an upgrade which would increase the quality and availability of power supply, but also sought a sustainable solution which supported the circular economy."

Not only did the carefully executed retrofit preserve the majority of the City's existing installed base, it also prevented the use of an estimated 358,400 liters of oil had like-for-like circuit breakers been used. Furthermore, the project ensured the safe and sustainable disposal of the old SF₆ breakers and gases. With one kg of SF₆ having equivalent greenhouse effect (or climate change effect) as 23,500 kg of CO₂, ABB's full-circle end of life service ensured that any risk from SF₆ disposal was eliminated.

Advancing Africa's Electricity Reform Agenda: Towards Increased Private Sector Participation in Clean Energy Infrastructure

Energy transition is a global priority but the way countries plan to address it can change depending on specific political priorities and conditions. This is especially true in a diverse continent such as Africa where it is crucial for each nation to carefully plan the steps which will lead to a just and sustainable transition.

In particular how the transition is translated into short- and medium-term actions must be carefully tailored to avoid the risks of adopting non-efficient or non-effective solutions, for example, locking-in obsolete technologies or overspending for renewable energy sources (RES) integration.

Considering the complexity of the challenge ahead, it is clear that the solutions prospected will be characterised by high capital intensity. For this reason, the energy transition will require massive investments that cannot be borne by governments alone, and the involvement of the private sector will be crucial for achieving it. In order to attract private investments, a sound regulatory framework defined by a high degree of predictability is key for the effective implementation of the energy transition.

The "Advancing Africa's electricity reform agenda: towards increased private sector participation in clean energy infrastructure" is an initiative jointly implemented by the RES4Africa Foundation, the United Nations Economic Commission for Africa (UNECA) and Gestore dei Servizi Energetici (GSE) for enhancing the preparedness of legislative and regulatory frameworks of African countries in order to attract private investments across the electricity sector value chain. Its purpose is to support the African countries through a tailor-made program able to capture the complex nature of the task of reforming the electricity markets.

Kenya has been the most recent country supported by the program. The project partners have assisted the Kenyan Government in designing and regulating the transitional phase of the energy transition in the country. In particular, the program focused on building internal capacity which will sustain the country in moving towards the open access of the national electricity market. The joint effort aims at developing a tailored approach will ultimately allow Kenya to fully benefit from the available resources, while building an attractive market for international investors.

While a one-size-fits-all solution does not exist, some measures can be considered as common steps aimed at setting the foundations for successfully transitioning towards a RES-based system despite differences which may occur among different countries.

First and foremost, unbundling is an essential step towards the liberalisation of electricity markets, as it allows for third parties to access the market next to statal actors. Kenya, in particular, commenced the unbundling process in 2019 through its Energy Act, thus preparing the ground for a broader sectorial reform.

Consequently, opening the energy markets shall occur. This entails the construction of well-structured markets in order to allow for the actual participation of private actors. Outlining a market which includes different segments and products, such as ancillary services and spot products, shall be a common characteristic among different geographical areas.

Kenya has recently been working on a new electricity market regulation aimed at designing an open market, which allows for the full participation of the private sector. Through the introduction of different products, from bilateral contracts to the provision of ancillary services, the Kenyan system will be structured in such a way to guarantee an active presence of private actors, resulting in higher investments and a diversified environment. This will also be made possible through the creation of a wholesale market pool, where demand and offer will be able to meet through the bulk purchase of energy. Also, the presence of multiple players in transmission, distribution and retail activities, under the supervision of a centralised system operator, will ensure the proper integration of renewable energy sources and improve the quality of services for consumers.

While drawing on the experiences of other countries with comparable characteristics can be beneficial, it is essential to tailor interventions to the specific needs of each country.

The program will continue to address the complexity of the energy transition challenge in Africa by focusing on regulatory frameworks, capacity building, and tailored solutions to attract private investments. By implementing these measures, African countries like Kenya can foster a conducive environment for renewable energy development, paving the way for a sustainable and clean energy future.

RES Integration in South Africa

According to the latest South African Integrated Resource Plan (IRP) 2010–2030 (2019 edition), around 20 GW of new non-programmable renewable energy sources (V-RES) capacity will be commissioned by 2030. Remarkably, the latest Transmission Development Plan (TDP) 2023-2032 of Eskom substantially increased these targets, considering around 53 GW of V-RES installed by 2035 and 8.5 GW of batteries.

In South Africa the most significant obstacle to investment in new renewable energy projects is the capability of the grid to meet the infrastructural challenges that are necessary to integrate and host all the expected increment in V-RES penetration into the power system. RES4Africa and CESI S.p.A have been working closely with Eskom on this topic, and following a request from the utility, the three entities collaborated to produce two studies on the integration of renewable energy in to the grid in an effort to better address these issues.

The South African system has been characterised by the following well-known peculiarities:

1. South-West side of the system: minimal national load, abundance of V-RES resource, weaker grid, little synchronous capacity installed.
2. North-East side of the system: majority of national load, little V-RES resource, stronger grid, majority of synchronous capacity installed.

With the expected increase of penetration of V-RES (i.e., PV and wind) into the South-West side of the South African system and the gradual decommissioning of the conventional coal-based thermal power plants in the East side, the net power exchanged within the Eskom supply areas and the net power transfer from the West side towards the East side is expected to substantially increase. This calls for urgent investments to reinforce both the network assets within the West side of the system and the transmission corridors that connect the West side to the East side, since this impacts in turn on the capability to accommodate and evacuate new V-RES capacity from the West, where the grid is currently more congested and weaker.

Looking forward to these medium- to long-term investments, every year Eskom provides short-term signals to the stakeholders (e.g., developers, IPPs) who seek to invest in V-RES plant to be connected to the Eskom grid. This is provided yearly through the Generation Connection Capacity Assessment (GCCA) report, which aims at giving stakeholders an indication of the available capacity for the connection of new generation at the main transmission system substations on the Eskom transmission network. Since the GCCA has a short-term forward-looking horizon, it forecasts the calculation of the available capacity based on the reinforcements on the grid that are expected to be available in the immediate future.

In this context, an appropriate short-term instrument to maximise the penetration of V-RES, which is complementary to the reinforcement of the grid, is the optimisation of the dispatching practices. These should build upon the possible complementarity of the PV and wind and the contemporaneity of V-RES output with load demand – the latter by relying both on the “natural” coincidence (e.g., PV

output during daily peak hours or wind blowing mainly during the night hours) or on a “forced” one (through peak-load shifting with BESS).

CESI S.p.A., in cooperation with RES4Africa and ESKOM, investigated the possible benefits of implementing such short-term instruments. Through hourly-based simulations of the South African power system, they achieved the following results and key-messages for South African stakeholders engaged in V-RES sector:

1. Building upon the possible complementarity of the PV and wind and the contemporaneity of V-RES output with load demand, a proper integration of BESS, and a prudent application of curtailment would unlock a significant additional amount [some GW] of new V-RES, that would be otherwise lost in almost all the Western supply areas of the Country.
2. The point above translates into the need to possibly revise the dispatching processes of Eskom to properly manage the complex challenges imposed by a system that is becoming increasingly decarbonised. For example: with new V-RES penetration, the time period where the grid usage is maximised is likely to be during the daily hours (when PV is on), and this will require to consider revising the operational planning practices and optimising maintenance during the night hours. Similarly, pumped-hydro-storages and hydro plants dispatching profiles should be re-optimised to better accommodate and maximise V-RES production.
3. Curtailment practice brings substantial system benefits, that, up to a certain extent, would be otherwise reachable only through uneconomical grid investments. All the stakeholders involved in the various sectors of the full electricity-supply chain would benefit from a carefully regulated and optimised application of curtailment: the IPPs-sector would gain from the increased available supply area capacity “unlocked” by curtailment; Eskom, as system operator, would increase the available resources to dispatch the system, solve congestion, and balance the system; consumers would benefit from an expected increase in the security-of-supply (reduced load shedding), a more decarbonised system and possible reduction in the cost of electricity. However, any implementation scheme of the curtailment practice shall be properly regulated and shall consider all the obligations that Eskom has in terms of guaranteeing of the minimum levels of network availability and the contractual arrangements with the existing IPPs.
4. Future rooftop PV penetration should be carefully addressed and wisely investigated, since it has a huge impact on the need and capacity to accommodate additional utility scale PV and on the expected benefits of the curtailment practice. A third report in this collaborative series will be carried out to study this issue.
5. The results clearly reveal that, although they bring substantial benefits to the system, curtailment and BESS alone does not off-set the limitations imposed by the existing congested network topology, which remains an important limiting factor to a further increment of V-RES, needed to deal with the gradual and expected decommissioning of thermal power plants in the East side. This still calls for strategic investments in reinforcing both the internal network components and some strategic inter-areas corridors.

The Case of South Africa

The energy crisis in South Africa, where the supply of electricity has been insufficient to meet demand, has created severe economic and social impacts. As part of the solution, wheeling has been identified as an enabler of additional generation through bi-lateral trade between private parties.

In 2021, the Minister of Mineral Resources and Energy published an amendment of the Electricity Regulation Act 4 of 2006 (ERA) as the first fundamental step to “unlocking” the private electricity generation and procurement market in South Africa. The amendment to the Licensing Exemption and Registration Notice (the Notice) increased the threshold for private IPP embedded generation projects from 1MW to 100 MW. The Notice exempts private projects from the obligation to apply for and hold a generation licence. Rather, they are required to register with the national regulator. Subsequently, in 2022, the 100 MW cap was removed completely thus paving the way for large-scale private IPP projects connected to the national grid to sell energy directly to large power users. Furthermore, the amendment of the Schedule II of the ERA introduced the possibility for wheeling electricity to multiple customers. The current regulation has been in place since January 2023 and has significantly changed the market landscape with more than 7 GW of private projects connected to the grid.

In such contexts Enel Green Power has developed the Impofu cluster currently under construction with commercial operation expected in 2026. The Cluster is made of a group of 3 wind farms which capacity is contracted for 330MW with two main large energy consumers in South Africa.

The projects consist of 57 turbines, eight high-voltage substations, as well as 120km of 132kV high-voltage overhead electricity lines, boasting the longest privately permitted powerline developed for any renewable energy project in the country. The cluster will provide up to 330MW of renewable energy via a wheeling framework agreement with Eskom to the client’s facility.

The use of national grid to wheel power from renewable-energy projects to private off takers is growing in South Africa and in other African countries. A wheeling-based business model can contribute to the scale up renewable installation and participate to the network development. Other benefits are represented by the development of other business aiming at enhancing the structure of the energy market.

For example, thanks to the amendment of the regulatory framework, accessing the grid in South Africa has resulted in the rapid evolution of energy aggregating and trading markets. Under this model, aggregators can use power from various generators and allocate the power efficiently to an aggregated list of customers that vary in terms of size, need and demand profiles.

Aggregation is attractive as provides flexibility in terms of power generation profile from intermitted resources, and allows a range of contracting options that better meets company’s needs (both from the generator and the offtake point of view). From generators perspective such flexibilities are not possible under traditional structured and rigid government PPAs with state owned utilities. Such flexibility and openness in commercial negotiation fast tracks the successful conclusion of deals.

The offtakes are attracted by those schemes usually to overcome the low availability supply of electricity from the public utilities, or by a better projection of their electricity cost (C&I RES PPA tariffs are contractually defined and escalated with specific formulas and usually subject to not change for long periods). But now there are other factors too, indeed those companies that export their products in the European market, are procuring renewable energy to enable their operations and help them meet the European Union's carbon tax rules.

The process is not perfect yet, further enhancements are required mainly to ensure a more transparent and predictable access to the network also in the early stages of development. However, it is a fact that, upon the amendment of the ERA and creation of a wheeling regulation, the South African market started to experience a quick growth in competitive processes and bilateral transaction between private companies under the schemes described above. In South Africa, till the 2022, REIPPP Program was the main instrument to deploy large scale renewable and it has successfully procured almost 7GW in the past 12 years, however showing some limitation due to the requirements imposed by public procurement procedures, local contents requirements and sometimes political drivers. Private to private C&I transactions seems to overcome some of the challenges affecting the government programs providing new opportunities and solution to fast track the energy transition and expedite the electricity market liberalisation.

Energy Plans and Policies & the Energy Poverty Index: the Case of Colombia

Empirical evidence has shown that access to electricity is a necessary condition, but in some cases, not sufficient to improve people's quality of life. The concept of a fair energy transition incorporates not only the concept of access to energy, but also that this access allows the population to improve their quality of life by fulfilling basic needs for a dignified life. Access to electricity "*per se*" does not meet a need; it is the use of this energy that allows us to cover basic needs such as having water, cooking, preserving food, lighting for education or leisure purposes, being connected to the outside world, having the home in an adequate thermal condition, etc. It is therefore necessary to use complementary tools that help focus and solve this problem. The design and implementation of an Energy Poverty Index appropriate to the reality of each country / region is one of these tools.

In Latin America, Colombia has been the first country to study this problem in a comprehensive manner. With almost 52 million people, it has 97% access to electricity; around 1.5 million people still do not have access to the service. In addition to the population without access, according to estimates made by the Energy Poverty Monetary Index (EPMOI) and the Energy Poverty Multidimensional Index (EPMUI), approximately 9.5 million people are considered to be energy poor, unable to develop adequately due to restrictions on energy use.

While the EPMOI measures energy poverty based on the household's ability to pay (monetarist or marginalist approach), the EPMUI evaluates poverty under the theory of capabilities, a concept developed by Amartya Sen, Nobel Prize winner in Economics. The capabilities approach is based on a notion of positive freedom, that is, a freedom that must be realised through real opportunities – capabilities – so that people can achieve valuable functions; in particular access to and use of energy to satisfy basic needs. The EPMOI and EPMUI encompass two complementary approaches.

The design and implementation of poverty indices in Colombia required interdisciplinary work and ongoing inter-institutional consultation, since it involves definitions of energy policy, e.g. the assigned function of the index, selection of the base year, number of dimensions and indicators to be defined in the EPMUI, etc. Additionally, the indices must meet certain attributes: be mathematically and statistically robust and communicatively simple.

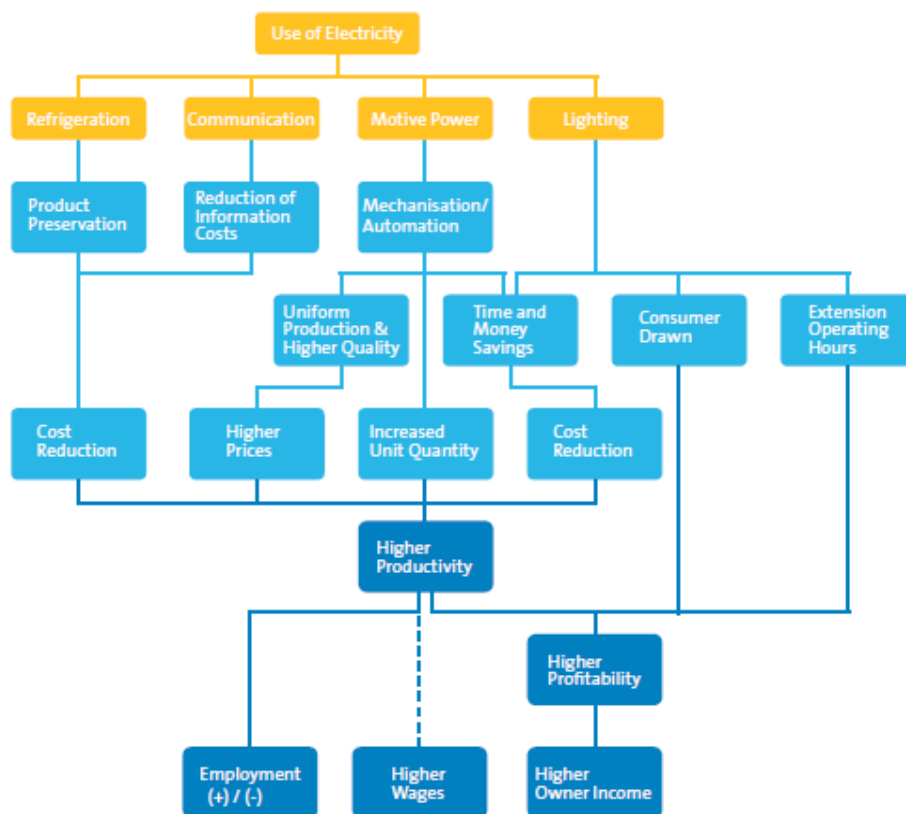
For the EPMUI, 12 indicators associated with 5 dimensions of multidimensional poverty were selected. Each indicator has an equi – proportional weight, and two poverty thresholds are defined: the economic threshold (EPMOI) for households that spend very little or a lot on energy in relation to total income, and the physical threshold (EPMUI) for households with 4 or more deficiencies out of a total of 12. Free software algorithms (R and Stata) were used to facilitate the replicability of the study.

The study provides a robust methodology to measure energy poverty in Colombia and is fully applicable to other contexts, such as African countries. This tool is essential for designing and monitoring effective energy policies that improve the quality of life of the population.

Energy Poverty and the Role of Productive Uses of Energy – The Case of Haiti

In many developing countries, the so-called Productive Uses of Energy (PUE) is becoming a tool not only for access to energy but also for community economic development. Indeed, the PUE or income-generating use of electricity is seen as a promising way to contribute to poverty reduction. With only a few dozen watts of solar electricity, entrepreneurs are generating income by mobile phone charging or powering hair clippers, while larger solar systems power village cinemas. In agriculture there are commercial opportunities for solar powered milk chilling, egg incubation, milling and refrigeration, which can require several kilowatts. Solar powered water pumps for drinking water and irrigation are being customised for the needs of smallholder farmers and ever increasing in popularity. Therefore, there is a need to better understand the full range of PUE applications, relevant to households, Small to Medium sized Enterprises (SMEs) and (mini-) grid operators, which is steadily expanding as a result of technological innovation. Next figure displays the pathways from electricity to income generation, categorised by refrigeration, communication, motive power and lighting. Motive power is arguably the most important trigger for the generation of cash income given that mechanisation and automation typically allow achieving higher outputs at constant inputs.

Pathways from Electricity to Income Generation



Source: PRODUSE, 2013.

PRODUSE is a joint initiative of the Energy Sector Management Assistance Program (ESMAP), the Africa Electrification Initiative (AEI), the EUEI Partnership Dialogue Facility (EUEI PDF) and Deutsche *Gesellschaft für Internationale Zusammenarbeit* (GIZ). In 2013 PRODUSE carried out a study called *"Measuring Impacts of Electrification on Small and Micro-Enterprises in Sub-Saharan Africa"*. While the interest of policy makers in the nexus between electrification, productive electricity usage and development impacts has been increasing steadily, the lack of robust evidence on causal effects of electrification is striking. The study is dedicated to improve the understanding of this issue. In detail, the PRODUSE study pursued two overall objectives:

1. gaining insights on the interaction between electrification and productive electricity usage by examining the impact of electrification on micro-enterprises and
2. improving the available toolkit for (robust yet cost efficient) impact evaluation of electrification projects and programs with a particular focus on productive usage.

Recently, the Government of Haiti, with the collaboration of the Interamerican Development Bank (IDB) carried out a study for the design and implementation of the National Plan for Productive Uses of Electricity in Haiti.

Haiti, with an estimated population of 10.5 million, poverty rate of nearly 60% (2020), Gross Domestic Product *per-capita* of around US\$1,150/year (2019), more than 50% living in rural areas (located mostly far from the national electricity grid), electricity coverage of around 40% and very high electricity costs (US\$0.33/kWh), presents socio-economic indicators comparable to many African countries.

The Plan included aspects such as:

- a) understanding and estimating the size of the current and potential market for PUE applications.
- b) identifying high-potential value chains and productive use applications in specific locations, including potential investment opportunities in line with the sector's absorptive capacity.
- c) analysing the main barriers to market growth.
- d) undertaking a stakeholder mapping to understand the current capabilities, priorities, activities and future plans of other actors in the sector, and recommend potential partnerships that could help to ensure the success of PUE interventions;
- e) providing recommendations for how market barriers might be overcome;
- f) designing and implementing activities as well as designing at least 10 PUE pilots, as available funding allows; and
- g) capacity building and trainings.

Fulfilling the objectives of the study required detailed, high-quality information. This is a challenge in Haiti where most official statistics are not up to date. The information requirements are multiple and range from knowing the main actors involved in the issue, demographic and socioeconomic statistics, sectoral information on the main value chains, entry of PUE equipment into the country, tax benefits, the participation and role of women in the different activities, case studies in countries comparable to Haiti, etc. Complementary tools such as literature review, analysis of secondary information, international benchmarking analysis were used, but the most important was qualified interviews and surveys. Five communities were selected that represent recently electrified and non-electrified localities and different productive profiles (agriculture, fishing). With the information from the surveys, included the secondary information mentioned above, the

potential market for the main PUE technologies was estimated. Before the identification of the 10 pilot projects and investment opportunities, a detailed selection criteria in accordance with the potential impacts of the projects was identified. Several key areas of interest were identified, they included; economic, health, productivity, community education, gendered impacts and spill-over effects. Upon review of the technologies and products required for Haiti's potential PUE market, analysing and estimating the market size and undertaking a decision criteria matrix of the impacts of these potential products in the country, the PUE technologies, their purpose and consequent building blocks were analysed in detail.

Given the similarities between Haiti and many African countries, the design and implementation of a National Plan for Productive Uses of Electricity can be a very powerful tool to improve the well-being of the population in the Continent as well.

The Digital Revolution of Distribution Grids

Today more than ever, power grids are facing important changes due to mainly increasing of electrification, extreme weather events and increasing share of generation from renewables. Because of that, grid complexity is increasing daily, and utilities are now facing new challenges in operating the system, such as unpredictable bidirectional power flow, MV harmonic pollution and grid management revolution. Designed over a century ago, today's grids are not prepared for the growth of electricity demand, the intermittent flow from renewables, the integration of active prosumers and distributed generation.

For facing these challenges, power grids need to go through a great technological transformation to increase flexibility, grid resilience and stability and quality of service, preparing for changing conditions and recovering rapidly from disruptions. All technological transformation that are seeking for technical improvements to the grids must be cost effective, bringing savings on OPEX and CAPEX to the Distribution System Operators (DSO) and, at the end, leading to a tariff's reduction for the final customers.

Many African distribution grids are large and complex and comprise a mix of outdated and modern technology. This aging infrastructure poses challenges to both the industry and the environment. Compounding these challenges is the sustained growth in demand, as well as environmental protection requirements while in the near future a major issue will be represented by the increasing of distributed generation, particularly from photovoltaic sources.

In this scenario, Gridspertise is playing an important role to build smarter and more sustainable grids by providing digital technologies and solutions to upgrade distribution systems all over the world. High technology solutions can help African DSOs to face their main challenges and to build more sustainable and digitalised grid infrastructure. Smart Meters, Head-End Systems (HES) and Meter Data Management Systems (MDMS) allow DSOs to effectively manage electricity demand through real-time data monitoring and enable grid reliability. An Advanced Metering Infrastructure (AMI) can help stabilise the grid with granular information on consumption, allowing real-time measurement and detection during critical events, such as blackouts. Thanks to its functionalities, final customers can be aware about their consumption and can adopt a more suitable behaviors by reducing their consumptions and take advantages by tariff hours.

To manage the complexity of power flows as well as the interplay between production and consumption, Gridspertise launched the QEd – Quantum Edge® device is all-in-one edge platform for substation virtualization. This solution tackles the needs of DSOs with different levels of digital readiness enabling different complexity of use cases from the basic stabilisation of the grid by managing metering data to grid automation for improving SAIDI/SAIFI. With its capabilities, QEd also enables to reduce the substation's carbon footprint, cutting down the number of devices required, internal wirings, power consumption and reducing field interventions, with benefits in terms of logistics optimisation and safety. Another potential solution to answer to some of these challenges is represented by the implementation of Smart meters. Smart meters offer the capability

to accurately monitor energy consumption, detect losses in real-time, and provide consumers with actionable insights into their energy usage.

By leveraging smart metering technology, African distribution grids can address the efficiency challenges while enhancing revenue protection, optimising grid operation, and promoting consumer engagement in energy conservation efforts. The following benefits can be achieved by implementing Gridspertise solutions:

- Tracking of energy consumption and early detection of losses. The implementation of smart meters enables precise tracking of energy consumption at various levels of the grid. This allows for early detection of losses, whether due to technical issues or unauthorised consumption, leading to improved efficiency and revenue protection.
- Enhanced fraud detection. Smart meters provide real-time data on energy consumption patterns, enabling better detection of fraudulent activities such as meter tampering or unauthorised connections. By reducing revenue losses associated with fraud, smart meters contribute to improved financial sustainability for utilities.
- Optimisation of grid utilisation and reduction of peak demand. Smart meters enable utilities to implement dynamic pricing schemes and demand response programs based on real-time data. This encourages consumers to shift their energy usage to off-peak hours, thus reducing load peaks and optimising grid utilisation. This, in turn, leads to improved efficiency and reliability of the grid.
- Increased consumer engagement. Smart meters empower consumers by providing them with detailed information about their energy usage and associated costs in real-time. This increased transparency encourages consumers to actively manage their energy consumption, leading to greater awareness and engagement in energy-saving practices.

BESS – South Africa Project

In the much-needed global challenge of decarbonisation, Africa's path to a sustainable energy transition is a crucial factor, with the opportunity for the continent to move directly toward clean energy by reducing reliance on polluting fossil fuels, even in traditional primary sector areas such as mining and quarrying. Africa is estimated to hold between 20 % and 90 % of the world's reserves of 11 minerals needed for the energy transition such as platinum group metals, but also significant shares of the global reserves of nine other essential minerals for the production of energy storage solutions, photovoltaic panels, wind turbine blades and various electric vehicle components. Therefore, it becomes of paramount importance to support the development in Africa of mining activities powered through renewable sources. Indeed, the mining industry has historically been an extremely energy-intensive sector that has been evolving for several years to reduce its environmental footprint.

An example of this comes to us from South Africa, where Nidec Conversion, part of the Nidec Group's Motion & Energy division, recently signed the largest-ever agreement to install battery energy storage systems (BESS) at a mining site. Confirming the "green" trend that is also engaging the mining industry, the site in South Africa will be powered by a solar farm and will be able to cover a significant portion of its energy needs. However, the installation of energy storage systems is a necessary condition for ensuring flexibility and suitability of the electricity system. As a matter of fact, the BESS system balances energy inputs and withdrawals and facilitates congestion and overgeneration management, while also helping to cover any peak demands.

At the site in South Africa, Nidec's BESS system is designed to ensure business continuity, improve energy efficiency, and reduce the carbon footprint, while also increasing capacity and performance. Therefore, as a result of the implementation of this technology, it will be possible to stabilise the mine's power supply by feeding energy stored in batteries during power outages or load reductions and save about 200 tons of CO₂ per cycle of 120MWh, equivalent to the CO₂ captured by 40 hectares of forest each year. More specifically, Nidec's intervention involves the installation of 43 converter blocks embedding batteries and power converters, for a total installed capacity of 40MW and a storage capacity of 160MWh. The batteries have an estimated lifespan of 15 years and will ensure at least three hours of power consumption by the full-scale mine, supplying on average the mine's share of power shortfall each day and replacing the diesel generators used so far. This project validates how sustainable and high-performing growth prospects are possible even for traditional industries such as mining, but it also highlights the importance of BESS as a strategic lever for energy efficiency and transition in Africa.

The presence of BESS in South Africa is experiencing a momentous growth with major projects throughout the country. South Africa, however, is not the only nation moving in this direction: Senegal and Morocco, for example, are equally active, and other countries will follow their lead in the short to medium term. The interest in BESS and the increase in demand should come as no surprise since it is, in fact, a direct consequence of the ever-growing penetration of renewable sources on the African continent. There is, clearly, a mutual and reciprocal benefit in the growth of the former to the benefit of the latter because, on balance, energy storage systems increase the capacity to install renewables while reducing their market risks and helping to mitigate the volatility of energy prices in individual national markets.

Deploying Battery Energy Storage Solutions in Tunisia

RES4Africa, in conjunction with RINA Consulting Services (RINA) composed a study that explored the potentials of the energy market in Tunisia, focusing on the technologies available in this geography.

Tunisia's location is close to the Middle East and Europe, therefore able to supply both markets easily with green energy if it becomes an overproducer. As Tunisia has excellent solar and wind resources, so the government plans (Tunisia Solar Plan 2012) to achieve 3.8 GW of renewable energy capacity by 2030. To support this international green energy market, the Tunisian energy market will also need to store the energy for times of demand.

Country interconnections, taken from Deploying Battery Energy Storage Solutions in Tunisia

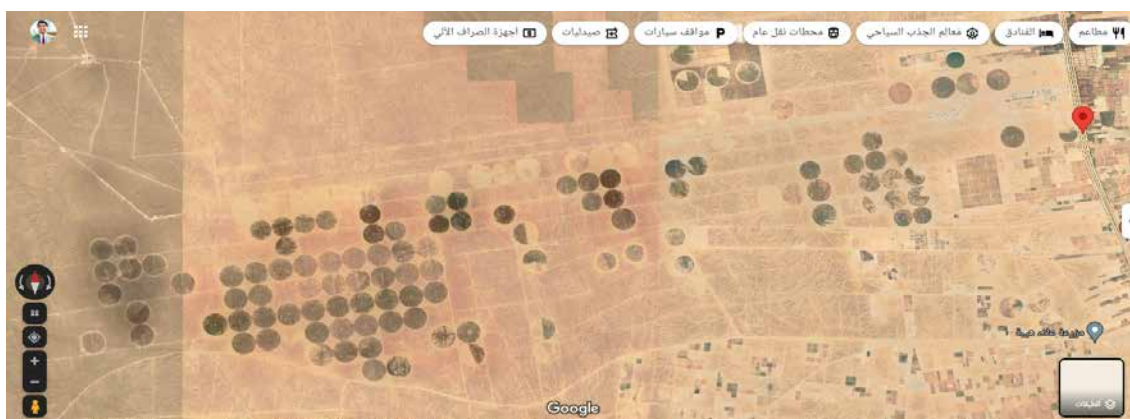


The paper explores the current energy market in Tunisia, seeking where additional support can be made, for example, by implementing new regulations that support and standardise the installation and remuneration of any Energy Storage Systems connected to the electrical network. It also explores the various technologies able to support the ambitions of the government and compares with established Energy Storage markets and how the projects are developed in these regions, before focusing on the possibilities of the Tunisian market, its Solar PV construction ambitions, and the support of Battery Energy Storage in its renewables expansion.

Replacement of Diesel Generators for Pumped Water Station

To reduce reliance on diesel, a river-source water station that services the local agricultural industry reclaiming land from desert, performed a feasibility study and basic design for implementation and finance in conjunction with RINA.

Courtesy of Google Maps, circles indicate areas irrigated and farmed using water pumped from the local river approx. 30km away.



The feasibility study included a solar profile of the area selected for the Solar PV, the load profile of the pumping station and a sizing study for the battery energy storage system. An Environmental and Social Impact Assessment was carried out by RINA's specialist ESG team which concluded that replacement of the diesel generators would lead to better health of the local residents and farm workers and the optimum water supply levels that would be required for each month of the year, so that the farms only draw what water they need.

An economic assessment of the cost for replacing the diesel generators with respect to agricultural production and future fuel costs formed a big part of this assessment. An extensive economic assessment of the replacement of diesel generators by Solar PV and battery Energy Storage was conducted, concluding in an optimal size and layout of the renewable energy installation with respect to the agricultural output expected.

In addition, RINA's ESG team conducted an extensive Environmental and Social Impact Assessment of the plans vs current state, concluding that the reduction of dependence and use of diesel will increase the wellbeing of the local residents and workers.

Sustainable Electrification Projects Empowering Communities in Menoufia Governorate

Electrification plays a pivotal role in achieving sustainable development across the globe. By transitioning to electric power for various applications such as agriculture, industry, and buildings, we can significantly reduce greenhouse gas emissions and curb air pollution. Additionally, electrification enables the integration of renewable energy sources, fostering a cleaner and more resilient energy system. This shift not only drives economic growth and job creation but also enhances energy access, reliability, and efficiency. Embracing electrification as a cornerstone of sustainable development paves the way for a greener, more equitable future for generations to come.



Schneider Electric and Crédit Agricole Egypt Foundation have joined forces to inaugurate transformative community development projects in the villages of Shubra Qubala and Mit El Qasri in Menoufia Governorate. These projects, born from a memorandum of understanding between the two organisations, are set to revolutionise the Water, Energy, and Food Nexus in the region through the innovative use of sustainable electrification.

The partnership's primary goal is to implement a series of initiatives powered by solar energy, including the establishment of greenhouses, fishponds, chicken incubators, irrigation pumps, and a compost unit for recycling agricultural waste. These endeavors reflect the shared commitment of Schneider Electric and Crédit Agricole Egypt Foundation to advance the Sustainable

Development Goals and align with Egypt's Vision 2030, aiming to achieve environmental sustainability, elevate the living standards of Egyptian citizens, and promote gender diversity and inclusion.

In Mit El Qasri village, the comprehensive projects encompass the integration of solar-powered greenhouses, creating a closed cycle system that minimises waste by utilising water from the fishponds to irrigate the greenhouse crops, and then returning it to the fishpond.

Integrated Renewable Energy Powered Greenhouse & Water of the Sun Irrigation System



Moreover, the village is set to benefit from chicken incubators and a compost unit, all operating sustainably on solar energy. Notably, a greenhouse fully managed by local women has been established, emphasising gender inclusivity and empowerment within the community.

Meanwhile, Shubra Qubala village has seen the installation of three solar-powered irrigation pumps, a game-changing solution expected to irrigate and cultivate around 700 feddans, significantly reducing expenses associated with diesel fuel usage. These projects are projected to impact approximately 26,000 local residents and 700 farmers, leading to an increase in crop productivity, with the cultivation of around 1,600 different plants and a total crop output estimated at 40 tons. The chicken incubators are anticipated to yield 12,000 hatched eggs annually, while the fishpond is projected to produce an annual fish yield of 3,000 fish.

The adoption of these electrification technologies is poised to deliver a positive environmental impact, foreseeably reducing carbon dioxide emissions by approximately 68 tons per year and conserving up to 70% of water consumption. These initiatives stand as a testament to the potential of sustainable electrification in driving societal and environmental progress.

Through these collaborative efforts, Schneider Electric and Crédit Agricole Egypt Foundation are not only transforming communities but also shaping a sustainable future for the region. The impact of these projects extends beyond immediate gains, leaving a lasting legacy of empowerment, environmental stewardship, and economic advancement.

As the world moves towards a more sustainable future, these initiatives underscore the pivotal role of electrification in fostering the sustainability of African countries, serving as a model for impactful change and collective progress.

Bibliography

- Acheampong Theophilus (2024), From mines to markets: how Africa and Europe can become green industry partners of choice, European Council on Foreign relations
- APP (2016), Lights, Power, Action, Electrifying Africa
- GEAPP (2022), Powering People and Planet
- IEA, IRENA, UNSD, World Bank, WHO, Tracking SDG 7: The Energy Progress Report, 2024
- IEA, Energy and Gender. <https://www.iea.org/topics/energy-and-gender>
- IEA (2024a), World Energy Investment 2024
- IEA (2024b), Global Critical Minerals Outlook 2024
- IEA (2023a), World Energy Employment, 2023
- IEA (2023b), Financing Clean Energy in Africa
- IEA (2023c), A Vision for Clean Cooking Access for All
- IEA (2023d), World Energy Outlook 2023
- IEA (2022), Africa Energy Outlook 2022
- IRENA (2024), The energy transition in Africa: Opportunities for international collaboration with a focus on the G7, International Renewable Energy Agency, Abu Dhabi
- IRENA (2022), Could the Energy Transition Benefit Africa's Economies?
- RES4Africa Foundation (2024a), Navigating the Transition in Times of Uncertainty
- RES4Africa Foundation (2024b), A Just Transition of Just a Transition: Making the Case for Women in Energy
- RES4Africa Foundation (2023), Towards a Green Hydrogen Ecosystem
- Statista, Forecast of the total population of Africa from 2020 to 2050. <https://www.statista.com/statistics/1224205/forecast-of-the-total-population-of-africa/#:~:text=According%20to%20the%20forecast%2C%20Africa's,as%20the%20most%20populous%20countries.>
- Statista, Climate change in Africa - statistics & facts. <https://www.statista.com/topics/9715/climate-change-in-africa/#:~:text=Floods%2C%20storms%2C%20and%20droughts%20have,of%2038.5%20billion%20U.S.%20dollars.>
- The African Tech Startups Funding Report, Disrupt Africa, 2023
- World Bank, The number of poor people continues to rise in Sub-Saharan Africa, despite a slow decline in the poverty rate, 2020. <https://blogs.worldbank.org/en/opendata/number-poor-people-continues-rise-sub-saharan-africa-despite-slow-decline-poverty-rate>

Acknowledgments

Production: RES4Africa Foundation Secretariat in Rome, Italy

Authors: Roberto Vigotti, Gus Schellekens, Fabrizio Bonemazzi, Sara Pochesci, Assia Bellaroto

Case studies by RES4Africa Members (by alphabetical order): ABB, Afry, CESI, Enel Green Power, GME, Gridspertise, NIDEC, RINA, Schneider Electric.

Special thanks go to Enel Foundation, RES4Africa's longstanding knowledge partner.

Contributors from RES4Africa International Advisory Board (by alphabetical order):

Ahmed Baroudi, Director General, Société d'Ingénierie Energétique (SiE)
Carmelo Cocuzza, Head of Unit, Advisory Services for Infrastructure and Climate, Corporate Finance and Global Activities Department, European Investment Bank Global (EIB Global)
Daniel Alexander Schroth, Director Renewable Energy and Energy Efficiency Department, African Development Bank
Esther Wanza, Youth Representative, Co-founder SDG7 Youth Constituency, Raynow Energy
Ignacio Pérez-Arriaga, Professor and Director of Energy Training, Florence School of Regulation
Laura Cozzi, Director of Sustainability, Technology and Outlooks, International Energy Agency (IEA)
Nicolas Felix Souche, Senior Investment Officer in the Infrastructure Africa team of IFC
Norah Magero, Co-Founder and CEO, Drop Access
Robert Lisinge, Chief of Section, PSDFD Energy Infrastructure & Services, United Nations Economic Commission for Africa (UNECA)
Rosemary Idem, Programme Manager, Women and Youth at the Forefront, SEforALL
Salvatore Bernabei, CEO of Enel Green Power and Head of Enel Green Power and Thermal Generation
Ute Collier, Acting Director, Knowledge, Policy and Finance Centre (KPFC), IRENA

Design and Layout: Gangemi Editore

Disclaimer: This report reflects the views of the RES4Africa Secretariat but does not necessarily reflect the views of the individual RES4Africa members or any particular funder, supporter, or collaborator.

This publication is available for download on www.res4africa.org/library

For further information: info@res4africa.org

Contact:

Via Ticino 14, Rome, Italy, 00198

T: +39 068552236

www.res4africa.org



This report reflects the views of the RES4Africa Secretariat but does not necessarily reflect the views of the individual RES4Africa members or any particular funder, supporter, or collaborator.

Contact:

Via Ticino 14, Rome, Italy, 00198

T: +39 068552236

www.res4africa.org

info@res4africa.org