European Commission

Scaling-up Energy Investments in Africa for Inclusive and Sustainable Growth

Report of the Africa–Europe High–Level Platform for Sustainable Energy Investments in Africa

Photo: Jesse Alegre

Photo: Lola Morales

Feed Africa, Light Up and Power Africa, Integrate Africa, Industrialize Africa and Improve quality of life of the African people. I firmly believe that if Africa focuses on these high 5s, the continent will achieve 90% of its SDG and 90% of its Agenda 2063 goals. It is why Industrialize Africa is at the heart of the African Development Bank's high 5 SDGS.

Akinwumi Adesina
President of the African Development Bank

Africa does not need charity, it needs true and fair partnership. And we Europeans need this partnership just as much. Today, we are proposing a new Alliance for Sustainable Investment and Jobs between Europe and Africa. This Alliance, as we envision it, would help create up to 10 million jobs in Africa in the next 5 years alone. I believe we should develop the numerous EU-African trade agreements into a continent-to-continent free trade agreement, as an economic partnership between equals

President Jean-Claude Juncker
On 12 September 2018, on the occasion of his State of the Union Address

Acronyms and Abbreviations

AEEP	Africa-Europe Energy Partnership
SEI Platform	Africa-Europe High Level Platform for Sustainable Energy Investments (the SEI Platform)
AMDA	African Mini-Grid Developers Association
AREI	Africa Renewable Energy Initiative
AU	African Union
AUC	African Union Commission
AFD	Agence Française de Développement
ARE	Alliance for Rural Electrification
C&I	Commercial and industrial (customers)
DFI	Development Financial Institution
DG DevCo	EU Directorate-General for International Cooperation and Development
EACREEE	East African Centre of Excellence for Renewable Energy and Energy Efficiency
EAPP	Eastern Africa Power Pool
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EU	European Union
EUEI PDF	EU Energy Initiative Partnership Dialogue Facility
EIP	European External Investment Plan
EIB	European Investment Bank
EEP	Energy and Environment Partnership
EFSD	European Fund for Sustainable Development
FiT	Feed-in-tariff
GDP	Gross domestic product
GHG	Greenhouse gas
HEPA	Health and Energy Platform of Action
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
IPP	Independent power producer
IFI	International financial institutions
MW	Megawatt
MDB	Multilateral development bank
MIGA	Multilateral Insurance and Guarantee Agency
NEEAP	National Energy Efficiency Action Plan
NLRP	National loss reduction programme
NDC	Nationally determined contribution under the Paris Agreement
PAYG	Pay-as-you-go payment scheme
PPA	Power purchase agreement
PPP	Public-private partnership
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency
RE	Renewable energy
REESP	Renewable Energy Entrepreneurship Support Facility
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme of South African Department of Energy
RES	Renewable energy sources
SHS	Solar home systems
SADC	Southern African Development Community
SACREEE	SADC Centre for Renewable Energy and Energy Efficiency
SAPP	Southern African Power Pool
SEFA	Sustainable Energy Fund for Africa
SSA	ub-Saharan Africa
SEforALL	Sustainable Energy For All Initiative of the United Nations
SDG	Sustainable Development Goal of the United Nations, 2015
SME	Small and medium enterprise
T&D	Transmission and distribution
Toe	Tonnes of oil equivalent
USD	United States Dollar
WEF	Water-Energy-Food Nexus
WACC	Weighted average cost of capital
WHO	World Health Organisation

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Context

The EU-AU Summit in Abidjan in November 2017 recognised the need to shape the right business framework to attract responsible and sustainable investment in Africa. The summit concluded that renewed engagement of public and private sectors of both continents is needed to boost investment in sustainable energy and energy access in urban and rural areas in Africa. It also concluded by committing to full implementation of the Paris Agreement, including with a focus on the importance of energy efficiency and the development of renewable energy, reiterating support to the Africa Renewable Energy Initiative (AREI) and deepening the strategic alliance through the AU-EU Energy Partnership (AEEP).

In his State of the Union Address on 12 September 2018, President Jean-Claude Juncker announced a new Africa-Europe Alliance for Sustainable Investment and Jobs. Recognising the long-standing political partnership, it deepens the economic and trade relations between the two continents and goes beyond a donor-recipient approach, to form an "equals' alliance". The EU is Africa's first partner in trade, in foreign investment and in development, including climate finance. One year after its launch, the Alliance is delivering, with many work streams in full implementation. Accompanying tools, such as the EU External Investment Plan (EIP) are being further developed and rolled out. The Sustainable Business for Africa Platform is reinforcing the facilitation of public-private dialogue in African countries by EU Delegations. Four Sectoral Task Forces have been set up as thematic platforms for high-level policy dialogue on agriculture, energy, digital economy and transport.

Serving as the task force for energy, the *Africa-Europe High Level Platform for Sustainable Energy Investments in Africa* (the SEI Platform) was launched in November 2018 during the Africa Investment Forum, organised by the African Development Bank (AfDB).

The SEI Platform engages public and private sectors alongside key financial institutions and academia to outline pathways for up-scaling sustainable energy investments, through innovative financial mechanisms and targeting successful business models. With this objective, the SEI Platform provides recommendations on how to improve policies, regulatory environments, markets and business climates. It identifies reforms to catalyse the scaling-up of sustainable energy investments, to streamline adoption of technological advancements, and to support pan-African sustainable energy integration. Its efforts to improve EU-Africa business-to-business and networking activities serve to increase coordination and effectiveness among key stakeholders.

The SEI Platform's ambitions are jointly pursued by the two continents within a broad global consensus on sustainable development and on the required shape of a future energy system that enables climate stability.

SUSTAINABLE ENERGY, ECONOMIC GROWTH AND JOBS. A CALL FOR ACTION IN AFRICA

The population in Africa will double by 2050 with increased pressure from climate change and environmental degradation. To power the ambitious call for sustainable development, enhanced resilience and poverty eradication, industrialization, high economic growth rates and job creation envisaged in the AU agenda 2063, massive reforms and investments are required along the whole supply chain of the energy system.

Sustainable development can only happen with access to reliable and affordable sustainable energy. Increasing sustainable energy services in Africa offers opportunities to progress in many dimensions of development, including alleviating poverty, enhancing food security, creating new jobs, and fostering education and gender equality. Clean energy solutions are also essential to reduce pollution and environmental degradation, provide access to water and sanitation, improve human health, and protect ecosystems while contributing to tackling climate change and enhancing resilience. Energy poverty coupled with increasing climate change and ecosystems damage can trigger conflict and drive people to leave their homes, contributing to rising urbanisation and migration in places where infrastructure already struggles to cope to meet people's needs. Providing universal access to affordable, reliable, sustainable and modern energy for all is the seventh Sustainable Development Goal (SDG) of the United Nations (UN).[1] A sustainable energy sector is also essential to address strategic interests of Africa and Europe and will contribute to the implementation of the UN Paris Agreement on Climate Change.

The population of sub-Saharan Africa (SSA) is expected to double by 2050, reaching nearly 2 billion.[2] Meanwhile, climate change is adding pressure on African ecosystems, food security, energy security, livelihoods, and economies, especially due to worsening natural disasters. By 2030, electricity supply across Africa must triple to meet the demand from modernizing economies, demographic growth, changing lifestyles and expectations, combined with projections for universal reliable, clean and affordable energy access under SDG 7. This calls for urgent steps to ensure that investments keep pace with energy infrastructure needs. Expanding and strengthening sustainable energy supply will help drive the industrialisation process (SDG 9) to advance socio-economic development while tackling the climate crisis (SDG 13). Therefore, the EU's partnership with Africa must tackle the problem at a scale that matches the challenge. This requires us to think big.

Access to affordable and reliable energy services remains a major challenge in large parts of Africa. Of the top 20 access-deficit countries in the world, 15 are in SSA, where over 570 million people lived without access to electricity in 2017.[3] The SSA population without electricity is projected to stabilise at around 585 million people in 2030, following current electrification trends and accounting for population growth.[4] Even those with access do not always receive quality supply, limiting the potential for electricity to improve quality of life and boost economic development. Africa currently has 80 GW of new electricity capacity under construction, compared to under 250 GW currently installed (of which only 80 GW in SSA, excluding South Africa).[5] Yet demand is projected to increase by 215% from 2016 to 2030.[6] The continent's primary energy needs (including electricity, transport, and industry) are overwhelmingly met with fossil fuels (50%) and unsustainable biomass or waste for

1 United Nations, About the Sustainable Development Goals. https://www.un.org/sustainabledevelopment/sustainable-development-goals/

2 United Nations Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019: Data Booklet. (ST/ESA/SER.A/424) available at https://population.un.org/wpp/Publications/Files/WPP2019_DataBooklet.pdf

3 IEA, IRENA, UNSD, World Bank and WHO (2019), Tracking SDG 7: The Energy Progress Report, Washington DC.

4 Ibid.

5 IEA (2019). Africa Energy Outlook 2019.

6 Multiconsult & AfDB. The AfDB New Deal on Energy for Africa: Optimal expansion and investment requirements. Report to African Development Bank. (2018).

cooking (45%), with consequences for air pollution and climate change.[7] Dependence on imported fossil fuels also harms local economies due to fuel price volatility. Electricity only represents 10"% of the continent's final energy consumption. The total installed generating capacity in SSA remains low, about equivalent to that of Spain, whose population is about 95% smaller. South Africa alone accounts for nearly half of the generation capacity for all of sub-Saharan Africa. From 2015 to 2016, Africa-focused investments made up only 16% of total global commitments, and about 26% of power sector commitments in Africa were concentrated on just four countries.[8]

The access challenge is equally acute for clean cooking solutions. The population in Africa without access to clean cooking solutions has grown to 900 million, a 20% increase since 2010. [9] Traditional use of solid biomass (fuelwood, charcoal, dung, agriculture residues, wood waste, other solid wastes) for cooking has damaging health and environmental impacts. Every year, around half a million premature deaths in SSA are attributed to household air pollution, linked to smoke from burning polluting fuels and inefficient technologies for cooking, heating and lighting. Fuel gathering takes up a significant amount of time for women and children, limiting their available time for education, leisure, or other productive activities. Black carbon and methane emitted by inefficient stove combustion contribute to climate change, while unsustainable wood collection causes deforestation and land degradation. Despite SSA countries' efforts, models predict that around 820 million people will still rely on non-sustainable biomass by 2030 (amounting to 56% of the population).

The African Union's (AU) Agenda 2063 highlights renewable energy as a priority pathway to achieve a prosperous continent with inclusive growth. The AU Commission calls for *"harnessing all African energy resources to ensure modern, efficient, reliable, cost effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions, through building the national and regional energy pools and grids."* The Commission stresses the need to ensure sustainable investment and continuous innovation in the energy sector. The AU's Africa Renewable Energy Initiative aims to mobilise potential to invest in at least 300 GW of renewable energy generation by 2030.

The new European Consensus on Development highlights three objectives in the energy sector: expand access to energy; increase renewable energy generation and energy efficiency; and contribute to the fight against climate change. Three strategic drivers underpin these goals: political ownership and partnerships on sustainable energy; unlocking the potential of sustainable energy resources through building adequate regulatory frameworks, developing energy markets and improving energy sector governance; and boosting investments in renewable energy generation, distribution and interconnections, notably through innovative financial instruments.

Sustainable energy in Africa offers significant potential to boost growth and jobs, both domestically as well as in Europe. This first report of the SEI Platform provides recommendations on how to leverage public and private investments in sustainable energy in Africa, and how to accelerate access to electricity and clean cooking for human development and sustainable growth.

[7] RES4MED and RES4Africa, 2019. White Paper: A New Instrument to Foster Large-Scale Renewable Energy Development and Private Investment in Africa https://www.res4med.org/wp-content/uploads/2019/02/RenewAfrica-White-Paper_FINAL.pdf

[8] SEforALL and CPI (2017), Understanding the Landscape – Tracking Finance for Electricity and Clean Cooking Access in High-Impact Countries.

[9] Ibid.

1 POWERING ELECTRIFICATION, SUSTAINABLE GROWTH AND JOBS.

Barriers to private and public investment exist across the electricity supply chain in SSA, resulting in a woeful shortage of generation and network infrastructures

Photo: Juan Manuel Becaña Morales

The AfDB's New Deal on Energy for Africa recognises that energy sector bottlenecks and power shortages are estimated to cost Africa 2 to 4 percent of GDP annually. This undermines economic growth, employment creation and investment. Strengthening power supply and expanding access to electricity is at the heart of the African Union's Agenda 2063,[10] and the AfDB's New Deal on Energy for Africa and Programme for Infrastructure Development in Africa (PIDA).

Delivering sustainable, affordable and reliable electricity services involves performing many activities, applying various technologies and business approaches, and enlisting diverse actors. African countries must examine each segment of the electricity sector to understand why progress in strengthening and expanding power systems has been slow.

The measures proposed in this report focus on creating the conditions to attract public and private investment in sustainable energy. Investments need to reach a scale that meets the ambition of the electrification challenge, to fit each country's context in a sustainable, climate-compatible way.

Traditionally, most investments in the electricity supply chain take place at bulk power system level (in utility-scale infrastructure). Roughly two thirds of investment is directed towards utility-scale generation and one tenth in the transmission network, with the rest for distribution. SSA is heavily underinvested in each one of these three segments for various reasons. Section 1.1 analyses the situation and interventions needed for centralised generation. Section 1.2 considers the transmission network, while section 1.3 addresses distribution. Zooming out, section 1.4 examines the impact of aggregation of national power systems into regional power pools.

[10] The New Deal on Energy for Africa calls for universal access to electricity for all in Africa through a five-pillar strategy. https://www.afdb.org/en/the-high-5/light-up-and-power-africa-%E2%80%93-a-new-deal-on-energy-for-africa

1.1. Utility-scale generation

Utility-scale renewable energy projects, in particular solar PV and wind, have grown in recent years. Thanks to excellent domestic resources and effective competitive procurement frameworks, many African countries have received record-low prices for new generation bids. Allowing private investment in generation has driven new grid investments in renewable capacity. The vast majority of new independent power producer (IPP) procurements—83% of IPP projects that have reached financial close since 2008—are for renewables, including solar, wind, biomass, hydro, bagasse, and geothermal technologies. Investing in expanding renewable generation capacity offers Africa a head-start on the transition to green growth pathways and in decarbonising the energy sector. It also helps boost countries' energy security by reducing their reliance on fuel imports.[11] Despite these encouraging trends, much larger sustainable investments must be mobilised, and these investments must be spread more evenly across the continent, to address each country's needs.

IPPs now frequently operate alongside—and contract with—Africa's publicly-owned, vertically-integrated electric utilities (which remain the most common structure for electricity companies on the continent). Privately-financed IPPs are the fastest-growing source of investment in generation capacity, present in more than 30 African countries, with 270 existing projects at utility scale.[12] Together, these projects total over 27 GW of new capacity, representing about €47 billion of investment. [13 ,14, 15,16]

Demand projections suggest that installed generation capacity in Africa's power system should reach 610 GW in 2030.[17] This would require on average €41 billion per year of investment by 2030, of which 71% for renewables.[18] The AREI targets 310 GW of new renewable energy generation capacity over the same period. Renewables have become the most competitive energy solution for Africa, thanks to the continent's abundant resource potential as well as cost reductions in the technologies.[19,20] Renewables also offer a key element to enhance sustainable economic development through fostering local value chains within sound, long-term markets. Approximately 277 GW of this new generation capacity is expected to come from on-grid generation, while 33 GW will need to be in the form of decentralised generation.

Competitive procurement programmes have become a popular, successful solution in Africa for encouraging investment in renewable generation. Implementing auction programmes helps attract lower prices in each successive round, as shown in South Africa's Renewable Energy Independent Power Producer Procurement programme (REIPPPP).[21]

The following section discusses the barriers to attract the investment needed to meet these targets. The recommendations to surmount these barriers follow in section 1.1.2.

[11] AfDB and APUA (2019), Revisiting Reforms in the Power Sector in Africa, https://africa-energy-portal.org/sites/default/files/2019-09/Revisiting%20Power%20Sector%20Reforms%20in%20Africa%20v03.pdf.

[12] Larger than 5 megawatts (MW) peak capacity.

[13] AfDB and APUA (2019).

[14] Eberhard et. al., (2017), Independent power projects in Sub-Saharan Africa: investment trends and policy lessons. Energy Policy 108:390–424.

[15] AfDB and APUA (2019).

[16] Ibid. Over 42% of new capacity additions through IPPs during the last decade has been for solar PV, and over 37% for other renewables including wind, hydro, biomass, and geothermal generation. Auctions (international competitive bidding programmes) are now a well-established trend to guarantee lowest prices for new RE projects.

[17] 318 GW in North Africa, 63 GW in West Africa, 25 GW in Central Africa, 55 GW in Eastern Africa, and 150 GW in Southern Africa. IRENA (2015), Africa 2030: Roadmap for a Renewable Energy Future. IRENA, Abu Dhabi.

[18] Ibid.

[19] Ibid.

[20] The share of public investment s in RE is 34%, higher than any other region and more than double the global average, which is 16%. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_Global_landscape_RE_finance_2018.pdf

[21] AfDB and APUA (2019)

1.1.1 Barriers

Many of the barriers to mobilising investment in power generation are well understood. These can be broadly classified as follows.

- *Level of liberalisation and regulations on entry*. Many low-energy access countries are only just beginning to authorise private-sector participation in the power sector. Several countries have now created conditions in the generation segment to encourage IPPs, even if they have not unbundled and liberalised the generation segment.[22]
- *Weak legal and regulatory frameworks*. The 'rules of the game' within the power sector are unclear in many countries, including with high levels of subsidies remaining for fossil fuels. This introduces substantial risk for private-sector investments and increases project development costs. Major investor risks lie in potential changes in law, resource availability, and responsibility for force majeure. Tariff-setting processes, network utilisation charges, permitting processes for power evacuation at the point of connection to the grid, and settlement of accounts also present risks for investment.
- *Poor governance*. Weak rule of law and lack of transparency in many countries provide opportunities for corruption and policy reversal in regulatory and other processes. These put contractual agreements at risk and further discourage private investment in the power sector.
- *Insufficient regional integration to allow economies of scale*. Limited integration of the power system at regional level reduces the commercial incentives to develop utility-scale power plants that maximise available resources, increase competitiveness, and optimise output efficiencies. This creates obstacles to achieving necessary economies of scale. For example, South Africa's solar and wind localisation roadmaps take into account regional economic development, even quantifying the level of local content that would be achievable if the region prospers. These require sufficient integration and electricity demand across the region to be considered technically feasible and bankable.
- *Financial risks*. The creditworthiness of the off-taker (often a vertically integrated national utility or distribution company in dire financial straits) poses a major investment risk. Often, governments need to underwrite the payment obligation of national utilities through guarantees, but are unwilling to do so due to debt sustainability caps.[23] Other de-risking tools are negotiated on a case-by-case basis with IPPs, with varying success (such as escrow accounts on the utility end, or comfort letters and put-call option agreements). Most available risk mitigation instruments designed to support IPPs are applicable only in cases where utility companies are public. The bankability of long-term power purchase agreements (PPAs) is undermined by additional financial risks, resulting from political instability, legal uncertainty, and currency fluctuations.[24]
- *Difficult macroeconomic and institutional conditions*. Macroeconomic policies and related factors influence the attractiveness of the investment climate, such as the country's credit rating (or that of the national utility) and its previous experience with private investment. Political risk in the country can also deter private-sector investment.[25]
- *Technical barriers*. These include poor transport infrastructure needed to facilitate the construction of power plants, and uncoordinated development or poor maintenance of grid infrastructure.[26]
- *Lack of energy planning*. Comprehensive energy sector planning, which is not widely conducted, provides investors with a long-term view on available and needed energy sources, based on both population and GDP growth.

[22] bid.

[23] Debt sustainability caps are set by the International Monetary Funds (IMF). Governments are especially reluctant to provide guarantees for privately-owned (or concessioned) utilities, as with ENEO in Cameroon. EU Technical Assistance Facility (TAF) SEforALL CW188, 2018. Market Study in view of preparing partial off-take guarantees under the European External Investment Plan (EIP) in Sub-Saharan Africa, conducted in 2018

[24] Eberhard et. al. (2016), Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries. Washington, DC: World Bank.

[25] Eberhard et. al., (2017), Independent power projects in Sub-Saharan Africa: investment trends and policy lessons. Energy Policy 108:390–424.

[26] For example, in Zambia, a private sector project was delayed by 8 years due to inadequate road infrastructure. EU TAF SEforALL (2016) ES-0059 : Technical Assistance Facility (TAF) for policy support to improve the enabling environment of the Zambian energy sector for rural electrification and IPPs

- *Other barriers*. Many partially-built assets across SSA are not operational. These could be revived under the right circumstances. Alongside a transformation of the distribution sector, this could help reduce the cost of generation as well as the off-taker risk. It is increasingly difficult for governments to approve new projects when assets are not being fully utilised on the ground.

The challenges faced in developing utility-scale projects are less connected to the nature of the generation business than they are related to external causes of risk. Solutions to these barriers exist, and depend on country context, readiness, and sectoral capabilities.

1.1.2 Recommendations

IPP investments in African countries are still largely driven by long-term PPAs. The following recommendations address barriers to achieving robust, commercially viable and attractive PPAs.

- *Redefine the sector's commercial structure*. Generation and transmission/distribution segments of the power sector should be separate to reduce conflicts of interest in procurement and to strengthen utilities' financial autonomy and creditworthiness. In over three quarters of African countries, public companies own the transmission and distribution segments (including South Africa, Kenya, Egypt, and Morocco). In most cases, these companies also own generation assets, which can conflict with their procurement decisions for new generation.
- *Create solid legal frameworks and offer well-designed, bankable PPAs*. Robust PPAs are necessary to secure IPPs' long-term revenue streams. This reduces risks and facilitates access to financing under more favourable conditions, by allowing project debt repayment and providing appropriate risk-weighted returns to investors.[27] Contract structures must clearly define the allocation of risks and rewards[28] and rights and responsibilities of stakeholders, and the quantity and price of power to be procured (see Rademeyer, 2016 for details of sound PPA provisions).[29,30] Standardised contracts can serve as a de-risking measure to facilitate IPP negotiation and development processes (see Box 1). The provisions should suit the local context and be understandable to both public and private sector counterparties. Countries should not retroactively and unilaterally change terms of procurement or power contracts.

Box 1 - Standardised procurement contracts

Various initiatives, such as the Open Solar Contracts (led by IRENA and the Terawatt Initiative) and the multidonor GET FiT programme, provide a set of standardised project documentation, including contract templates and procurement processes for renewable IPPs. These are developed through a collective process including market-leading energy stakeholders. These offer models of a Power Purchase Agreement, Implementation Agreement, O&M Agreement, Supply Agreement, Installation Agreement and Finance Facility Term Sheet, as well as implementation guidelines. Such standardised documents help streamline project development and finance, as well as helping to balance risk allocation and simplifying project aggregation and securitization.

- *Provide clear regulatory frameworks*. Regulatory certainty, backed by sufficient political stability, is necessary to support legal contracts. Tariffs agreed with an IPP often depend heavily on the prevailing costs at financial close of the project, including construction and financing costs. The agreed tariff (including any tariff adjustment mechanism built into the contract) must be honoured regardless

[27] Ideally, a 'bankable' PPA creates a long-term agreement with a creditworthy off-taker over a time horizon that allows debt servicing and provides for risk-equivalent returns for investors.

[28] Rademeyer, G. (2016), How can Independent Power Producer (IPP) investments be accelerated on the African continent?, Norton Rose Fulbright, https://www.insideafricalaw.com/publications/how-can-independent-power-producer-ipp-investments-be-accelerated-on-the-african-continent

[29] Ibid.

[30] Nehme, B. (2013), PPAs and Tariff Design, Presentation at the Renewable Energy Training Programme, https://esmap.org/sites/default/files/esmap-files/ESMAP%20IFC%20Re%20Training%20World%20Bank%20Nehme.pdf.

of whether technology costs subsequently reduce (which allows future IPPs to offer lower tariffs). Retrospective tariff adjustments deter future investments in the country. There must also be a clear, independent legal system that allows for the fair enforcement of contracts. Licensing procedures must be simple and transparent, and the term of any applicable generation and export licences should be at least as long as the tenor of the debt provided to the IPP.

- *Define clear planning and policy frameworks for IPPs*. Programmes for IPP development (whether solicited or unsolicited) must be created at government level, based on integrated planning to identify capacity thresholds, project locations, distribution model (on- or off-grid), and desired technologies. This project pipeline must define clear objectives to provide direction to the private sector.
- *Phase out fossil fuel subsidies to provide fiscal space for sustainable energy*. Other fiscal measures such as tax exemptions to sustainable energy technologies or carbon pricing policies to avoid carbon leakage also support sustainable energy development. These should align with complementary policies, such as energy efficiency policies, emissions performance standards, and research and technology policies, etc.
- *Implement competitive procurement procedures*. IPP procurement processes must show integrity and transparency, while increasing competitiveness. Globally, over 95% of power-sector investments rely on regulated remuneration, or long-term PPAs, instead of short-term wholesale markets. Across Africa, power utilities and energy ministries are increasingly employing competitive procurement mechanisms to develop new capacity, increase private sector participation, and reduce costs compared to unsolicited, directly negotiated projects. Additional support from governments in the preparation phase of such projects, such as with pre-feasibility studies, site identification, and guidance on licensing, helps boost bidder participation and reduces overall project development costs. This naturally has a positive impact on the tariff required to make the project bankable. The regulatory framework should clearly define the work to be done upfront during the preparatory phase, as well as the respective responsibilities of government institutions and the private sector.

Box 2 - Technical assistance and knowledge sharing for competitive procurement

The European Commission's External Investment Plan and programmes such as Get.Invest, ElectriFI, renewAfrica, and Scaling Solar provide technical assistance, donor financing, and de-risking packages to support the preliminary development of power projects prior to tendering. As well as offering standard and tailored contract documents, the technical assistance helps design the tendering process and enables pre-feasibility studies, including environmental and social impact assessments.
For example, renewAfrica is an innovative European private sector-led programme, launched in 2019 to support investment growth in renewable energy sources (RES) in Africa. renewAfrica brings together leading EU renewable energy industry players, financing institutions and African governments. The Europe-wide initiative is designed as a one-stop shop to support the creation of a conducive energy investment environment through enhancing financial instruments, sharing knowledge on successful supporting policies, and disseminating best implementation practices. The initiative, which aims for technological neutrality, offers technical assistance along the whole project lifecycle, and promotes high-level dialogue between public institutions and public-private collaborations. It also offers a full staple blending finance package for bankable projects, supported by guarantees and insurance as financial de-risking tools.

- *Strengthen coordination*. Public institutions need to coordinate to avoid overlaps or contradictions in licensing procedures. For example, the permitting process and tests required from environmental agencies as well as entities in charge of providing land or water permits may be duplicated or have conflicting timelines, increasing government as well as project costs and delays. More transparent information sharing systems and more efficient guidance should be provided to private players willing to develop unsolicited projects. This can be achieved notably through the establishment of independent authorities or agencies acting as one-stop-shop institutions.

Box 3 – Developing local value chain with stable planning and policies

The first wind turbine blade plant in Africa and the Middle East was opened in Morocco in 2017 by Siemens Gamesa Renewable Energy (SGRE), a global leader in the wind sector and overall leader in Africa. The Government of Morocco's sound policy frameworks convinced the company to invest there. Enabling policies include a target to achieve 52% electricity generation from clean energy by 2030, and the Ministry of Industry, Investment, Trade and Digital Economy's Accelerated Industrialization Plan (2014).
The plant aims to serve the domestic market as well as to export to Europe, around Africa, and to the Middle East. SGRE also built a training centre to facilitate knowledge transfer from Denmark to Tangier. The learning process ensures the complete transfer of the technical and process skill sets necessary to optimise the manufacturing process. SGRE has devoted over 350,000 hours of employee training to Moroccan employees, both in-house in Tangier and at other locations. The plant has created 700 jobs, as well as about 500 auxiliary jobs.

https://www.siemensgamesa.com/newsroom/2017/10/siemens-gamesa-inaugurates-the-first-blade-plant-in-africa-and-the-middle-east

- *Set up risk mitigation tools to facilitate financing*. Creditworthy, financially viable power purchasers boost the attractiveness of the generation sector to investors. To begin, structural reforms may be necessary to improve the technical and financial performance of distribution companies. At the same time, measures should also be introduced to mitigate risks for IPPs. IPP project financing often requests a sovereign guarantee aimed at shifting investment risk to the government, especially when the off-taker utility has poor credit rating.[31] But sovereign guarantees depend on the government's fiscal position and its ability to take on debt. The principal de-risking mechanisms to date have been provided by export credit agencies, DFIs and multilateral development banks (MDBs),[32]

Box 4 - Intermediary off-taker for risk mitigation: Africa GreenCo model

New structures are being developed to leverage the benefits of aggregation and diversification—inherent in interconnected regional electricity grids—in order to mitigate risk and provide an alternative route to market in case of default. Africa GreenCo is implementing this approach in the Southern African Development Community, starting in Zambia (part of the Southern Africa Power Pool, SAPP), aiming to operationalize in early 2020. This will introduce a creditworthy intermediary off-taker, buying renewable electricity from small to medium IPPs through take-or-pay PPAs and on-selling to utilities and private off-takers through long-term contracts, as well as proactively interfacing with the regional power pool. This reduces the risk, and therefore the cost, of finance at IPP level by providing IPP developers and lenders with a creditworthy long term PPA counterparty. This leads to lower tariffs required to make the IPP bankable. A reduced risk profile should also make investment better suited to the risk profile of local institutional capital. This approach—working with increasingly liquid regional power pools—can alleviate problems related to the traditional single buyer-single seller model, transforming the risk to the level of the interconnected regional pool.

Source: www.africagreenco.com

such as through political risk insurance[33] and partial risk guarantees.[34] However, such instruments often entail long negotiation processes and are often inaccessible to smaller projects. The EU's

[31] Rademeyer, G. (2016), How can Independent Power Producer (IPP) investments be accelerated on the African continent? Norton Rose Fulbright.

[32] European DFIs committed to energy projects in Africa, especially renewable projects, include: KfW (Germany); DANIDA/IFU (Denmark); PROPARCO and AfD (France); FMO (Netherlands); FIEM (Spain); CDC and UK Aid (UK); and the Nordic Development Fund and related partners: Norfund, Swedfund, Danida/IFU and Finnfund.

[33] Political risk insurance is provided by the Multilateral Insurance and Guarantee Agency (MIGA), part of the World Bank Group

[34] Partial risk guarantees are provided by the World Bank and AfDB.

External Investment Plan (EIP), adopted in September 2017, supports partner countries in Africa and the European Neighbourhood by i) mobilising finance (through the European Fund for Sustainable Development (EFSD)); ii) providing technical assistance to help prepare investment projects; and iii) helping partners to develop a favourable investment climate and business environment. Alternative models to address off-taker risks are emerging under the EFSD, such as the Africa GreenCo model (see Box 4) and the European Guarantee for Renewable Energy being proposed by the European Investment Bank (EIB) Agence Française de Développement (AFD), Cassa depositi e prestiti (CDP) and Kreditanstalt für Wiederaufbau (KfW). These guarantees provide significant comfort to private sector beneficiaries, often by leveraging the broader relationship of the guarantor with the host country to deter defaults arising. However, they have limited ability to mitigate underlying risks in case of a default.

Section 6.1 (Access to finance), below, offers further recommendations on cross-cutting financing issues.

1.2 Transmission[35]

The transmission segment accounts for only around 10% of the total cost of the entire traditional power-sector supply chain,[36] but it serves essential functions in the power system. It connects low-cost, large-scale sources of electricity generation with important load-bearing distribution centres in cities, and with large industrial or commercial loads. Energy-efficient and robust transmission networks help develop renewable energy capacity at greater scale in resource-rich areas to serve distant loads, allowing efficient dispatch of electricity across national and regional networks. Transmission networks also reduce the operating and capacity reserves needed to ensure security of supply, and support the integration of variable renewables into the power system. New transmission investments depend on new generation plants' technical characteristics (including siting, capacity, and technology), and on the volume and location of new demand connected to the distribution grid. Upgrading and building new transmission infrastructure is an essential part of the overall expansion of the power sector.

The existing African transmission system,[37] with a total length of less than 90,000 km, is the major bottleneck for further energy system integration and cross-border trade.[38] This presents a huge opportunity for improvement. SSA has a combined transmission network smaller than that of Brazil. Nine sub-Saharan countries have no lines rated above 100 kilovolts (kV). Africa has fewer kilometres of transmission lines per capita than any other region of the world, despite having a much larger land mass and more dispersed population. As with generation, substantial investment in transmission infrastructure is needed to contribute to full electrification by grid extension, and to achieve globally competitive electricity prices. Understanding how to plan, operate, and manage transmission grids, as well as combining high voltage with lower voltages, will be essential. A strong interconnected transmission network can also help to mitigate the variability of wind and solar production.

1.2.1 Barriers

Transmission investment in SSA has lagged for several reasons:

- *Limited public budget and donor financing*. Most countries finance transmission investments directly from utility revenues or from the government budget, which creates a major constraint on network expansion. Others rely on concessionary financing from DFIs, and in some cases grants from donor countries.
- *Policy and regulatory barriers to private investment*. Transmission has not benefited from the same influx of private investment as generation in African countries. This is especially true in SSA, where only a handful of governments have introduced regulations to allow any form of private participation in

[35] This section and section 2.3 owe much to World Bank, 2017. Linking Up – Public-Private Partnerships in Power Transmission in Africa, Washington DC.
[36] Equivalent to 10% of total cost of electricity supply.
[37] Defined as lines with a voltage equal to or greater than 100 kV.
[38] World Bank (2017).

transmission. Weak private investment in transmission results from the absence of enabling policy, gaps in regulation (for example, relating to construction agreements, cost-sharing arrangements, payment guaranties, and right-of-way permits), and country-specific risk.

- Regulatory risks and uncertain cost allocation. Flaws or uncertainties in the regulation of transmission developments add another risk factor (which varies between countries). For example, challenges can be associated with reaching agreements for line construction, obtaining permits for necessary rights-of-way, enforcing sound rules for cost-sharing among different parties (particularly important for cross-border transmission lines), and providing payment guaranties. Lengthy negotiation and construction processes for new transmission networks (in some cases, up to 10 years) add additional barriers.

  Transmission lines are most often financed by DFIs and MDBs. According to the EIB, public finance is already challenging for transmission projects due to lengthy and complex negotiations surrounding contractual and financing processes, especially for those that involve multiple governments. Private investors also struggle to raise investors' interest in transmission. Poorly designed or uncertain transmission charges create barriers to raising the investments needed to support network infrastructure, especially for cross-border lines.[39] The lack of sound, commonly agreed procedures for allocating transmission costs create uncertainties for ensuring adequate returns on investment.

- *Lack of energy planning and insufficient regional integration*. These prevent opportunities to create economies of scale and fail to provide the vision and stability needed to foster investments. Transmission lines crossing two countries are often planned and built on the basis of bilateral discussions and negotiations, without taking into consideration the regional or continental context. Bilateral planning of transmission networks risks overlooking opportunities to use the full potential of interconnected electricity markets. This can detract from optimal use of generation resources.

- *Non-specific country-dependent risks*. As previously described for generation investments, this set of risks includes macroeconomic conditions, political stability, legal security, and currency convertibility.

1.2.2 Recommendations

- *Facilitate private sector participation in transmission*. Several developing and low-access countries have introduced viable transmission business models—such as independent transmission projects mostly financed by private capital—to attract investment in transmission. Many countries in Latin America and Asia have successfully introduced private-sector participation in transmission financing, resulting in investments at attractive costs. The approach is similar to the concept of IPPs in generation, which has already yielded good results in sub-Saharan Africa.

  The most appropriate model for private-sector participation depends on the local context. IPT tenders offer a promising model for both national and regional-level investments, as shown in numerous experiences.[40] The IPT model can use different PPP structures, most commonly build–own–operate–transfer and build–own–operate.

- *Strengthen the financial viability of national utilities*. Public electricity utilities in SSA need to be financially sound to ensure investors' recovery of transmission costs. The power sector's financial weakness poses a challenge for implementing the IPT model, which requires returns to private investors. One option to address this challenge is to use revenue escrow arrangements to ring-fence consumer payments. Where escrow arrangements are deemed insufficient to make a project bankable, governments may also have to use government and multilateral guaranties to back payment obligations to IPTs.

- *Invest in technological solutions*. Various technologies are available to improve operations efficiency, technical efficiency, integration of renewable energy and network management. For example, SCADA systems are not widely implemented across SSA. These are critical for network planning and management, and efficient dispatch of generation as well as load management. The system can also

[39] An AfDB-funded study performed by Multiconsult, "Roadmap to the New Deal on Energy for Africa: An analysis of optimal expansion and investment requirements", published in June 2018, estimates total investment needs of $8.9 billion in regional interconnectors from 2018 to 2030 to support a least-cost power investment and expansion plan across the African continent.

[40] There are four typical models for private sector participation in transmission: i) complete privatisation; ii) concession for the entire network for a period of time (e.g. 20 years); iii) independent power transmission (IPT), a concession for one or few lines; and iv) merchant lines. World Bank (2017), Linking Up- Public-Private Partnerships in Power Transmission in Africa, Washington DC

benefit from increasing levels of automation and implementing other basic systems to improve overall reliability.

- *Invest in capacity building for planning and operation.* Good planning and operations are essential to avoid stranded assets or unsuitable investments, as well as to integrate renewable energy sources.

1.3 Distribution

African utilities are frequently vertically integrated: a fully publicly-owned utility performs distribution services through grid extension, while also operating generation, transmission, and retail services. Many countries have allowed private sector involvement in some or all of these segments, most commonly in generation. Only few have incorporated private participation in distribution, such as Cameroon, Nigeria, Uganda, or Ghana.[41]

The distribution segment of a power system—which in SSA systematically includes retail—is closest to the end-user. It has played a central role in the failure to provide universal access to electricity in many African countries. Traditional distribution companies connect and supply electricity to different customers, procure this electricity at the wholesale level, and are responsible for developing and maintaining distribution infrastructure. They require a business model that ensures long-term sustainability and quality of service. Challenges in the distribution sector have negative implications at the wholesale level if they mean that distribution companies become unreliable off-takers, eroding the confidence of potential investors in centralised generation and transmission.

1.3.1 Barriers

- *Electrification difficulties.* Electrification is costly and difficult, especially in remote, sparsely populated regions, which make up most of the remaining areas needing grid extension. Providing a grid connection to poor communities often causes losses to the utility, due to low initial electricity demand from new customers and their inability to pay for the full connection cost. Distribution utilities in SSA frequently need significant subsidies or government bailouts to continue operating.
- *Financial viability.* Many distribution companies in Africa are in a financially dire state. To begin with, tariffs are often set at levels that inhibit financial viability and cost-recovery for the utility. Although electricity tariffs are supposed to cover the costs of all segments in the electricity supply chain, the deficit typically accumulates in the regulated distribution segment. A study in 2016 found that only two countries in SSA had a financially viable electricity sector (the Seychelles and Uganda), while utilities in only 19 countries covered operating expenditures.[42] This leaves distribution companies lacking the resources needed to invest in strengthening existing networks to improve quality of service, or in expanding infrastructure to connect additional consumers. Non-cost-reflective tariffs lead to limited investments, poor quality of service, customer dissatisfaction and defection. A vicious circle of theft and unpaid bills can further erode distribution company revenues.
- *Serving commercial and industrial (C&I) customers.* C&I customers are a huge source of revenues for utilities, consuming power at higher voltage and volumes. They can also represent an important source of cross-subsidies for residential consumers. When they defect from the grid in favour of other sources of power, the distributor loses a major source of revenue. This is increasingly common thanks to distributed generation (grid connected or not). For example, in Kenya, Nigeria, and Ghana, on-site solar power (at small and medium-size facilities) can now be generated for $0.10 to 0.14 per kilowatt-hour (kWh), which is cheaper than the regulated tariffs for grid-connected C&I customers. As of 2018, a total of 74 MW of installed PV capacity has been recorded in sub-Saharan Africa (excluding South Africa), which is expected to double in 2019. Where a PPA or leasing deal has been signed, it has

[41] AfDB and APUA (2019), Revisiting Reforms in the Power Sector in Africa, https://www.gsb.uct.ac.za/files/Final_Report_Revisiting_Power_Reforms.pdf.

[42] Trimble, Chris, Masami Kojima, Ines Perez Arroyo, Farah Mohammadzadeh. "Financial Viability of Electricity Sectors in Sub-Saharan Africa: Quasi-Fiscal Deficits and Hidden Costs" 2016. Policy Research Working Paper, World Ban

usually been financed with developer equity. Developers almost unanimously cite the lack of access to debt financing as the biggest hurdle to growth.[43] Policy makers and regulators in African countries increasingly face the challenge of creating enabling regulations to support the growth of this sub-sector, driven in large part by economics, while also ensuring the resilience and long-term viability of the distribution segment.

- *Regulation on tariffs*. Power sector investments are greatest in markets with cost-reflective tariff-setting, where utility companies can adequately recover their supply costs.[44] Achieving these conditions in low-access countries requires structural adjustments in the power sector, including tariff-setting regulations, support mechanisms and incentive structures that enable distribution companies to move toward long-term sustainability.

1.3.2 Recommendations

- *Diversify electrification solutions*. Distribution companies could make use of the three modes of electrification—grid extension, mini-grid, and standalone solutions—to efficiently achieve universal access. However, so far, fragmented approaches are widespread, in which grid and off-grid solutions (discussed in chapter 2) are pursued in silos by independent agents with limited institutional interaction and planning. Recent technological innovations can enhance the operational capacity of distribution companies. For example, smart metering, GIS-based integrated planning,[45] and advanced power electronics and control devices (such as Demand Side Management with billing for real time use and dynamic pricing) enable efficiency improvements and better monitoring of assets, while also reducing the cost of new connections in unconnected or under-served rural areas.
- *Support utility finances*. Financing distribution in rural areas still presents a major challenge in terms of regulation and business models, unlike the situation for centralised generation and transmission, where problems and solutions have been identified and multiple success stories exist. Utility-driven electrification approaches have been successful in contexts where substantial public financial support was available, and/or where the utility's financial condition was acceptable and the socio-economic profile of consumers was relatively more affluent (such as in Morocco and South Africa).
- *Expand private participation models for distribution*. Utility scale distribution remains the last frontier for private investment, and needs fixing for all the pieces of the puzzle in the power sector value chain to start working together efficiently. Classic distribution by grid extension is critical to achieving full electrification, but open questions remain about the format of the most promising business models, the need for enabling regulations, and the financial viability of distribution service providers. Investors tend to hesitate to invest in the traditional distribution sector given the regulatory, tariff and overall challenges with the under-invested state of the network. While some investors are turning their focus from generation to distribution, they still focus on more 'bankable customers', like commercial and industrial off-takers. Alternative delivery models have been tried in an effort to catalyse private sector participation and investment in electrification, including through zonal concessions (such as in Senegal) and transformation of existing mini-grids into small power distributors when the grid arrives (such as in Tanzania). Most of these initiatives have been implemented with little or no utility involvement, which risks creating conflict in the future as the grid expands into areas that are being served by private-sector entities. The success of some distribution franchises in India—which typically involve long-term territorial concessions based on PPPs—is encouraging, although these franchises have so far been limited to mostly urban areas.

[43] BNEF (2019), Solar for Businesses in Sub-Saharan Africa, https://data.bloomberglp.com/professional/sites/24/BNEF_responsAbility-report-Solar-for-Businesses-in-Sub-Saharan-Africa.pdf

[44] IEA (2019), World Energy Investment 2019, International Energy Agency, Paris.

[45] Geographic information systems

1.4 Power pools and system operation

Energy trade through regional power pools is a core part of the AU's long-term strategy to achieve universal access to electricity and to increase the share of renewable energies. The vision of the new African Continental Free Trade Area (AfCFTA) is to expand cross-border cooperation in larger regional power generation projects and strengthen interconnections, to facilitate trade and mutual support to increase energy access and to decarbonise the electricity system. Power pools exist in all continents, with different levels of maturity and success. They connect a group of countries by cross-border transmission lines to enable regional power trading arrangements and to coordinate operation and investment. Four power pools have been established in sub-Saharan Africa, and one in North Africa.[46] The oldest, the Southern African Power Pool (SAPP), was launched in 1995. Further initiatives such as the African Clean Energy Corridor (ACEC) have also been launched to connect SAPP with the Eastern Africa Power Pool (EAPP).

Regional power pools and cross-border electricity trading provide several benefits. They help attract investors in generation who can expect to gain access to larger and more diverse markets, while achieving economies of scale that can help reduce costs. Power pools increase liquidity in trading, which is mostly dominated by physical bilateral contracts. Meanwhile, better coordination of generation dispatch among power pool members can reduce supply costs and improve system reliability, reducing curtailments of grid-connected demand and therefore increasing economic output.

Box 5 - Regional integration in Nordic countries

Nordic countries have cooperated on electricity market issues since the 1990s. Norway, Sweden, Finland and Denmark have shared a common electricity market since 2000. The Louisiana declaration, signed by Nordic energy ministers in Denmark in 1995, has guided the Nordic electricity market towards closer cooperation and increased harmonisation since its publication. The Nordic region benefits from RES and hydro power synergies, supported by their electricity market collaboration. The increased wind, solar and bioenergy production occurring throughout the Nordic region is balanced out among the different RES generation technologies (wind, solar and bioenergy), as well as by adapting Norway's hydropower production to other RES production and demand curves.

Source: Nordic Energy Research

The African Union's Agenda 2063 also recognises the benefits of regional integration, particularly relevant for electricity trade in SSA. The size of the national power system in at least 20 countries in SSA is below the efficient level of output for a single power plant.[47] At the same time, some countries have sufficient hydro resources both to meet domestic demand and to export excess power. The same can apply to solar and wind resources in various SSA countries. By using dispatchable hydro resources to balance intermittent generation resources on a regional basis, resource efficiency can be greatly improved for the benefit of all (see Box 5 for the Nordic context).

Maximising the potential for trade and integration through power pools relies on three conditions:

- Cross-border interconnection infrastructure to integrate national power grids
- A common legal and regulatory framework (involving memoranda of understanding between governments, utilities, and power pool)
- A multi-country organisational structure to oversee planning, harmonise rules, and develop a commercial framework for cross border power trade.[48]

[46] he Maghreb Electricity Committee (COMELEC), since 1989, promotes energy exchange and interconnection between members; the first true power pool is Southern African Power Pool (SAPP), with 16 members representing 13 countries; West African Power Pool (WAPP) since 2000, in 14 countries; Eastern Africa Power Pool (EAPP), 7 countries; Central African Power Pool, 10 countries. AfDB and APUA (2019)

[47] Programme for Infrastructure Development in Africa (2012), Interconnecting, integrating and transforming a continent, www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/PIDA%20note%20English%20for%20web%200208.pdf.

[48] Vanheukelom, J., Bertelsmann-Scott, T. 2016. The political economy of regional integration in Africa - The Southern African Development Community (SADC). Maastricht: ECDPM

1.4.1 Barriers

- *Weak regional institutions.* Despite its clear benefits, regional integration is hampered by the absence of strong regional institutions and enabling regulations. From a governance perspective, the most salient issue is that existing power pools generally lack executive powers in the two key regional institutions: the regional system operator, and the regional regulator.[49] This undermines regional transmission planning, and results in poor regulatory harmonisation. In addition, national institutions often lack trust towards other states and are reluctant to assign power to a regional institution.

Regulatory weaknesses are common to most power pools that serve African countries:

- *The system lacks sound rules*, which need to strike a delicate balance between i) pooling together generation resources to efficiently meet regional demand, ii) coordinating the expansion of generation and interconnected network capacity, and iii) preserving the autonomy and sovereignty of participating countries. Countries prefer to be in the position of exporter, to avoid dependence on imported power and ensure security of supply. To make regional power trade work, conditions that guarantee the firmness of cross-border contracts are essential.
- *Inefficient physical bilateral contracts.* Much of the trade in SSA power pools is through physical bilateral contracts between utilities. Their design frequently results in inefficient expensive generators being dispatched, while others with lower operation costs remain idle. This mandatory dispatch also reduces the liquidity in incipient regional wholesale markets.
- *Resisting security of supply at regional level.* Power pool members can be reluctant to trust security of supply in generation at the regional level, fearing that exporting countries will not be honoured in a situation of supply shortage in the exporting country. This, in turn, inhibits investment in large power plants, depriving the power pools of important economies of scale.
- *Asymmetric allocation of benefits of trade* among the parties in exporting and importing countries reduces incentives to invest in interconnection infrastructure. This problem is compounded by existing vested interests. Countries are unwilling to liberalise markets. For instance, 'energy champions' such as Ethiopia appear to have limited incentives to pioneer the development of a regional power pool, as opposed to seeking bilateral contracts.[50]
- *Lack of regulatory mechanisms to mitigate risks in long-term contracts within a power pool*. Such regulatory mechanisms include allowing open access to the grid, permitting buyers to freely select suppliers, mechanisms for hedging price differences between countries, intervening in scarcity situations, and managing uncertainty in the determination of transmission charges.

Proven solutions to address these regulatory and governance issues exist, based on the experiences of other power pools and regional markets. The EU Internal Electricity Market (EU Energy Union) and the Nord Pool offer excellent sources of successful regulatory measures and experiences. Others, such as the Central American Market (MER), whose features are more similar to SSA power pools' stage of development, also offer helpful lessons in successful regulatory practices.

1.4.2 Recommendations

Economic and human resources are needed to advance regional integration, including through defining power pools' executive responsibilities. Effective interventions must focus on removing remaining obstacles or at least mitigating their impact.

- *Empower and strengthen existing regional institutions for effective regional integration*. For example, the Economic Community of West African States (ECOWAS) has developed a set of criteria for regulators (including open access and independency), which can be further expanded for West Africa. The

[49] We resist using the term "regional market" and we typically opt for "power pools" or an equivalent proxy, when the basic conditions for a wholesale market are not met.

[50] Medinilla, A., Byiers, B. and Karaki, K. (2019), African power pools: Regional energy, national power, ecdpm, Maastricht, the Netherlands, https://ecdpm.org/wp-content/uploads/DP-244-African-Power-Pools-1.pdf.

ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) has a legal mandate to deliver on these criteria. The parallel Regional Sustainable Energy Centres[51] in the remaining African Regional Economic Communities (REC) may follow suit. A low-cost, two-pronged approach could work well: offering capacity building (see section 6.2) and political influence to increase national political commitment. Regional institutions should create a stronger coordination mechanism between the different ministries and institutions involved (notably for generation, transmission and distribution plans).

- *Revise power pool design*. Best existing international practices must be applied to revise important aspects of power pools. The Single Market Paradigm is the guiding principle in power pool design. This holds that a power pool must resemble a single country as far as possible in its operation and planning decisions, transmission regulation, and institutional design and governance. In practice, loss-of-sovereignty concerns and implementation issues limit the reach of this principle. In this context, regional integrated planning should be emphasised at national level, based on strong understanding of economic and environmental implications for each state, and consistent with national integrated plans and goals as well as investment and access priorities. Regionally integrated transmission planning should be a part of a common pan-African approach to ensure necessary coordination between the power pools.

When existing power pool rules fall short of this ideal, the efficiency and security of supply deteriorate. As mentioned above, this is frequently the case in African power pools, where poor implementation of physical bilateral contracts distorts the economic dispatch of generation and demand.

- *Introduce sound transmission rules and regulation*. The absence of sound, commonly agreed procedures to allocate transmission costs, for example, deters potential investors because it increases their risk of not receiving sufficient compensation. Inadequate charges for cross-border transactions using regional interconnections stifle trade, a lesson learnt from Europe and Central America before sound transmission pricing rules were implemented. Power pools must create congestion management rules to establish priorities for using scarce network capacity efficiently. The AU Commission is working on harmonising regulation and tariffs with the support of the EU. For example, these will clearly define rules for allocating transmission costs among different states, as well as how and to what extent such costs impact end-user tariffs in individual countries. The protocol of agreement between governments, which already exists in power pools, must be enhanced.
- *Define environmental and social standards*, including environmental and social impact assessment.

Experiences from other regional markets can provide valuable lessons to address regulatory barriers. The implementation of the EU Internal Electricity Market (IEM), Central America's MER, the Indian and Australian National Electricity Markets, and regional transmission organisations (RTOs) in the United States[52] offer various helpful measures to apply in African contexts, combined with adaptations to reflect specific conditions and needs of emerging economies. Rules such as "beneficiary pays" (applied to cost allocation for investments in cross-border transmission infrastructure) or "transmission charges must not depend on commercial transactions," which have been successfully implemented in some power pools, can equally be applied in African contexts.

[51] Notably, the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) in the Arab region, including North Africa, the East African Centre for Renewable Energy and Energy Efficiency (EACREEE), and SADC Centre for Renewable Energy and Energy Efficiency (SACREEE).

[52] Although it should be noted that US RTOs do not encompass different countries and face lesser integration challenges.

2 THE GROWTH OF THE OFF-GRID SECTOR IN AFRICA

The distributed and decentralised nature of off-grid renewable technologies offers the opportunity to maximise the socio-economic benefits of energy access by engaging local capacities along different segments of the value chain.[53]

Technological advances combined with innovative financing and delivery models in the off-grid sector are disrupting traditional electrification processes. Opportunities are emerging to accelerate progress towards universal access as well as socio-economic growth. Rapid cost reductions of renewable technologies and improved reliability have enabled off-grid technologies, notably stand-alone systems and mini-grids, to provide alternatives to centralised power infrastructure for different end-users. Off-grid systems provide a variety of electricity services from basic lighting and mobile charging, to 24/7 supply for households and commercial or small industrial use. Globally, at least 154 million people were estimated to have benefitted from electricity services from off-grid renewable energy technologies through 2017—a seven-fold increase over 2011.[54]

While grid extension-based electrification has long been perceived as the reference model in developing economies,[55] private stakeholders are spearheading the design of innovative electricity supply models based on off-grid technologies.[56] These solutions hold the potential to successfully address peri-urban and rural contexts that are characterised by limited, sparse demand as well as lower ability to pay among customers. These three factors increase the cost of grid-based electrification, reducing the economic feasibility of traditional energy access approaches.[57]

As affordability of off-grid solutions improves, access to energy efficient appliances for household use and to services and tools for productive use also grows. These enable off-grid companies to offer a wider range electricity services. There is consensus among electrification institutions and investors that off-grid solutions represent a key pillar of a universal electrification strategy. Their value can be maximised when deployed in coordination with on-grid solutions as part of a comprehensive plan, which should adopt a mid- and long-term vision of the national power sector including all three delivery modes. Taking a piecemeal approach to off-grid and on-grid electrification investments—where incumbent distributors and third party developers plan and operate in parallel without coordination—risks producing outcomes that are not sufficiently inclusive, efficient, or permanent.

This chapter presents the emerging opportunities and existing landscape for mini-grids in Africa, followed by stand-alone systems for rural electrification, and systems for commercial/industrial end-uses. It highlights the challenges faced in the deployment of these solutions and offers recommendations to address them. Off-grid business models need immediate support through financial and regulatory measures. Taking a comprehensive approach, this report proposes to integrate all support mechanisms under a regulatory and management framework. This could transform the existing SSA distribution companies into viable businesses, which integrate on- and off-grid technologies and can attract serious investment.

[53] IRENA (2019). *Off-grid renewable energy solutions to expand electricity access: An opportunity not to be missed*. IRENA, Abu Dhabi.

[54] IRENA (2018), *Off-grid Renewable Energy Solutions: Global and regional status and trends*, IRENA, Abu Dhabi.

[55] World Bank (1995), Photovoltaic Applications in Rural Areas of the Developing World, ESMAP, The World Bank, Washington D.C.

[56] Lepicard et al. (2017), Reaching Scale in Access to Energy: Lessons from Practitioners, Hystra, Paris

[57] Debeugny et al. (2017), L'Électrification Complète de l'Afrique est-elle Possible d'ici 2030?, Afrique Contemporaine, Agence Française de Développement, Paris.

2.1 Mini-grids

About half a billion people in Africa and Asia can be cost-effectively supplied with electricity through mini-grids, according to a recent World Bank report.[58] The combination of falling costs, improved quality of service, and favourable enabling environments have made modern mini-grids a scalable option to complement grid extension and solar home systems (SHS). A study of 53 operational mini-grids found that connection costs for mini-grids were competitive with grid connections, particularly for demand clusters located far from the existing grid or with total low demand.[59]

Modern mini-grids can pave the way for more financially viable future grid expansion. They stimulate demand for electricity and enable growth in income-generating activities, so by the time the main grid arrives customers have a greater ability to pay and are also already used to paying for electricity service. Mini-grids can also be connected to the main grid, if and when the grid reaches the mini-grid electrified area. This can be taken into consideration when designing business models and financing schemes. Electrification planning and regulatory frameworks must define, in advance, technical standards to enable grid interoperability and regulatory options that enable a mini-grid developer to safeguard its investment if the main grid arrives. The aim is to create a win-win situation for both mini-grid developers and the national utilities.

For some communities, mini-grids are the most effective and least-cost way to provide access to energy as they can be easily deployed almost anywhere, they are flexible, scalable, and can connect to the main grid if and when the national network expands. They also offer sustainable long-term development impact by reducing carbon emissions, pollution, environmental degradation and creating new jobs and business opportunities.[60] Most mini-grid systems have a productive life span of 15 to 25 years, which can be extended with new investments.

Financing and business models

As the technology becomes more standardised, mini-grids can be rapidly replicated and disseminated after a successful test pilot, with sufficient financing. Creating portfolios of projects can interest larger investors, as aggregating projects considerably increases the size of the investment, and optimises the risk-return ratio.[61] Cooperatives or social enterprises have also proven to be effective and sustainable models in rural areas where initial margin returns are limited. However, these run the risk of being phased out in time.

Over the past several decades, mini-grids have grown from a niche solution for electrification to being deployed widely across the globe. At least 19,000 mini-grids have been installed in 134 countries, representing a total investment of €25 billion and providing electricity to about 47 million people. Asia has the most mini-grids installed today, including about 2,000 from solar sources, compared to about 800 in Africa. The latter has the largest share of planned mini-grids: 4,000 out of 7,500 planned mini-grids based on solar-hybrid technologies, aiming to connect more than 27 million people worldwide at an investment cost of €11 billion.[62]

African countries need to actively mobilise public and private investment for mini-grids, which so far has been mostly private. At present, mini-grid investments in sub-Saharan Africa total only €3.6 billion, a fraction of investment needs by 2030.[63] Public finance should play a key role in meeting the funding gap in the off-grid renewable energy sector, working through three channels. First, direct financing can be allocated to power public services and for rural households unable to afford available solutions on the market. Second, financing instruments can be used to de-risk investments and leverage private capital (such as through high-risk innovation

[58] This section on mini-grids is directly based on a recent World Bank report: Energy Sector Management Assistance Programme. 2019. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers. ESMAP Technical Report;014/19. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/31926

[59] Cost of connecting a customer to a mini-grid ranges from around $1,000 to $2,100. Ibid.

[60] Energy and Environment Partnership (EEP), Opportunities and Challenges in the Mini-Grid Sector in Africa – Lessons Learned from the EEP Portfolio, 2018, p. 7. Available on https://eepafrica.org

[61] EEP, Opportunities and Challenges in the Mini-Grid Sector in Africa – Lessons Learned from the EEP Portfolio, 2018, p. 7. Available on https://eepafrica.org

[62] World Bank, Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, 2019, p. 2. Available on https://www.worldbank.org/en/topic/energy/publication/mini-grids-for-half-a-billion-people

[63] An estimated $220 billion is needed worldwide to connect 490 million people with 210,000 mini-grids. Ibid.

funds, or funding initial feasibility studies). Third, the public sector can play a crucial role in supporting innovation in delivery models, through research and pilot projects.[64]

Productive uses in rural areas

Mini-grids offer the potential for transformative socioeconomic impacts for end-users. One of the advantages of mini-grids is replicability, which means that a system design can be implemented across a wide range site conditions (such as weather, terrain, ease of access). Standardising the system design also lowers development costs. Replicability suits productive uses (using electricity for small industrial or manufacturing purposes), which increase the load requirement and boost the mini-grid's potential, affecting a wider range of income generating activities.

Mini-grid models are evolving, from providing only basic electricity services for households, to providing electricity services for income generating activities. These bolster the systems' financial sustainability and viability. The rural population in Africa mainly depends on crops and livestock farming as income-generating activities, accounting for more than 50% of income generation in rural communities,[65] using rudimentary traditional practices. Mini-grids can improve rural livelihoods by increasing efficiency and productivity in agricultural value chains. At the same time, they allow other electricity-based services to develop. The systems' financial sustainability relies on the expectation that farmers and entrepreneurs can generate increased income through improved productivity, which increases their ability to pay for electricity services, and in turn increases their demand for electricity.[66] Access to electricity can increase crop production, facilitating soil preparation, sowing, fertilising, irrigation, harvesting and storage. The same applies to livestock farming and other productive processes in rural areas.[67] Using mini-grids to power mechanical and electronic agricultural technologies, combined with automation of certain processes, also dramatically reduces the need for manual labour. This frees up time for leisure or education.

Box 6 - International financing cooperation: renewable mini-grids for productive uses and health services

ACCESS SARL (an ARE member) is a Malian solar and hybrid energy systems company with 10 years' experience in urban and rural electrification. After being awarded a $230,000 grant from OPEC Fund for International Development, ACCESS mobilised the equivalent sum of finance to invest into a solar hybrid system in the Malian municipality of Blendio (population of about 4,000). Mali's electrification rates are below 20%. This project is expected to present a model for sustainable solar and renewable energy solutions in the country.
ACCESS installed a mini-grid system of 55 kW capacity, including solar panels, inverters and batteries provided by SMA Sunbelt Energy GmbH, as well as a backup diesel genset of 68 kW. The seven-kilometre distribution line that was developed will offer long-term socio-economic benefits beyond the 15-year concession period. To date, 205 residential and 19 productive users are connected to the mini-grid. Three clinics/doctors are also connected. Three women started small restaurant businesses following their electricity connection. Blendio women's groups were given access to capacity building opportunities, and they were connected with Nyetaa Finance, a local Malian micro-finance institution.

See: www.accessenergie.com/; www.ofid.org/; www.ruralelec.org/

Even lighting can be considered a productive use. Electric lighting can increase the income of small businesses, allowing them to open longer hours. Electricity also offers opportunities to diversify business models and provide new services, such as Wi-Fi hotspots and mobile charging stations.

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[64] IRENA (2018), Off-grid Renewable Energy Solutions: Global and regional status and trends, IRENA, Abu Dhabi.
[65] FAO (2007), Rural income generating activities in developing countries: re-assessing the evidence, FAO
[66] Fritzsche et. al (2019), Exploring the nexus of mini-grids and digital technologies, IASS, Postsdam.
[67] Hamadani et al. Automation in livestock farming - A technological revolution, (2015)

2.2 Stand-alone systems for rural electrification

Several East African start-ups developed a new generation of SHS in the late 2000s, providing remote rural markets with sustainable, affordable and safe electricity on market terms. These took advantage of mature solar technologies and mobile money markets, supported by favourable regulatory policies. With a basic package usually offering only basic lighting and phone charging, the service is typically prepaid by mobile payments on a pay-as-you-go (PAYG) basis. PAYG allows companies to significantly reduce the costs associated with bill recovery in remote rural areas, while maximising affordability for customers. Prepayment pricing schemes are are based on rural households' usual expenses for traditional energy sources such as kerosene, as well as for outsourced phone charging. Systems have inbuilt remote controllers that can block the system once the prepayment balance is spent, and restart it after a new prepayment. This creates strong incentives for customers to prepay on time. Lastly, a technical warranty and after-sale services ensure system durability for the whole repayment period. This is crucial in establishing a trust relationship between private companies and local populations, and also maintains the profitability of the company's fixed assets.[68]

Within less than a decade, digitally financed off-grid solar has transitioned from pilot scale to a diverse and substantial sub-sector of the global off-grid energy market. More than 3,000 PAYG SHS are sold every day by nearly 30 companies operating in at least 32 countries in SSA. These operate in nearly complete independence from public supervision or any national electrification plans.[69] The number of PAYG SHS sold in Kenya is about to reach 300,000 kits per year,[70] which is about equivalent to the annual growth in new rural households.

The flexibility of PAYG business models allows off-grid companies to work within the major economic and financial constraints of rural populations, providing an immediate solution to their basic power needs. PAYG solar business models reduce information asymmetries and transaction costs by integrating into a single commercial structure the financial, technical, and operating functions that have previously been split between a range of local actors, including civil society organisations, microfinance institutions, and solar product suppliers.[71] Once markets are more mature, these functions might become separate again.

The major innovation of PAYG solar initiatives is to pursue rural electrification on market terms with high profitability, in sharp contrast to the poor financial records of existing utilities, or the need for subsidies of most existing mini-grid companies. This greatly increases the systems' per-unit cost (per kWh of electricity consumed) compared to mini-grids and to grid power. The systems are typically smaller, so little power is consumed and the total (absolute) cost remains low. But the long term outcome is not ideal from a systems perspective. PAYG solar companies generally focus their activities on 'low-hanging fruit', primarily targeting wealthy rural populations. Leading companies therefore concentrate around densely-populated urban and rural regions of the most densely populated countries.[72] This diminishes these systems' poverty-reduction potential. Within less than a decade, the private sector managed to completely redesign the dynamics of rural electrification by making energy access profitable,[73] but not accessible to everybody.[74]

The resilience of current PAYG business models is still to be seen. In May 2019, one of the sector's leading companies, Mobisol, went bankrupt in response to high costs of capital and growth expectations from private investors. The company was recently acquired by ENGIE. Nonetheless, the sector keeps growing and serving previously unelectrified people at a fast pace. More than 30 PAYG solar companies are now operating in the peri-urban and rural areas of Kenya, Rwanda, Tanzania and Uganda. New companies appear every year in neighbouring countries. Other business models have been successful, like the innovative financial approach for SHS in Bangladesh. The sector remains justifiably optimistic about its long-term prospects, driven by the need to achieve universal access, provided the right regulatory and policy conditions are met.[75]

68 Alstone et al. (2015), Off-Grid Power and Connectivity, Pay-as-you-go Financing and digital supply chains for pico-solar, Lighting Global, IFC, Washington, D.C.

69 GOGLA (2017), Providing Energy Access through Off-Grid Solar: Guidance for Governments, GOGLA, Utrecht

70 Ibid.

71 Winiecki et al. (2014), Access to Energy via Digital Finance: Overview of Models and Prospects for Innovation, CGAP, Washington D.C.

72 Ibid.

73 Debeugny et al. (2017), L'Électrification Complète de l'Afrique est-elle Possible d'ici 2030 ?, Afrique Contemporaine, Agence Française de Développement, Paris

74 GOGLA (2017), Providing Energy Access through Off-Grid Solar: Guidance for Governments, GOGLA, Utrecht

75 Lecoque D, Wiemann M, Mohapatra D (2019), High-profile bankruptcies in the off-grid sector: Where do we go from here? http://www.ruralelec.org/publications/high-profile-bankruptcies-grid-sector-where-do-we-go-here

2.3 Stand-alone systems for commercial and industrial consumers

Diesel generators—increasingly complemented with solar PV—offer a flexible, although sometimes expensive, alternative to unreliable centralised generation. Also called self-generation, captive power or embedded generators, they may be developed on a standalone basis or connected to the grid. They are typically managed by residential, industrial or commercial energy users for their own consumption.

Box 7 - Renewable hybridisation standalone projects: already a reality

Hybrid solutions—that combine both wind and solar alongside storage technologies—provide a powerful technical solution to accelerate the penetration of renewables in Africa. Hybrid projects have already been developed in various contexts, proving that the technology is ready and demonstrating its attractiveness to investors. Siemens Gamesa has shown the competitivity of the hybrid approach by pioneering standalone hybrid systems combining different sources of power for both on-grid as well as off-grid applications. The company commissioned the first ever large-scale wind hybrid off-grid project in 2007 (in the Galapagos Islands, Ecuador). The project maximises wind power penetration to save on diesel fuel, achieving an annual reduction of 20,359 tonnes of CO2 with 2.4 MW of wind backed up by 1.95 MW of diesel generators, driven by a Hybrid Plant Controller. Siemens Gamesa has expanded its hybrid developments to Spain (using wind-solar PV-storage-diesel), India (two projects: Kudgy 4 MW and Kavital 78,8 MW), and the Philippines (with 16 MW wind + 6 MWh Battery Storage).

Source: Siemens Gamesa

Captive generation offers operational flexibility in rural areas and some independence from national grids with unreliable service. But when the plant relies on fossil fuel, it comes at a financial and environmental cost, and can be hard to deploy, operate and maintain in remote areas. It also presents important regulatory challenges when producers connect to the distribution network. While benefits may outweigh costs in certain geographies, diesel-based captive generation often remains less cost-effective than innovative and well-designed mini-grid- or standalone solar/hybrid system-based solutions (combining solar, wind, and storage, for example). Diesel is also much more polluting and subject to price volatility. Once grid reliability ceases to pose a problem and deter large customers, in the medium and long term, the optimal solution is to connect all C&I customers to the national grid, which should provide cheaper and more reliable power. In the short term, hybridisation with solar power can reduce the costs of diesel in certain price contexts, as well as improving the environmental sustainability of the system.

2.4 Sector diagnostic: barriers and recommendations

This section discusses the barriers to scaling up investment in off-grid systems, and proposes some recommendations to overcome these.

2.4.1 Barriers

Many obstacles to investment in off-grid technologies remain, despite significant market growth, drastic cost reductions in technologies, and improved policies across the continent. Challenges especially relate to raising private sector capital and the lack of conducive policies, which hinder up-scaling and technology deployment.[76]

[76] See ARE, High-profile bankruptcies in the off-grid sector: Where do we go from here, 2019. Available on http://www.ruralelec.org/publications/high-profile-bankruptcies-grid-sector-where-do-we-go-here. See also, ARE, Energy Access from the Bottom Up: Start-up and SME Showcase, 2018. Available on http://www.ruralelec.org/publications/energy-access-bottom-start-and-sme-showcase-2018

Enabling environment:

- *Unsupportive or non-existing policy frameworks*. While a growing number of low-access countries are introducing dedicated measures to support off-grid solutions,[77] many are yet to do so, and policy implementation remains a key challenge. Off-grid solutions represented less than 1% of total electricity access financing commitments in 2015-16. In some cases, policies are public-sector oriented, such as in Ghana, and do not always address the question of end-user prices and subsidies. Abrupt policy changes, such as adjustments to import duty for equipment and appliances, and lack of a long-term market development view (backed by integrated electrification planning and targets) have also inhibited the growth of the sector. Also, policies are silent or unclear on the outcome for scenarios where the central grid reaches a location electrified by mini-grids or SHS.
- *Poor legal and regulatory framework*.[78] Regulations on mini-grids often do not adequately address aspects related to licensing provisions, tariff setting and implications when the main grid arrives.[79] These are crucial to assess the viability and sustainability of mini-grid projects. In some countries, for instance, tariffs are set by regulators or the statutory entity in charge of electricity (in some cases the energy ministry) which may not allow sufficient cost-recovery.[80] Few countries have regulations allowing—and setting the methodology to determine—developers to set tariffs alongside subsidies to cover any viability gaps. Also, licensing may require lengthy, unclear processes and inappropriate fees given the size of installations, such as in Cameroon.[81] Procedures associated with concession models (such as for the supply of SHS or lighting applications) are complex and could slow the project development process.[82] Finally, regulation is in many cases not efficiently and effectively implemented.

Lack of access to finance and de-risking instruments:

- *Difficult access to finance*. Small-scale projects struggle to access finance due to the perceived risks of these types of investment, especially for local off-grid small and medium enterprises (SME) in early stage financing. Financing in local currency may be scarce. Often, companies' own resources are used to cover preliminary studies. Funds to cover upfront investment also remain hard to reach, including working and medium to long-term capital from private sources (whether through equity or debt), as in the case of mini-grid developers for unsolicited projects in Nigeria.[83]
- *Limited private investment*. Private investment is limited due to the risks associated with the overall enabling environment (see above). Communities' financial viability is often questionable. At the same time, regulated tariffs—usually not cost reflective—affect the bankability and financial viability of projects. The investing and regulatory environment seems to expect the rural electrification sector to be achieving full commercial viability, and has reduced the amount of de-risking support accordingly. This is unrealistic in a sector that targets the hardest-to-reach clients, the rural energy poor, and which faces a distorted market situation in view of the heavily subsidised central grid and fossil fuel sectors.
- *High cost of capital*. Many rural electrification projects and companies need to rely on venture capital and private equity funding, as large swathes of the sector are perceived to be risky. In addition to raising the weighted average cost of capital (WACC), this also creates a potential conflict of interest, where an industry that operates in long(er)-term horizons needs to rely on investors with shorter horizons.

When companies must rely on investors who seek high returns in a relatively short time horizon, they have more incentive to develop scale-up strategies seeking growth at any cost. This can jeopardise the sustainability of the business model and the quality of the value proposal to clients.

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77 Countries that have increased electricity access rates the most since 2010 have also shown a concurrent improvement in electricity access policies. The share of low-access countries adopting measures to support mini-grids and SHS has grown from around 15 percent in 2010 to 70 percent in 2017, as concluded by the World Bank's Regulatory Indicators for Sustainable Energy 2018 report (www.worldbank.org/en/topic/energy/publication/rise-2018)

78 The renewAfrica programme, in charge of assessing existing tools aimed at supporting RE projects in Africa, remarks that the real risk lies within the poor regulatory frameworks (seconded by ECREEE and ARE).

79 IRENA (2016), Policies and regulations for private sector renewable energy mini-grids, Abu Dhabi.

80 https://greenminigrid.se4all-africa.org/file/152/download

81 EU TAF SEforALL for West and Central Africa: Mission CW188 (2018)

82 SEI Platform Working Group 1 meeting with GOGLA (5th of June 2019)

83 EU TAF SEforALL for West and Central Africa, 2018. Mission CW216: "Scoping Mission - Nigeria: Market Potential for Renewable Energy and Private Sector-led Investment Opportunities under EDFIMC/ElectriFI"

- *Expensive financing*. In this context, commercial banks provide short-term loans at high rates, making debt finance challenging. In some cases, they may not be willing to support businesses in the renewable sector, as is the case with several banks in Nigeria.
- *Difficult environment for DFIs*. DFIs also face challenges in supporting small-scale projects, due to the perceived risk and size of the investments. To mitigate these risks, in many cases they operate through financial intermediaries (for example, with lines of credit to local commercial banks, or dedicated fund structures such as AfDB's Facility for Energy Inclusion (FEI)).[84]
- *Insufficient public financial support*. A clear trend in the last few years has seen public investment in the sector shift from grants to blended finance. This helps companies to futureproof their business models and to plan their projects over longer-term timeframes. However, the pendulum of providing adequate de-risking support may have swung too far in the direction of expecting rural electrification companies to achieve full commercial viability. This could be expecting too much of a sector that targets the hardest-to-reach clients—the rural energy poor—and faces a distorted market situation, competing with the heavily subsidised central grid and fossil fuel sectors.
- *Limited de-risking instruments*, such as operational guarantees, for small-scale projects. Such instruments address risks associated with currency fluctuations (impacting the cost of finance and repayment capacity of debt obligations) and off-takers' creditworthiness (the end-users). In this context, the ability of existing instruments (see Box 10) to increase investments in the RES sector from local SMEs is yet to be proven.

Long-term perspective and energy systems sustainability:

- *Scale and replication challenges*. Small-scale projects developed under unsolicited proposals face problems with replicability and scalability, especially due to lack of access to finance and in many cases poor local development framework.
- *Lack of monitoring and evaluation*. Energy projects' impacts on community livelihoods, spanning economic, environmental, and social dimensions, tend to have weak monitoring and evaluation systems (exceptions include South Africa's pioneering REIPPPP). This limits the interest and engagement of both private and public investors as well as the donor community, and makes projects more difficult to replicate. For example, some of the drivers in the water-energy-food (WEF) nexus approach still need to be understood and properly deployed through local energy projects (see section 6.6 on the WEF Nexus).[85]
- *Lack of off-grid market information*, data and transparency. While many studies have been conducted on off-grid RES systems, results are seldom shared. More data is needed on the performance and costs of private sector operated mini-grids to increase investor confidence, such as through benchmarking studies on mini-grid deployment and costs. Knowledge sharing is also needed on the role of different productive uses in business models.

2.4.2 Recommendations

The following recommendations aim to increase investment and deployment of renewable technologies for mini-grids and standalone systems. They focus on improving the enabling environment, expanding finance and de-risking instruments, and ensuring long-term systems and sustainability.

Enabling environment

- *Organise policy dialogue* through stakeholder meetings (stand-alone or in parallel with private sector business delegations) to sensitise policy makers and to discuss rural electrification strategies. These should communicate the added value of off-grid solutions to provide reliable electricity supply and spur rural socio-economic development. Recent meetings carried out by the Alliance for Rural Electrification

[84] FEI, operating through two dedicated funds (FEI off-grid and FEI on-grid), is designed to close funding gaps in the small-scale energy infrastructure sector, mitigate key credit and local currency risks, and catalyse growth in last-mile energy access solutions.

[85] Energy is a necessary condition but not sufficient to leverage alone local development.

(ARE) with the EU Directorate-General for Development Cooperation (DG DevCo), EU Delegations, AEEP, and GET.invest (formerly RECP) provide good examples of such dialogue. Collaboration among government institutions and the private sector should be enhanced, especially with local SMEs. This should clarify the private sector's needs and challenges (including in terms of investors' risk perception and business environment) and identify key areas needing government support. The Africa Energy Market Place (AEMP) platform also offers a good example of fostering tri-partite dialogue between governments, private sector and development partners.[86]

- *Develop a regulatory toolkit* with sector-wide input on policy best practices and lessons learnt to reach 100% electrification in target countries. This can be built based on the 2016 Mini-Grid Policy Toolkit created by EU Energy Initiative Partnership Dialogue Facility (EUEI PDF), RECP, REN21 and ARE in 2014.
- *Enhance the regulatory framework to ensure policy and regulatory certainty* over the short and medium terms. Regulatory frameworks should encourage grid-compatible mini-grids for those that might connect in future. Regulation must also define geographical boundaries for utilities or distribution companies and provide investment safeguards for mini-grid operators. Energy efficiency and quality standards should create incentives to develop high-quality standalone systems with energy efficient technologies , as well as preferential custom duty on certified equipment. Regulations should support participation from both local and foreign private sector companies, with specific focus on SMEs (see Box 8).

Box 8 - Support for mini-grid policymakers and regulators

Several entities have been set up to increase local capacity-building in off-grid sector development, both for policymakers and for entrepreneurs. The Sustainable Energy Fund for Africa (SEFA)-funded green mini-grid market development programme has set up a Green Mini-Grid Help Desk that provides hands-on support to developers and policymakers (greenminigrid.afdb.org).
The Renewable Energy Entrepreneurship Support Facility (REESP) was established in West Africa. It aims to bridge the gap between entrepreneurs and local financial institutions by increasing the capacities of local entrepreneurs to develop renewable energy projects, and offers them opportunities to benefit from mentoring. It also informs local banks on the business case of small-scale renewable energy projects. The REESP originated as a joint effort by IRENA, ECREEE, and LuxDev, and is being carried forward by the World Bank under the Regional Off-Grid Electrification Project. IRENA is also implementing the REESP in the SADC Region in collaboration with ECREEE and SACREEE.

- *Evaluate options to cross-subsidise tariffs*, to make tariffs affordable for end-users. PPP frameworks with a subsidy component can be effective to make tariffs affordable while being profitable for mini-grid operators.
- *Create a stronger framework to facilitate aggregation of projects* (e.g. clusters of mini-grids) through policy and regulation. Aggregation can be achieved at different stages (see Finance and de-risking instruments below), such as through a multi-project procurement process, which requires restructuring tender approaches. For example, in the DRC, a Government-led auction programme for a private electrification approach to deploy renewable-based mini-grid solutions is expected to provide access to 150,000 people.[87]
- *Further enhance the legal set up of mini-grids* including by streamlining licensing and permitting procedures. This should simplify procedures for opening SMEs and registering jobs. Procurement procedures should be evaluated for effectiveness to identify an optimal approach (such as auction processes for mini-grids).
- *Include the off-grid sector in energy sector planning* at ministerial level as well as for the utility or rural electrification agency. Today, off-grid technologies offer robust quality to households, and the off-grid

[86] https://www.afdb.org/fr/topics-and-sectors/initiatives-partnerships/africa-energy-market-place

[87] https://www.afdb.org/en/news-and-events/african-development-bank-approves-20-million-facility-for-green-mini-grid-program-in-democratic-republic-of-congo-19136

private sector should be considered essential partners. This requires utility companies to implement a holistic integrative approach in their planning, investment and overall development of the sector.

Finance and de-risking instruments:

- *Scale up the financing initiatives/funding mechanisms* aimed at supporting local private sector enterprises in early stages of project development. Several facilities are available to support early project development stages. Information and access to these facilities must be clear and available.
- *Promote financial incentives for the private sector* to establish modern energy services in rural and peri-urban areas. The provision of working capital is critical. This type of financial support needs to be patient as the customers of off-grid companies are poor and significant cash earnings will only build slowly. One key instrument provides grants at a results-based level (see Box 9). Such targeted grants should become part of every development bank's portfolio, with the purpose to incentivise companies to enlarge their markets and to build a solid base, which will in future attract more commercial types of investment. Taking a long-term view, combined wih local currency funding, can help reduce the project's cost of capital (whether for standalone systems or utility-scale mini-grids).
- *Create innovative products* to support small-scale finance, building on existing financing and de-risking instruments. For example, enhance support to MFIs, engage with local banks through debt co-financing, and design new lines of credit or dedicated funds to facilitate rural households' access to finance.[88] Tailored schemes such as results-based finance (RBF) and climate finance reward strong results and track records, while levelling the playing field with the grid.[89] Such instruments should be specific to clean energy projects, and complement or align with existing support mechanisms. Pension funds may also offer potential for supporting RE project investments (for example, these have been used in Kenya). While grants remain necessary to activate markets, especially given the customers' low ability to pay, the sector should not rely on such financing means in the long term, and should aim to be financially sustainable and make projects viable.

Box 9 - Zambian off-grid results-based financing

The Beyond the Grid Fund, financed by Sweden and implemented by NEFCO and REEEP, monitors implementation and impact metrics of off-grid companies in Zambia. In addition to underpinning results-based financing, it provides critical insights into Zambian off-grid markets.

See: www.edison.bgfz.org

- *Identify public sector roles* forthe early stages of project development, to reduce development costs (and optimise electricity supply cost to communities). For example, the government could elect to carry out de-risking measures such as site identification and conducting preliminary studies for project preparation, or could facilitate permitting and licensing for solicited and unsolicited proposals (see section 6.2 on Capacity Building).

[88] The economic situation of households makes it complex and challenging for companies to sell their products.
[89] Such instruments and support are strongly expected by private sector companies and investors.

Box 10 - SMART programme for results-based mini-grid subsidy

Over € 1.1 bn of donor funding is committed to the mini-grid sector, but the programmes are fragmented, creating gaps in the funding cycles, and creating uncertainty for the private sector. African Mini-Grid Developers Association (AMDA) members have aligned to advocate for SMART results-based financing to close the financial viability gap. This proposes a standardised, Pan-African subsidy programme that will attract talent and capital to scale the sector. AMDA's key principles for SMART RBF are:

Simple—one solution, one subsidy amount, certainty and simplicity

Measurable—results-based and easy to measure what the subsidy achieved

Africa-Wide—remove fragmentation between countries, encourage movement across SSA

Repeatable—a revolving facility, instead of time-bound programmes that take years to design

Timely—connections are verified quickly, and payments made in a timely manner

The SMART RBF aims to scale-up infrastructure subsidy with a simple, results-based model where developers receive a set subsidy per connection, once completed. Sites must be built to a technical standard to qualify. Developers must share data to allow donors to make data-driven decisions on reducing the subsidy over time. The connections are verified remotely through smart meters, and include random in-person audits to ensure robust control and governance. The first call for proposals will launch late 2019/early 2020 in Nigeria, Kenya, Tanzania and potentially Benin, with the goal to eventually launch in all African countries that have conducive mini-grid regulations. The SMART RBF facility will also open a collaborative window to multilateral donors while harmonizing efforts across parties.

Source: ESMAP (2019); AMDA. Africa Mini-grid Developers Association SMART RBF Policy Recommendation. (2018).

- *Deploy instruments that address local currency financing challenges*. For instance, under the EIP's upcoming guarantee instrument, the Distributed Energy Service Companies (DESCOs) programme, a joint AfDB-EU initiative, will provide credit enhancement to support local currency financing to companies deploying off-grid solar products.
- *Set up a framework to strengthen coordination between financial institutions*. Coordination between international financial institutions (IFI), MDBs, commercial banks, equity providers and funds should include discussing areas of cooperation—such as through blended investing—and aim to avoid duplication of efforts, specifically regarding small-scale investments and support. Financial institutions should coordinate in monitoring and evaluation of current financing tools, and follow up on existing financial and de-risking mechanisms. ElectriFi presents a good example of a new financing aid tool created via multi-stakeholder dialogues.
- *Aggregate projects to access finance*. Putting together larger portfolios of projects can engage larger investors, by increasing the investment's ticket size, while optimising the risk-return ratio. For example, the Nigeria Electrification Programme aggregated 10,000 mini-grid projects in clusters. This allowed it to mobilise €315 million from the World Bank complemented by €180 million from the African Development Bank. Stronger frameworks are needed to facilitate aggregation of off-grid projects. A developer can bundle projects when seeking finance, or a financier can take a portfolio approach to risk assessment when financing multiple mini-grids. This can also be achieved at the offtake level, by a single off-taker purchasing (or backstopping payment obligations) from multiple mini-grids and thereby providing payment security to the mini-grid developers, improving the bankability of the projects. A feasibility study to create such an aggregate mini-grid off-taker is currently being conducted.[90]

Long term perspective and energy systems sustainability:[91]

- *Promote needs-based design and demand side management*. Without revenue-generating productive uses, the economics of mini-grids are challenging. The AfDB/SEFA Green Mini Grid Help Desk (a market development programme) has published results and guidance on productive uses of energy to advise

[90] http://minigridgate.com

[91] Some recommendations proposed by ARE as a result from the ARE Energy Access Investment Forum in Abidjan on 13-14.03.2019

green mini-grid developers in addressing demand risk and revenue sustainability.[92,93] (See section 3.2 on Productive uses of renewable energy)

- *Use new and available tools for energy planning and optimisation*. Latest tools, such as geospatial information (via GIS), enhance system planning and determine the most appropriate energy access solution for each location and the local needs.
- *Develop a common impact evaluation framework*, which would allow for better planning of the energy sector. This could also help evaluate the effectiveness of business models based on smart mini-grids, grid connection or productive uses, and may support financial institutions in their selection phase of bankable projects.
- *Promote technical quality standards* for mini-grids and standalone systems to avoid local markets being flooded by poor quality, inefficient products. While some standards have now been developed, markets in various countries such as Mauritania have fallen prey to poor quality devices.[94] Mini-grids especially need to meet specific grid standards when their integration into the national grid is planned.
- *Define and propose a joint industry initiative to collect aggregated data* from clean energy mini-grids and standalone systems in selected countries to create a benchmark on mini-grid performance and costs, and to analyse data on business models and local entrepreneurial activity related to productive use of energy.
- *Include a life cycle perspective and awareness of Water-Energy-Food nexus* into the development of off-grid projects to address the question of waste (electronic and battery) and develop recycling value chains, integrating water quality and environmental dimensions into project design.

92 AfDB, 2016. Green Mini-Grids in Sub-Saharan Africa: Analysis of Barriers to Growth and the Potential Role of the African Development Bank in Supporting the Sector. GMG MDP Document Series: n°1. https://www.energy4impact.org/file/1818/download?token=j67HKZEy

93 Energy4Impact and Inensus, 2019. Mapping of Cereals, Fisheries and other Productive Use Businesses for Village Mini-grids: A Review of 15 African Countries. Report for AfDB's Green Mini Grid Help Desk. https://www.energy4impact.org/file/2097/download?token=HAPpuCJW

94 AfDB, 2017. Strategy for the utilisation of solar energy for water pumping in rural and semi-urban areas in Mauritania

3 THE INTEGRATED GRID OF THE FUTURE

To achieve the full benefits of renewable energy solutions, more support is needed for creating grids of the future that combine grid-based and off-grid solutions within an integrated distribution strategy, which also accounts for the productive services enabled by electricity supply

This chapter presents a vision for the integrated grid of the future. Integrated planning at distribution level will be essential to reveal the least cost delivery modes to achieve universal access. The integration needs to take place at three different levels to catalyse successful electrification efforts.

First, the three modes of electrification—stand-alone systems, mini-grids and grid—need to be integrated. The IEA has published some estimates of the economically viable share of off- and on-grid solutions for people currently lacking access.[95] In most countries, there is poor coordination between commercial, technological, and regulatory development of the three delivery modes, if any. This results in inefficient infrastructure investment, poor service standards, sub-optimal resource utilisation and, importantly, people being left behind. A key building block of this integrated vision requires a coordinated approach to on-grid and off-grid development with a view to ensure inclusive and permanent rural energy supply.

A second level of integration must take place between electricity supply and end-uses. This would aim to optimise the economic, climate, environmental and social impact of access, for example by matching planned distributed renewable energy. generation investments with demand from productive uses Power network planning must consider cross-sector demand growth, with in-depth understanding of energy needs, including in industry, heating/cooling and transport sectors, and others that underpin long-term economic growth, sustainability and human development. At a higher level, integration between the power sector, environment and other sectors of the national economy is also necessary. Section 3.2 discusses this in further detail.

A third level of integration is needed system-wide, and at regional level. National and regional power sector institutions should coordinate distribution planning with transmission and large generation planning. Plans at national and regional levels should also integrate climate change and environmental factors and forecasts. Most of the energy being distributed continues to be supplied from the bulk power system. Regional integration is discussed in further detail in section 3.3.

3.1 Integrating distribution models

The mission of distribution is to reach every individual customer with reliable and affordable power. Power distribution is particularly important not only to deliver electricity services to customers, but also to act as a financially trustworthy off-taker for large generators. Distribution in rural areas of low-access countries is expensive and the prospective customers' ability to pay is typically low. Targeted internal (through cross-subsidies) and/or external subsidies (from public funds) are required. Yet distribution revenues depend on regulated tariffs that are often politically motivated and too low to recover the incurred costs.

Making rural electrification attractive to private investors is harder than for other segments of the electricity supply chain. Furthermore, new disruptive technologies and business models are laying down a challenge to

[95] IEA (2017), Energy Access Outlook 2017. According to this analysis, decentralised systems, led by solar PV in off-grid and mini-grid systems, would be the least-cost solution for three-quarters of the additional connections needed.

the traditional, dominant approach to distributing electricity. All these factors make distribution in developing countries a complex activity, where technology, economics, politics, and social norms play important roles.

Distribution concerns the supply of electricity to end customers, of all sizes, whether in urban or in rural areas. Traditionally, supply has been performed by distribution networks at various voltages connecting the transmission substations of the bulk power system to residential, commercial, and industrial customers. Grid connection continues to be the majority electrification mode in SSA, and will probably continue to be in the long term. But technological advancements and innovations in financing and delivery models of distributed renewable energy solutions are disrupting the traditional electrification processes. This offers new opportunities to accelerate progress towards universal access. Rapid cost reduction and improved reliability are allowing distributed renewable energy technologies, both grid-connected and off-grid, to offer alternatives to centralised power infrastructure for end-users. This chapter considers both on- and off-grid distribution solutions, as both share a common purpose from the customer's perspective.

Business model for an integrated distribution framework

This section defines the business models for distribution—both on- and off-grid—that can attract investment and provide reliable and affordable services without leaving anyone behind. This is possible under an Integrated Distribution Framework (IDF) vision.[96]

A key feature of the IDF is that the three modes of electrification (on-grid, mini-grids and stand-alone systems) are seen in an integrated manner and placed on a level playing field. So far, the three solutions have been developed in a largely uncoordinated manner by different entities, leading to competition rather than complementarity between the approaches. A comprehensive integrated planning using advanced GIS technologies can find the least cost mix of electricity delivery modes. A dedicated entity needs to oversee implementation of the plan, and dedicated policies and regulations should address any problems arising from the interaction between on- and off-grid solutions, as well as tariff-setting.

Electrification can no longer be perceived as a static process, but rather a dynamic one. Mini-grids and stand-alone systems are crucial solutions to deliver initial electricity access relatively faster than grid-based solutions. They can unlock latent community demand for sustainable electricity. As the understanding of local consumption patterns and willingness to pay evolves, investments in larger systems or grid extension can be justified. Local communities could be active stakeholders in certain contexts, partnering with the concessionaire and the private sector to own, operate and maintain decentralised energy systems in their unserved areas.

Financing and fiscal allocation

It is important to emphasise that in every country, developed or not, rural electrification has needed subsidies. Extending the power grid to serve diffuse, low-level loads is much more expensive than electrification in urban areas. A subsidy is needed for any distribution utility that expands access where regulatory authorities are not willing to apply retail tariffs that reflect the actual costs. Subsidies can adopt different formats, ranging from tariff cross-subsidisation to direct payments to the incumbent distribution company (such as capital subsidies linked to performance), or territorial concessions under mutually agreed conditions. This applies to both on- and off-grid solutions. In either case, subsidies need to be designed in a manner that crowds in private investments and reduces risks associated with the delivery of the financial support.

Any potential investor in the distribution company will require guarantees that the government will deliver adequate timely subsidies for some agreed period of time. This would require cooperation from DFIs. The government can only provide such guarantees if its debt lies within debt sustainability caps, or the limits acceptable to credit rating institutions. The situation is even more difficult for privatised distribution companies.

[96] There are some ongoing activities in relation with the design and implementation of the IDF. The initial concept was developed by MIT researchers in collaboration with the Shell Foundation. This resulted in the creation of Konexa/Energy Company of the future – which is a donor funded business that is now catalysing private sector capital to put the concept into practice in a pilot in Nigeria by end 2019. See https://www.powerforall.org/news-media/articles/konexa-seeding-integrated-utility-future
The Global Commission to End Energy Poverty (GCEEP), with support by the Rockefeller Foundation and with MIT as the research team, is working towards the implementation of the IDF at large scale in some selected countries. See https://www.endenergypoverty.org and the Inception Report issued by the GCEEEP.

Financing the IDF is only feasible through a consensus among the major stakeholders for implementing this approach. The national government, the regulatory authority, the distribution company and the off-grid developers, the investors, and the DFI (providing some sort of financial guaranty) must all come to the table. This would create conditions to radically improve the distribution segment and open the door for necessary investment. The IDF concept is versatile and can be adapted to diverse circumstances for the diverse African countries that face access challenges. Adaptations can be made to suit different power-sector structures and regulatory regimes.

3.2 Integrating power supply with services and productive uses

Taking only supply-side aspects of electricity access into account—considering the number of connections, generation capacity or consumption levels—risks overlooking opportunities to offer electricity services for end-uses that can have a transformative impact on socio-economic development. Energy is a primary input to any economic activity, essential for production and transport of goods, information, and people, as well as for domestic uses and service industries. Energy scarcity, by consequence, constrains economic growth. Industrialised economies have benefited from exploiting diverse energy resources to generate electricity in past centuries, which has contributed to their growth. However, most African countries still lack sufficient modern, efficient, reliable and sustainable energy services to meet demand and improve economic productivity, growth, and livelihoods.

The accelerated expansion of rural electrification must be supported by sustainable consumption patterns, including energy efficiency. This calls for sustainable business models that link energy access with productive sectors (such as agro-processing, assembling and manufacturing, or service sectors)[97] to increase local productivity. Growth in these sectors also supports job creation and can catalyse gains in education, health and general well-being.[98] Nonetheless, the energy-water-food-agriculture-climate-development nexus that empowers people with electricity access to improve their living conditions and be able to afford the energy bill still needs to be investigated.[99]

Sufficient, affordable, sustainable, and reliable power supply is crucial to support a range of economic end-uses and income-generating activities. Off-grid systems, notably mini-grids, can more easily anticipate and manage customers' supply needs by sizing up and integrating 'anchor' productive loads into the system, such as with agro-processing machinery, irrigation pumps, or telecommunications equipment. Advancements in energy efficient appliances offer a growing portfolio of productive end-use technologies that are compatible with low-voltage off-grid systems, including milling machines, welding equipment, and pottery wheels.

Integrating Productive Uses of Renewable Energy (PURE) strengthens off-grid business models by:[100]

- Boosting local energy demand, complementing low household consumption.
- Boosting local incomes, enabling a higher ability to pay for off-grid solutions.
- Underpinning local productive activities, which equally increase willingness to pay.
- Diversifying the off-taker risk profile by including business users, which could become anchor clients in time.
- Improving capacity utilisation of renewable power.
- Taking advantage of sector nexuses, such as between small industry, agriculture, or water.
- Increasing resource and energy efficiency, recycling/reusing and proper waste management.

97 See for details https://www.ruralelec.org/publications/productive-use-renewable-energy-africa

98 Several case studies of productive end-use examples can be found here http://www.ruralelec.org/project-case-studies.

99 Riva, F., Ahlborg, H., Hartvigsson, E., Pachauri, S., Colombo, E.; Electricity access and rural development: Review of complex socio-economic dynamics and causal diagrams for more appropriate energy modelling (2018) Energy for Sustainable Development, 43, pp. 203-223.

100 See also NREL, Productive Use of Energy in African Micro-Grids: Technical and Business Considerations, 2018

Linking electricity supply with public services, such as education and healthcare, can also have positive impacts on rural populations' well-being and on human capital development. In the health sector, for instance, typically solar-powered off-grid technologies are delivering reliable, affordable, and sustainable energy to power medical devices and support the provision of basic amenities (including lighting, cooling, communications, and water). About one in four health facilities in 11 countries in sub-Saharan Africa have no access to electricity; most facilities that do have access have an unreliable supply.[101] Some African countries are already embracing solar energy for the health sector: for example, in Sierra Leone, 36% of all health facilities and 43% of hospitals use solar energy in combination with other electricity sources. In Liberia, more public sector primary health clinics use PV solar systems than diesel generators. Meanwhile, in Uganda, 15% of hospitals use it to complement electrical grid access.[102]

Interlinking electricity supply with different end-uses requires several additional measures. Capacity building in recently connected areas can be pivotal to develop local skills and improve market access for new products and services, which help sustain productivity gains from electrification and support new and existing income-generating activities. Financial services are a cornerstone of electrification outcomes, as formal and informal enterprises in rural areas need access to financing to invest in new equipment and meet other enterprise development needs (such as working capital). Utilities and private sector suppliers may have limited capacity to develop the ecosystem for productive end-uses of power. Partnerships with local NGOs and community-based organisations, as well as local financing institutions can play a crucial role in providing the necessary support. Likewise, DFI-sponsored electrification programmes can ring-fence financing for additional efforts needed to link electricity supply with various end-uses.

An electricity as a service approach creates an opportunity to optimise the impacts of reaching SDG 7 across multiple other SDGs. New opportunities are unlocked when power sector development is integrated with other sectors, such as water and agriculture (see section 6.6 on the WEF nexus), transport (to meet electric mobility needs and opportunities), heating and cooking, and information and communication technologies.

3.3 Integrating regional grids

Regional integration of economies and power systems offers important opportunities to support the continent's sustainable growth agenda. The AfCFTA is the world's largest free trade zone, with the potential to boost intra-African trade by 52% by 2022. A greater integration of power systems also offers major benefits. It is estimated that power market integration—through bilateral trades until 2025, followed by a liquid market—could collectively provide around €29 billion of benefit to the region throughout the next decade.

Regional power integration offers several opportunities, including to:

- lower electricity procurement costs
- benefit from pan-continental domestic energy resources, in particular renewables
- allow power producers to sell surplus power and generate additional income
- reach economies of scale to attract large amounts of private capital.

Transmission planning is essential here, since adequate transmission capacity is necessary to allow cross-border trade and regional generation plants. The bulk power system continues to supply most of the energy being distributed, , so distribution planning must also continue to be coordinated with transmission and large generation planning, and even with regional or multinational power sector planning. However, no existing models are capable of addressing the distribution and bulk power system segments together in sufficient detail. Coordinating the distribution power supply needs with investments in transmission and large generation infrastructure requires an iterative, procedural approach.

[101] WHO (2019), "Harnessing Africa's untapped solar energy potential for health", www.who.int/bulletin/volumes/92/2/14-020214/en/
[102] Ibid.

To harness the opportunities offered by regional power integration, the governance of power pools must be reinforced, notably by empowering:

- The regional regulator to establish regional market rules and enforce regional transmission planning
- The regional system operator to dispatch generation efficiently, keep security at regional level, and make transmission plans
- Pan-African institutions to develop a common approach on transmission planning between regions.

Power pools design must make use of best international practice in several respects: i) in dealing with physical bilateral contracts; ii) in allocating the cost of regional transmission network investments; iii) in providing regional security of supply; and iv) in providing capacity building at all levels, from technical to political and managerial. In addition, the chief obstacles to successful implementation of multi-national power pools must be addressed, especially countries' reluctance to trust their neighbouring countries to honour supply commitments, and countries' fears of losing sovereignty over their electricity supply.

For the AfCFTA agreement to be successful, and for the successful development of the power pools in particular, African leaders must play their part, keeping the bigger picture in mind. Long-term economic growth and Africa's betterment must be prioritised above short-run political agendas.

Capacity building, opinion-shaping and political nudging can go a great distance to overcome this low-hanging-fruit barrier at minimum cost. The European Union's rich experience in garnering the political will for regional integration, as well as in developing the guiding market frameworks and infrastructure, can provide valuable experiences to inform African regions' steps towards integration.

Photo: Ishwar Rauniyar

4 ACCESS TO CLEAN COOKING SOLUTIONS

Access to clean cooking solutions has massive environmental, economic and human co-benefits. It must be a high priority on the development cooperation agenda for the next few years. [103]

The situation for the clean cooking sector is bleak, even compared to electricity access (which has made important gains in past decades). If current trends continue, about 1 billion people in Africa will still lack access to modern cooking services by 2030, jeopardising not only the achievement of SDG7, but also several other related SDGs.[104] In SSA as many as 83% of households are still cooking mainly with polluting fuels and technologies, leading to 500,000 additional deaths each year linked to household air pollution.[105]

Up to one gigaton of CO2/year (approximately two percent of global emissions) arises from the use of non-renewable wood fuels for cooking worldwide, including from black carbon pollution.[106] Up to 34% of biomass fuel harvested is unsustainable, contributing to climate change and local forest degradation.[107] Several causes underlie the limited progress in achieving access to clean cooling solutions globally, and in SSA in particular. Energy for cooking is often overlooked by governments and by international initiatives in favour of more easily achievable electrification objectives. Resources for clean cooking have fallen well short of the estimated necessary investment levels needed (from €1.8 billion to €4 billion annually).[108] Responsibility for cooking falls between competing areas of political responsibility, and the sector has lacked powerful national and international champions to help channel the needed financial resources. Current approaches to promoting clean cooking—despite some small successes—remain piecemeal, uncoordinated, frequently offering partial solutions (e.g. the poor emissions performance of many lower tier stoves) and with limited consumer buy-in. At the same time, many barriers remain to scaling up cleaner cooking technologies such as electricity or gas, including widespread electricity load shedding, weak grids, and the perceived high cost of electricity. In addition, a lack of political prioritisation and investments, poor access channels to liquid petroleum gas (LPG), local traditions, perceptions, and a lack of suitable cooking appliances hamper efforts to supply improved clean cooking technologies.

4.1 The clean cooking landscape

A recent WHO survey on the disease burden across SSA showed that household air pollution from solid fuel cooking emissions is now the second largest health risk factor in terms of death and disability in the region. These health costs add to a laundry list of socio-economic and environmental burdens arising from solid fuels, including: time losses due to firewood collection, increased mortality and morbidity, continuing deforestation and carbon dioxide emissions, and avoidable spending on solid fuels. These collectively cost the region about three percent of GDP annually.

The World Bank's comprehensive review of the SSA cooking sector in 2014 reveals why these circumstances persist. Across SSA, 95% of rural households and 62% of urban households still depend on traditional solid fuels

[103] This chapter draws heavily from two World Bank ESMAP Studies on clean cooking in SSA, namely Clean and Improved CookIng In Sub-Saharan Africa, November 2014; and Scalable Business Models for Alternative Biomass Cooking Fuels and Their Potential in Sub-Saharan Africa, 2017.

[104] IEA, Africa Energy Outlook 2019. IEA, Paris

[105] Ibid.

[106] Bailis, R.; Drigo, R.; Ghilardi, A.; Masera, O. The carbon footprint of traditional woodfuels. Nature Climate Change. 2015, 5, 266–272.

[107] Rob, B.; Yiting, W.; Rudi, D.; Adrian, G.; Omar, M. Getting the numbers right: revisiting wood fuel sustainability in the developing world. Environ. Res. Lett. 2017, 12, 115002

[108] IEA (2019); SEforAll, 2017. Energizing Finance: Scaling and Refining Finance in Countries with Large Energy Access Gaps, SEforAll: Washington DC, USA.

for their cooking needs. Only around 11% of SSA households use 'modern' fuels like LPG or electricity for cooking (a further seven percent use highly polluting kerosene stoves). Fewer than one percent use alternative renewable fuels such as biogas, ethanol, or advanced gasifier stoves, and 3.5% use 'rocket stoves.' Up to 10% use legacy improved cooking stoves (ICS), which show little improvement on traditional three stone fires. Many households continue to use traditional biomass-burning stoves as a secondary cooking device alongside a cleaner option, a common phenomenon known as "fuel stacking" (simultaneous usage of multiple fuels and stove technologies).

These dismal figures hide some partial success stories.[109] The Clean Cooking Alliance[110] has tracked significant growth in sales of improved stoves: over 80 million stoves were sold between 2010 and 2015. The sector is becoming more professionalised. Research and development into fuels and stoves has increased and more innovative business models are emerging. For example, businesses are experimenting with PAYG models for LPG distribution and new ways to efficiently disseminate ethanol (standardised canisters). At the same time, donors have introduced results-based financing programmes into their portfolios in order to channel capital into the market. Impact and commercial investors are beginning to show interest in clean cooking business models. This trend has been supported by the emerging policies and standards for biomass and biofuels. Political and financial engagement are growing. Recently, the World Bank launched a $500 million Clean Cooking Fund, connected to the Health and Energy Platform of Action (HEPA). This platform supports the Leaders for Clean Cooking Coalition, aimed at increasing political prioritisation of clean cooking.

4.2 Technology assessment

The clean and improved cooking sector in SSA has evolved significantly, but is still stunted.[111] The quantity of clean biofuels (including ethanol, ethanol gel, pellets, and briquettes) sold across the region remains low in absolute terms, and especially low compared to the number of distributed biofuel stoves. This suggests that most households only use these biofuels as a secondary or tertiary backup.

Two basic strategies are used to achieve clean cooking: "making the available clean," and "making the clean available." The former consists of making the most accessible fuels (mainly wood and charcoal) cleaner for the end user through improved cookstove technologies. The latter consists of making cleaner fuels (mainly gas and electricity) more accessible to consumers.[112] In recent decades, several biomass-based improved cookstoves have been promoted, but with poor results in reducing emissions. Biogas-based cooking is more successful as a real clean cooking solution, especially economically attractive for households with livestock or other suitable feedstocks.

Some experts see electric cooking as the cleanest cooking solution, provided that it is based on renewable energy sources (either via renewably sourced grid electricity, or off-grid mini-grid or individual systems). Unlike biogas, electricity can eventually be available for everyone. The social cost of electric cooking can be competitive with LPG-based cooking in the absence of fossil fuel subsidies. Moreover, the costs of cooking with electricity both in mini-grid contexts and via SHS are now well within the range of cost competitiveness of other cooking alternatives, since the costs of solar and storage systems have come down by between 30-50%, and continue to decline as markets scale-up and technologies improve.[113]

Electric cooking offers the additional advantage of reducing the per-unit cost of electricity supply because of the increased utilisation ratio of network infrastructures. Electricity for cooking would encourage the use of very high efficiency electrical appliances, such as slow cookers and pressure cookers, with significant energy savings. By scaling down the actual demand of the appliances used, it is possible to install a much smaller SHS,

[109] Hivos and SNV run the African Biogas Partnership Programme, funded (among others) by EnDev. This develops the biogas sector through growth and development of manufacturers, entrepreneurs, local finance, maintenance, and service call centres. The programme led to installation of 80,000 bio digesters. See https://www.africabiogas.org

[110] Formerly the Global Alliance for Clean Cookstoves.

[111] World Bank. Scalable Business Models for Alternative Biomass Cooking Fuels and Their Potential in Sub-Saharan Africa, 2017

[112] Smith, K. R. & Sagar, A. Making the clean available: Escaping India's Chulha Trap. Energy Policy 75, 410–414 (2014).

[113] Couture, T. D. & D. Jacobs, 2019. Beyond Fire: How to achieve electric cooking, Hivos, World Future Council. https://greeninclusiveenergy.org/publication/beyond-fire-how-to-achieve-electric-cooking/

saving substantial costs in both the solar array and battery bank required. These cost savings translate directly into a lower cost for the end user.[114]

PAYG companies and other stakeholders can start playing a role in driving the transition "beyond fire".[115] Many PAYG companies operating in Africa and Asia already offer their customers a range of other high-demand appliances, driven mostly by customer demand. Against this backdrop, it is time for solar PAYG companies to start exploring the economics of adding cooking technologies to their product lists, supporting not only electricity access but also access to clean cooking.

A basic requirement is the availability of reliable electricity supply, either grid or off-grid, and adequate storage, as cooking needs to happen several times daily, including after sunset. The connection must also have sufficient capacity and power quality to serve the load, and offer affordable power. The power source must be clean and offer continuous supply to be sustainable.

An inclusive, reliable, affordable, and sustainable electrical supply is possible to achieve, following the recommendations in chapters 1 to 3 of this report (notably through the "integrated distribution framework"). Electricity supply represents an ideal opportunity to kill two (or more) birds with one stone, and should be vigorously pursued. This calls for a synergistic approach to electricity and clean cooking access. [116]

4.3 Sector diagnostic: barriers and recommendations

This section discusses the barriers to scaling up clean cooking solutions, and proposes some recommendations to overcome these.

4.3.1 Barriers

Compared to the rapid growth of electrification, and in particular decentralised off-grid solar, the provision of clean cooking solutions has been very slow. In addition to the challenges highlighted earlier, several specific barriers forestall the adoption of clean cooking solutions.

- *Lack of political will.* Most governments and donors have treated cooking as a low-priority sector. The topic of clean cooking is often **absent from national development plans** or negotiations with MDBs and DFIs, unlike electrification. A lack of awareness of the economic, health and environmental impacts of using solid fuels means few local champions emerge at the civil society and political levels. The worst affected households are often poor and in rural areas, and may not even be aware of the impacts of household air pollution. There is also the general misconception that cooking technology is "low-tech", does not have formal market structures and is not attractive to investors and policy makers.
- *Demand barriers to adoption.* The cost of available clean cooking technologies may be too high for both urban and rural poor. **Inability to pay** is a major barrier to access to clean cooking technologies. Roughly half of the continent's population lives in rural areas and half are below the poverty line of $1.25 a day. Many cannot afford clean cooking stoves or fuels and rely on free collection of biomasses. High poverty rates in urban and peri-urban areas also makes clean cooking solutions unfordable to many.
- *Absence of electricity and LPG supply networks.* Without available and reliable clean energy supply, cooking solutions—whether traditional or improved cookstoves—must continue to depend on largely non-sustainable solid biomass or other dirty, unsustainable fuels.
- *Cultural cooking practices.* Cultural practices of cooking with wood or on stones are deeply embedded. Combined with limited awareness among consumers of the risks of solid fuels for health, this complicates the introduction of alternative fuels, such as LPG, biogas, and ethanol, to be accepted by consumers. On

[114] Couture & Jacobs (2019)
[115] Ibid.
[116] Batchelor S, Brown E, Scott N, Leary J. Two Birds, One Stone—Reframing Cooking Energy Policies in Africa and Asia. Energies. 2019 Jan;12(9):1591.

the other hand, the comfort and advantages of modern cooking technologies must strongly incentivise cookstove users (predominantly women) to switch.

- *Regulatory constraints*. Lack of enabling regulatory and policy environments stifles the growth of suppliers of LPG, natural gas, and biofuels. These ecosystem-level challenges include policy barriers, such as poorly calibrated tax and tariff regimes that make it difficult to import fuel production equipment, stoves, and biofuels (which are essential when local supply is inadequate, as is often the case in the early stages of market development).[117] Explicit government endorsement of clean alternative fuels and stoves can help, such as through policies to create a favourable enabling environment.
- *Limited private sector capacity*. Financial and management constraints of cooking sector entrepreneurs have stifled growth of suppliers of clean fuels and stoves. Lack of finance for suppliers is acute and pervasive, with scant global impact investment or commercial investment capital being directed at the sector.

  The sector receives a minuscule amount of investments, and depends heavily on international finance. The most recent picture of total financing for clean cooking businesses tracked by the Clean Cooking Alliance was about €36 million in 2017. This is far from reaching the level of €3.6 billion a year until 2030, including €1.8 billion in SSA, required to reach universal access to clean cooking. The sector is considered too nascent for local banks to invest in. The dependence on international finance adds to the financial risks associated with currency.
- *Limited research and innovation*. Low creativity in the sector has produced a somewhat meek approach, dominated by piecemeal innovation rather than the emergence of disruptive ideas and technologies. Clean cooking tends to be treated as a separate sector rather than an integral part of the wider energy system. This has resulted, for example, in the lack of interest in cleaner alternatives such as gas and electricity, until recently.

4.3.2 Recommendations

- *Take a systems approach* to promoting access to clean cooking. To shift the mix of cooking fuel and technology requires a multi-sectoral and coordinated approach. This must span regulations, research and development, manufacturing, distribution, and affordable entrepreneurial and end-user finance across value chains (including cookstoves, firewood and charcoal, biofuels, gas and electricity). The starting point is a national programme with high-level support and sizable investments to scale up access to clean cooking. Such a programmatic initiative should adopt a multi-stakeholder approach, including local civil society. Effective inter-ministerial coordination is needed at the country level, since clean cooking solutions touch on so many aspects of human development, including gender, health, and environment.
- *Adopt a synergistic approach to electricity and clean cooking access*. Policymakers and planners should take advantage of the co-benefits of promoting access to electricity and clean cooking together, by jointly considering both sectors for electrification planning. Synergies between electricity and clean cooking also have consequences for the cost of energy, for electricity delivery business models, and the role of utilities. Electric cooking presents an interesting option for distribution utilities or mini-grids that have a reliable supply of wholesale or local power and that operate under a cost-reflective revenue requirement.
- *Offer capacity building* to shape the regulatory and policy environment in African countries. These need to promote an integrative approach for electricity and clean cooking solutions for market development, and rapid deployment of technologies and fuels. Capacity building of financiers is also critical. The health and energy sectors must coordinate on political and technical approaches, through a multi-stakeholder platform of action (with governments, civil society, UN, private sector). This should build and/or strengthen existing national coordination mechanisms on energy and health policies and programmes. Donors and sector intermediaries should provide capacity building and business advisory support to key value chain actors to scale-up production and build out fuel and stove distribution.
- *Design interventions that drive consumer behaviour change through research and data collection* at the country level. Such research can lead to local innovation and contextualised solutions to ensure

[117] World Bank, 2017

long-term sustainability. Simply distributing cleaner cooking solutions and fuels will not lead to optimal health and environment outcomes. The challenge of achieving the benefits of universal clean cooking in SSA is not simply one of technology and economics. Consumer education, access to finance, funding for research and development, the expansion of standards and testing, and clean cooking-focused policies (tax, tariff, and subsidy reform) are key pillars of the solution.

- *Use results-based financing approaches* to leverage public resources to incentivise the market. This can be designed to fit the country context and market conditions.
- *Leverage funding* from MDBs and institutions (such as the EU Commission) to attract private sector investments in the clean cooking sector. Lack of equity and debt investment for clean cooking enterprises (manufacturers, fuel producers, distributors) is a critical bottleneck for the growth of the entire industry. MDB and donor funding can be blended to create an investment fund or vehicle targeting private enterprises in the clean cooking value chain, taking into account the different needs in the sector, reflecting a broad range of financial ticket sizes. This would also leverage commercial and institutional investors into the sector. For example, the AfDB is working with the Clean Cooking Alliance to set-up the SPARK+ Africa Fund, a €45-63 million equity/debt fund for enterprises in the clean cooking value chain.
- *Provide direct subsidies* linked to health and climate impacts, and targeting hard-to-reach communities and areas. Market-led models should be promoted wherever feasible to ensure financial viability. But maximising climate and health benefits sometimes calls for targeted subsidies delivered through public finance for infrastructure (where consumers are paying for use), or through carbon markets and mechanisms such as results-based credits for health benefits.
- *Mobilise global political leadership* through EU and UN diplomacy. This is crucial to secure EU leadership to galvanise political action, similar to their leadership in mobilising global support for SEforAll, SDG 7 and the Paris Accord. The EU should support HEPA's ongoing work to raise awareness about the dangers of household air pollution and to make clean cooking a political priority. The EU should also mobilise global support for initiatives to deliver cleaner fuels and stoves to poor communities. Given the environmental, economic and human co-benefits of access to clean cooking solutions, it must be a high priority on the EU development cooperation agenda for the next few years.
- *Create consumer demand* through national campaigns on social drivers (norms, gender, cooking habits, finance accessibility, political support), targeted behavioural change interventions and increasing availability of consumer finance.

5 ENERGY EFFICIENCY

Energy efficiency (EE) is a powerful solution to the challenges posed by increasing energy demand across Africa, catalysed by growing populations and economies. This supply challenge is exacerbated in many cases by dependence on energy imports, combined with underexploited indigenous energy potential, especially from renewables. Energy efficiency—defined as the ratio of GDP to the primary energy supply—is key to ensure access, affordability, and energy security in sub-Saharan Africa. It eases the pressure on security of supply by reducing primary energy consumption and decreasing the need for energy imports. It is also a cost-effective way to reduce greenhouse gas (GHG) emissions, bringing associated benefits for climate change mitigation.

The IEA's model for emissions reduction to meet the Paris Agreement shows that energy efficiency will account for over 40% of emissions reductions in the energy sector (without factoring in new technologies).[118] Today's global demand is 30% less than it would have been without the energy efficiency improvements of the past 25 years.[119] This represents 251 Exajoules of energy use avoided annually, equivalent to 5,987 million tonnes of oil (Mtoe), or the total annual demand of China, India and Europe combined. But despite its clear financial, economic and environmental benefits, global improvement in energy efficiency has slowed in recent years, while investment has flattened.

Energy intensity in SSA has plateaued in recent years, at 147 tonnes of oil equivalent (toe) per $1 million of GDP.[120] This is 40% higher than the global average of 106 toe/$1m, which has been decreasing for several years. This is partly explained by SSA's dependence on biomass fuel for cooking, and partly due to a lack of regulation, such as for car efficiency standards. The average African car uses 25% more fuel than an average European car. This is both a problem for transport cost, as well as local air pollution and greenhouse gas emissions. Current policies and investment trends suggest African energy intensity will reach 115 toe/$1m by 2030, which will still be 45% above the global average of 79 toe/$1m in the same year. Reaching universal access and reducing pollution emissions across sectors will require an improvement to 65 toe/$1m by 2030.[121]

Energy efficiency will be a central pillar to reach the aspirations of Agenda 2063. Africa could more than double its GDP by 2030 with the same energy used today thanks to energy efficiency.[122] Shifting to an energy efficient economy will require deploying existing technologies at scale across the continent. Ensuing energy savings will, in turn, improve the competitiveness of African enterprises and industries vis-à-vis international competition and create white-collar jobs in the energy hardware and service sectors of the economy. African countries will need to adopt an integrated approach to identifying the most accessible and cost-effective energy savings measures addressing both supply and demand sides. As Africa develops, investment in energy efficiency measures across different sectors can avoid locking in demand for decades to come.

The different regional centres for renewable energy and energy efficiency, such as RCREEE, ECREEE, EACREEE, and SACREEE, are responsible for setting guiding principles and frameworks for specific energy efficiency policies as well as issuing and implementing National Energy Efficiency Action Plans (NEEAP) in African sub-regions, in cooperation

[118] OECD/IEA. Energy Efficiency 2018: Analysis and outlooks to 2040. (2018).
[119] EN21, 2017, Renewables Global Futures Report, Paris, REN21 Secretariat - http://www.ren21.net/future-of-renewables/global-futures-report.
[120] IEA (2019).
[121] Ibid.
[122] Ibid.

with national public institutions. NEEAPs include estimates of energy efficiency potential, viable energy efficiency and energy conservation programmes, long term indicative saving targets, and concrete measures for the short and medium term. Regional centres should guide individual African countries to adopt a NEEAP that sets their energy savings goals and defines actions that fit their socio-economic situations and trends. With a NEEAP in place, African municipalities and other public bodies can oversee implementation or outline their own sub-plans based on integrated approaches to energy saving and energy supply, for example via energy covenants uniting groups of municipalities.

This chapter reviews the challenges and provides recommendations towards promoting EE investments in Africa across different market segments. For the SEI Platform, four sectors stand out for immediate action in energy efficiency: electricity supply, industry, transport, and buildings. Corrective action in all four segments will reduce stress on the power grids, improve economic and business opportunities, reduce pollution in- and out-doors, and bring further socio-economic benefits, including job creation.

5.1 Energy efficiency: tools, technologies, and opportunities in Africa

Many opportunities exist to improve energy efficiency in Africa. Interventions can target either the supply or demand side of energy use. The following sections discuss measures to improve efficiency for the bulk power system, and how to incentivise energy efficiency on the demand side, including through demand management, smart meters, and the building and transport sectors.

5.1.1 Supply-side: bulk power systems

The low efficiency of generation plants and high transmission and distribution (T&D) losses in the grid pose a major burden on African countries' energy systems. New generation installations need to have close efficiency monitoring, accompanied by measures to modernise the existing asset base, as well as to reduce technical and commercial losses. The latter lie in the range of 25 to 40% across the continent, with 37.5% in West Africa (over twice the acceptable norm of about 15%). The cost of commercial losses alone in the subregion is estimated to be in excess of €1.5 billion/year (equivalent to 8.6 TWh/year).[123]

Box 12 - Cogeneration: recycling waste heat

Waste heat can be used in industries and in district cooling with significant potential for energy savings, especially when the location of heat generation and supply is relatively close to the point of use. New generation plants, as well as existing installations undergoing extensive refurbishments, can be equipped with high-efficiency cogeneration units to recover waste heat to use in nearby industries. Cost-benefit analyses should be conducted to determine the feasibility for new projects. Such activities may be rare in Africa, but given the associated high energy savings potential, they could be feasible in various contexts. Investigation should begin with existing industrial parks housing power plants that supply adjacent factories with electricity.

Utilities need to design, implement and monitor preventive and curative maintenance programmes to reduce the high technical losses in the system. For example, United for Efficiency is working to develop efficient distribution transformers.[124] As an essential component of electricity distribution, transformers are a common source of loss. Utilities should prioritise reducing losses, including through road maps with annual targets for cutting losses. Similar to NEEAPs, utilities should create a network losses reduction programme (NLRP) aiming to identify the source of losses and ways to reduce them, with an action plan defining needs, investments and timeline.

[123] The Southern African region records losses from 25% to 30% of electricity injected into the grid. In the Central African Economic Community (CEMAC), electricity losses over T&D networks reach 40%.

[124] See united4efficiency.org/products/distribution-transformers/

Future investments in generation, T&D assets should meet higher efficiency standards, associated with enhanced procurement requirements. Supply-side energy efficiency (generation, transmission, and distribution) will have direct positive impacts on energy system costs, and tariffs by extension. Investing in new infrastructure technologies such as smart grids can facilitate these improvements. Other low-cost modifications are available to address high losses, such as the technology-based loss minimisation project carried out by Electricity Company of Ghana (see Box 13), which identified sources for technical and commercial losses.

The information management techniques offered by smart grids can implement energy efficiency measures across the supply chain, from generation to distribution.[125] Technological enhancements on T&D networks should prioritise reducing losses. Smart grids can rank various access and dispatch priorities from different power sources, including by differentiating among renewable sources. Grid operators can then provide priority dispatch of electricity from efficient sources, such as renewable energy or cogeneration plants, while guaranteeing secure grid operations. Some North African countries, such as Egypt, have conducted studies on adopting smart grid technology to accommodate higher intermittent renewable penetration, supported by grid-scale storage through pumped storage facilities or batteries to decrease electricity network losses.

Box 13 - Technology-based loss minimisation pilot project, Ghana

In 2016, the Electricity Company of Ghana's (ECG) power system aggregate technical and commercial (AT&C) losses were estimated at 22.72% of energy purchases. The company then commissioned a pilot to implement a technology-based loss minimisation system in April 2016. The primary objective of the project was to identify commercial losses in the selected areas of deployment. The pilot was deployed in two high-consumption industrial and commercial areas, Tema and Kaneshie Districts, where in spite of smart meters, 20% overall losses persisted. The investment cost was US$ 345,580.
The implementation was successful, and identified US$ 1,560,000 of unbilled annual consumption on ECG's customer network (worth 7.2 gigawatt-hours). After analysing usage patterns of the customers involved in the study, the pilot recommended focused investigations on 5 customers with abnormal consumption patterns.

Energy efficiency measures that depend on smart grids and power systems operation may not be an immediate solution for Africa, since distribution and retail activities are performed by the same company. Adequate incentives must be designed taking this situation into account. Many examples exist of good practices in electric utilities operating under similar conditions. New generation capacity planning must consider the lower-cost generation option through energy efficiency. Generation projects should include energy efficiency components to reduce losses, allocating part of the investment to the T&D network (for both public and private projects). Losses will remain stable regardless of source of the investment, or the type of project, if no actions are systematically integrated in all new generation projects.

Regional centres and utility associations such as the Association of Power Utilities of Africa (APUA) should replicate past successful loss-reduction projects. Installation of smart meters and highly efficient transformers represent good first steps for utilities' loss-reduction strategies.

[125] Smart grid is a power system in which power retailers, distributors and customers communicate their market needs to each other through digital technology.

Box 14 - Energy management systems (EMS)

Energy management systems allow grid operators to monitor, control, and optimise grid performance. Scaling up EMS on grids will be particularly effective for optimising electricity supply to large consumers. RCREEE has implemented in collaboration with several regional partners the Pan-Arab Certified Energy Management Professional certification scheme, which professionals of several North African countries have enrolled in. Such a certification scheme could be deployed in other regions of Africa.

5.1.2 Demand-side energy efficiency: residential and commercial customers, buildings, transport and industrial applications

Demand-side measures offer various pathways to improve energy efficiency in SSA, including in clean cooking, transport, buildings, SMEs, and household electrical appliances. For example, switching to efficient stoves for fuelwood and charcoal burning can cut down biomass consumption for cooking in Africa by 70% by 2030.[126] This would reduce charcoal demand by over 60%, representing an important tool for protecting forests, biodiversity, and carbon sinks. Energy audits and energy management regulations are effective tools to enforce energy efficiency at an industrial level (see Box 15, below).

Efficient household appliances—allowing consumers to access higher levels of energy services at lower costs—offer the potential to cut energy consumption by up to 5 times compared to standard appliances (with associated benefits for household energy spending).[127] PAYG schemes with multiple instalments and digital payments could help alleviate the high upfront costs of energy efficient appliances. Several East African countries are front runners in energy efficiency of residential appliances, with supportive policies and private companies having provided SHS with very low-consumption TVs on a significant scale.

In ECOWAS, residential and commercial buildings consume 25% to 30% of total electricity supply for cooling and water heating. This represents a major opportunity for investing in thermal renovation to improve the energy performance of building stock. The public sector, with its significant number of office buildings, can be a natural multiplier of energy efficiency measures. One proposed measure would set an annual rate (such as 2-3% of floor area) for thermal renovation of publicly-owned and occupied buildings in each ECOWAS country, with the aim to improve their energy performance, based on a set of legally binding minimum requirements.

Regulations must play an active part in encouraging energy efficiency for buildings. Enacting and enforcing rigorous building codes can clearly improve energy use through better design and construction methods. Green building rating systems would encourage compliance with such systems. A common barrier to energy efficiency in buildings is the split incentive that exists between landlords and tenants. Landlords typically bear the brunt of costs to upgrade the energy efficiency of a building, but the tenants stand to benefit most from the reduction to their power bills. Equitably sharing the benefit of energy efficiency among landlords and tenants (both in residential and commercial property) can increase the proportion of energy efficiency investments in the building sector. For example, the PACE programme (developed in the United States) offers building owners the chance to finance retrofits or energy efficiency improvements and repay over time through voluntary assessments of the property.[128]

Governments can lead efforts to improve buildings efficiency through Super ESCOs, which act as an interface to customers for the wider ESCO market. Private ESCOs then implement the energy efficiency upgrades through investments from government. This creates an energy efficiency market by providing a pipeline of thousands of projects, with bulk procurement to drive prices down. Private sector entities also gain the opportunity for capacity building and to offer energy performance contracting, a mechanism to reduce energy bills through guaranteed project performance (such as from savings produced by LED lights). The Indian Ministry of Power's Energy Efficiency Services Limited offers a good example of such a mechanism.[129] Building market capacity allows expanding these services to commercial and industrial sectors.

[126] IEA (2019).
[127] Ibid.
[128] See https://www.energy.gov/eere/slsc/property-assessed-clean-energy-programs
[129] See https://www.eeslindia.org/content/raj/eesl/en/home.html

Box 15 - Energy efficiency policies for industries, Tunisia

Tunisia has comprehensive policies targeting energy efficiency in the industrial sector. Existing installations that consume over 800 toe/year are required to have energy audits, dedicated energy managers, and annual energy reporting. For new industries, the law mandates prior consultation with the national energy conservation agency, ANME. Tunisia also requires prior ministerial authorisation before the commencement of any industrial project with a projected annual energy consumption of over 7,000 toe/year. This strong policy framework to provide energy efficiency services to industrial facilities has supported the local ESCO market.

In the transport sector, introducing regulation on energy efficiency would make transport more affordable, while at the same time, not increasing oil use or dependency. However, including transport reforms in national energy strategies is rare in Africa. Tools and procedures to assess and monitor vehicle efficiency are also needed to accompany any programme for regulating transport efficiency.

Fuel quality standards and carbon dioxide emission caps are effective tools to improve fuel efficiency in transport. Adopting such standards is an important first step to improve energy intensity in Africa, as well as reducing transport costs and emissions levels. African Regional Economic Communities (REC) can play a role in encouraging national stakeholders to adopt appropriately stringent measures.

Energy suppliers use demand-side management (DSM) to modify consumer demand for energy through various methods, such as financial incentives and behavioural change through education. The objective is often to encourage consumers to use less energy during peak hours (thereby reducing electricity peaking load and associated costs), or to move the time of energy use to off-peak times such as night-time and weekends. Peak demand management does not necessarily decrease total energy consumption, but is expected to reduce the need for investments in networks and/or power plants for meeting peak demand. For example, energy storage units can be used to store energy during off-peak hours and discharge them during peak hours. A newer application for DSM is to aid grid operators in balancing intermittent generation from wind and solar units, particularly when the timing and magnitude of energy demand does not coincide with the renewable generation. Smart meters can also prompt new consumption patterns from electricity customers allowing least-cost operations. Senegal's electricity utility, SENELEC, is developing SMARTSEN, a project to install 2.5 million smart meters over the next decade.

Cost-effective technological innovations such as smart meters offer significant efficiency gains by influencing behavioural change. Smart meters track end-users' actual energy consumption, providing information on actual time of use and transmitting consumption data to the utility in real-time. Utilities must deliver clear billing to produce efficiency gains from smart meters: billing based on actual consumption (rather than on deemed consumption or on 'bulk billing by cubic meters of premise'), offered regularly enough to allow consumers to regulate their own energy use. Clear billing can also be effective in areas where smart meters are not immediately available. When consumers can regularly read their installed meters and transmit data to their electricity supplier, they are more likely to modulate their energy use.

Smart meters also enable net-metering policies, by accounting for electricity fed into the grid. This has been an important function of smart meters in supporting African countries' medium-term renewable energy and demand management initiatives.

Box 16 - Seawater desalination, Cabo Verde

High population growth in Africa has exacerbated drinking water shortages, especially in arid and semi-arid regions, island nations and areas where populations are affected by climate change. In 2015, over 300 million people worldwide relied entirely on desalinated drinking water. Desalination requires 2 to 12 kWh of energy per cubic meter of water, depending on the technology applied. Solar PV and wind energy are already being used for powering some desalination plants. There are opportunities to completely phase out thermal power for this application. Cabo Verde, a country that relies almost entirely on desalinated water, is spearheading one of the first successful wave-to-power projects in Africa, harnessing tidal wave power for electricity generation. The feasibility of this concept for other sea-adjacent parts of Africa should now be investigated and replicated where viable.

Public bus fleets used for mass transport in large African towns and cities present an immediate investment opportunity that has largely been ignored in energy efficiency programmes and by the investment community. Phasing out diesel buses and introducing Compressed Natural Gas (CNG)-fuelled vehicles is feasible in certaing cases where bus fleets are refuelled at a single or limited number of municipal gas stations, even in large towns. It is especially efficient when CNG is available from refineries located close to demand centres. CNG buses also reduce harmful and smelly particulate pollution, road vibrations, and internal and external noise emissions. Electric buses might require a higher capital cost outlay, but offer equally attractive reduction of operating cost, greenhouse gas and particulate emissions, and noise.

5.2 Energy efficiency sector diagnostic

The energy efficiency sector faces several barriers spanning policy, planning, laws and regulation, institutions, and financing.

5.2.1 Barriers

This section discusses barriers to scaling up energy efficiency investments, presented in the following categories:

- Policies, planning, programmes.
- Institutional framework.
- Legal and regulatory framework.
- Capacity building.
- Access to finance and investments.
- Lack of awareness and data scarcity.
- Lack of aggregators or facilitators.

Policies, planning, programmes

African countries often lack integrated, coherent and comprehensive energy policies and planning, which are essential for implementing national energy efficiency strategies. Targets need to reflect the local level of industrial or economic development, and should be accompanied by detailed plans on national and sectoral levels. Regional standards can be set to guide countries in setting their own policies. Regulations designed for implementing NEEAP programmes should help guide energy consumers (including industries, enterprises, and households) in their energy efficiency activities.

Even where energy efficiency targets are in place, several African countries lack well-designed conservation and demand management programmes, for example to address energy efficiency funding, mandate energy labels on appliances and equipment, set minimum energy performance standards (MEPS), and conduct energy audits.

These programmes should capitalise on the socio-economic benefits of energy efficiency investments, tailored to the country's economic and industrial context.

Many African countries' policies and support frameworks do not provide for transparent energy pricing mechanisms, which drive energy efficiency. Tariffs are not cost-reflective in most countries, which hinders the utilities' financial sustainability. Utilities therefore struggle to invest in energy efficiency and conduct appropriate maintenance programmes, limiting opportunities for growth and expansion. For example, ESKOM, South Africa, implemented the Power Conservation Programme in 2008 to reduce demand by 10%, especially among industrial users.[130]

Energy efficiency measures must be carefully balanced against the commercial interests of African utilities. RECs, working alongside their respective member states, should propose a range of measures that minimise impacts on utilities' commercial performance, and on utilities' existing contractual off-take obligations, as parties to PPAs.

Institutional framework

State and donor financial investments and technical assistance in energy efficiency are scattered. An effective institutional set-up is essential to streamline sustainable initiatives and pilot projects that can attract further public and private sector investments. The success and sustainability of energy efficiency programmes depend on dedicated institutions and units on a sectoral level (such as in industry and buildings), ensuring coordination among different actors. Local ownership of the programme is critical, as progress in energy efficiency typically relies on multifaceted approaches combining financial and price incentives, regulations on high-energy consuming appliances and equipment, cutting down on peak-time electricity use, and promoting energy efficiency in buildings. For example, Tunisia's ANME is a dedicated entity in charge of implementing energy efficiency policies, as well as promoting energy conservation and conducting studies. The AfDB recently presented a new instrument, energy savings insurance, which combines financial and non-financial mechanisms to mitigate the risk of energy efficiency investments.[131]

Legal and regulatory framework

The absence of labels and MEPS, and where they do exist, weak enforcement and compliance measures, represent a chronic concern in many African countries. Several markets suffer from least efficient products distorting the market, where providers of less efficient and lower-quality products crowd out high-efficiency products. Such markets should adopt regulatory phasing out of inefficient appliances and reform subsidies to improve the market conditions for energy efficient appliances. Standardisation and equipment certification form a part of such remedial measures.

Capacity building

African countries lack implementation capacity to adopt energy efficiency measures. Experiences in countries such as Egypt, Tunisia and Morocco show the success of energy efficiency programmes in the industrial sector relies on technical assistance and capacity building for industry and ESCOs. Countries need training on technical and financial assessment of energy efficiency and renewable energy solutions, including energy management systems, motor system optimisation, compressed air system optimisation, and solar heating for industrial processes. In the building sector, for example, software tools are available to help developers, builders, and designers in tracking and drafting reports on code compliance. RCREEE supported Tunisia to develop a national code compliance tool customised to the local conditions, and provided capacity building for stakeholders.

Access to finance and investments

Investments in efficient equipment generally produce cost savings over the course of several years. Customers seldom see the financial benefits of EE equipment in the short term. This can discourage purchases at commercial and residential levels.

On a larger scale, investments in energy efficiency technologies often come with high capital costs. These can be prohibitive for smaller companies with limited access to loans from the formal banking sector. In practice, this means high interest rates, short loan tenors and typically large financial securities required by the borrower.

[130] IEA, 2011. Saving Electricity in a Hurry: Update 2011. IEA, Paris.

[131] See BASE, Scaling up energy efficiency with energy savings insurance, at energy-base.org/project/scaling-up-energy-efficiency/

In this context, companies only consider energy efficiency investments that have short payback times, but even those tend to take low priority when competing with business growth and expansion investments (where risks and returns on investment are better understood). Higher efficiency equipment with higher incremental cost is often avoided, even when payback times appear otherwise very convincing.

Senior business leaders tend not to pay enough attention to energy efficiency, which means CAPEX budgets often overlook capital-intensive efficiency upgrades. Instead, industrial efficiency investments are typically financed through OPEX budgets, and thus limited to incremental improvements. At the same time, affordable financing for bigger purchases—or the option of 'green public purchasing' for public bodies—is scarce.

The public sector must play a leading role in promoting EE investments. Public spending makes up a major share of African countries' GDP. The public sector is an important driver to stimulate market transformation towards more efficient products and services, as well as to trigger behavioural changes in energy consumption by citizens and businesses. Decreasing public-sector energy consumption through EE improvement measures can also free up public funds for other purposes.

Box 17 - Business model for energy efficiency: Energy performance contracting (EPC)

EPC is a type of third-party financing arrangement that is not yet widely used in Africa but may warrant pilot project identification among more industrialised countries. The term denotes a contractual arrangement between a beneficiary (power consumer) and a provider of an energy efficiency improvement measure (an ESCO). The performance is verified and monitored during the term of the contract. Under the EPC, if the ESCO's investment brings about energy savings for the beneficiary, the latter will pass on part of the savings as payment to the ESCO.

EPC contracts tend to be complex. National energy agencies can provide templates to facilitate their deployment. Capacity building would be required to shape the required skills and awareness, including for ESCOs, finance providers, and the client (such as industries, utilities, and consumers).

Regulatory and accounting-related obstacles still prevent a wider deployment of EPC in Africa. Traditional accounting rules and annual company audits can sanction investments under the EPC. Regional alliances such as RECs will need to step in and propose changes in accounting legislation of their member states.

Lack of awareness and data scarcity

African policy makers, entrepreneurs and businesses, the finance sector, and consumers commonly lack awareness of the potential benefits of energy efficiency. Industrial customers tend to be risk-averse towards new or unknown energy efficiency technologies, and often suspect hidden costs or lack confidence in the technology's savings potential.

This lack of trust must be mitigated by information and awareness raising campaigns. Customers should base their purchase and investment decisions on verified data on risk and returns, rather than on partly-informed preconceptions.

Data scarcity also poses a challenge in scaling up energy efficiency investments. Many projections currently in use are based on empirical data from other parts of the world. For example, governments and regional organisations need data to assess how each sector of the economy can contribute to energy efficiency targets, to map out energy savings potential and actual savings per sector or market segment, and to assess market potential for energy efficiency appliances.

Lack of aggregators or facilitators.

Public energy bodies tend to address the above-mentioned barriers in isolation. Countries lack comprehensive programme development to catalyse energy efficiency market growth. This results in piecemeal, small impacts on energy efficiency market development and project implementation. This is further impeded by development partners' piecemeal support as facilitators for market development.

5.2.2 Recommendations

- *Design and formulate dedicated energy efficiency policies and targets*. Policies are needed to accelerate energy efficiency investments, tailored to the country context and following advancements in the sector. Enhanced policy dialogue and information sharing platforms should promote the benefits of energy efficiency and energy conservation. Dedicated policies must address both supply and demand side management in electricity (at utility level), industries, commercial, and buildings sectors, as well as green public purchasing.
- *Design regional and national action plans and programmes* with strengthened cooperation between regional organisations and national public sector authorities, including to:
  - Assess energy savings potential in the industrial, building, transport and electricity supply sectors.
  - Set up energy efficiency targets and strategies.
  - Develop dedicated energy efficiency programmes.
  - Support utilities in developing an NLRP to reduce network losses with a well-defined action plan and investment strategy.
  - Create a regulatory framework to encourage investments in energy efficiency.
  - Prevent dumping of obsolete or inefficient technologies from wealthy nations in Africa, which causes pollution and GHG emissions leakage.
- *Develop and implement complete project packages* for energy efficiency, covering policies, project pipeline development, financing, capacity building and performance tracking. Technical assistance should help establish programmes for project design, financing, implementation, measurement and verification. These should develop an initial pipeline of projects to catalyse sustainable market growth.

Box 18 - Energy efficiency legislation, Egypt

Egypt's electricity law, adopted in 2015, mandates transmission and distribution companies to purchase energy from cogeneration and energy recovered from secondary sources with less than 50 MW capacity, and to conduct necessary expansion to accommodate this supplied energy. Companies can also issue demand side management bids. The law requires each facility with a contracted capacity equal or above 500 kW to appoint an energy manager as well as an energy register. The government must set policies and programmes to expand energy labels for energy equipment and appliances, and to phase out inefficient equipment. Programmes must also support energy efficiency activities in industrial and commercial systems.

- *Formulate, review and strengthen laws and regulations*. Energy sector legislation should articulate energy efficiency measures. Climate change and environmental legislation should also recognise and provide for energy efficiency opportunities in the electricity, fuels, transport and buildings sectors. Laws and executive regulations help advance energy efficiency across sectors through rules that:
  - Amend building codes and establish green building rating systems, especially for new buildings.
  - Incentivise high-quality efficient goods through reduced customs duty or value-added tax.
  - Enforce certification and establish test centres.
  - Review tariff settings to link tariffs with utilities' and customers' energy efficiency performance.
  - Link subsidies with the degree of end-users' energy efficiency performance.
  - Scale back price-distorting fossil fuel subsidies.
  - Conduct energy audits (audit firms and independent experts).
  - rovide technical assistance to help set up Super ESCOs for government facilities, and to support the market development of the ESCO sector, including through operations, financing, and capacity building.

  - Support the establishment of ESCOs.
  - Promote energy management systems at a regional level.
  - Mandate energy labels on appliances and equipment.
  - Set minimum energy performance standards.
  - Create thermal insulation codes and offer rebates/coupons to trade in inefficient equipment.
  - Enforce fuel economy standards to encourage more fuel-efficient vehicles, including hybrid, as well as promoting full-electric vehicles.

- *Prioritise demand-side management programmes.* Utility companies should allocate resources to develop and implement DSM programmes to help reduce peak load and improve resource efficiency. Utilities' implementation of DSM is essential to support the development of smart networks. Utility programmes can implement energy efficiency projects across sectors, for example in the residential sector, where on-bill financing schemes have been successful in driving behavioural changes and potential market transformation.
- *Provide technical assistance and capacity building to utility companies* for designing and implementing maintenance programmes to improve power systems efficiency.
- *Improve the institutional framework* by creating dedicated energy efficiency and conservation entities as implementing agencies for policies, programmes and action plans.
- *Provide capacity building to public entities for implementing* policies, programmes and action plans, and to support energy efficiency investments. Regulators need capacity building to understand principles of design, implementation, and monitoring of energy efficiency measures. Institutions and local ESCOs need technical expertise for installation, maintenance and control of efficient products and services.
- *Offer support through capacity building for domestic commercial banks*, to increase investment in energy efficiency projects and to support SMEs' involvement in the sector. Banks need capacity building that explains how to develop investment pipelines, overall risk assessment and due diligence for energy efficiency projects. Some MDBs are extending credit lines to selected African commercial banks, for on-lending to their clients, which should be supported. This can include risk sharing or blending of concessional support from DFIs to unlock energy efficiency potential through the private sector. Capacity building can help businesses to understand and take advantage of energy efficiency opportunities.
- *Encourage MDBs to incentivise green public purchases in projects they are involved in.* This could take the form of collateralising loans to unlock access to finance for large energy efficiency purchases by the public sector. OECD countries have applied green public purchasing policies supporting energy efficiency, and these can be replicated in Africa, although they may take a long time to implement. Green public purchasing policies create incentives for public authorities to procure goods, services and works with reduced environmental impact through their life cycles. Energy efficiency purchasing decisions implemented by administrative departments, municipalities, among others, can serve as examples and contribute to raising awareness about energy efficiency benefits.
- *Put in place accounting and regulatory tools* that allow accounting for energy savings as revenue streams, or encourage ESCO models that remunerate service providers for verified energy efficiency gains.
- *Ensure access to adequate finance and investment for energy efficiency through dedicated credit lines* or loan products that can be added to other credit lines, for example to support incentives and subsidies. Access to targeted energy efficiency funding encourages companies to explore potential for efficiency, and to pursue such potential investments when faced with competing investment options.
- *Support SMEs to extend multiyear loans at reasonable rates for energy efficiency investments*, through specific credit lines with concessional support by DFIs. Loans could include partial grant components as an incentive for successful implementation. Setting up such lending programmes may require technical assistance to show the benefits to lenders and final beneficiaries, and to support implementation.
- *Establish information sharing platforms and create awareness raising campaigns* to promote the benefits of using energy efficient products and services, in terms of cost, environment, health, and job creation. Communication strategies involving key stakeholders—policy makers, businesses, finance, consumers—can highlight the importance and potential benefits of EE across sectors.

- *Allocate funds to offer incentives for energy efficiency.* Re-allocating energy subsidies towards energy efficiency measures can improve public welfare by lowering households' energy spending, and can reduce overall fiscal spending on subsidising energy. Institutional capacity building and regulatory interventions could help address systemic misalignments of incentives, such as split incentives in residential housing, inefficient energy subsidies, or harmful taxes and duties for necessary EE equipment. In Algeria, for example, energy taxes are used to fund energy efficiency measures.
- *Earmark funds for investing and administering subsidy schemes for energy efficiency initiatives*. Countries such as Egypt, Tunisia, Algeria, and Morocco already earmark funds for energy efficiency. Typically, international financing agencies offer favourable terms for such credit lines, which are a common funding mechanism used to promote energy efficiency technologies, raise awareness of energy efficiency programmes, reduce operating costs and encourage competitiveness. The business case and feasibility of energy efficiency investments can be demonstrated through technical assistance.
- *Conduct studies to analyse energy savings potential* in cogeneration at the level of energy ministries or dedicated energy efficiency institutions. New generation plants (and existing installations that need extensive refurbishments) should be equipped with high-efficiency cogeneration units to recover waste heat, specifically when heat demand is in nearby industries. Cost-benefit analyses should be conducted to show their feasibility and savings potential in various contexts. Studies should begin with existing industrial parks housing power plants to supply electricity to adjacent factories.
- *Deploy smart meters to end-users of electricity everywhere* where it is technically possible, financially reasonable, price-competitive, and proportionate to the expected potential of energy savings. RECs should set regional goals that specify which segments of households and enterprises must be equipped with smart meters by a certain time horizon. Local regulations should require newly-connected (or extensively renovated) buildings to install individual smart meters.
- *Publish data on public building energy performance and encourage thermal renovation, to raise awareness* and encourage similar measures in privately-owned buildings. National strategies and policies to address thermal renovation of the public building stock could encompass the following steps: i) review the building stock's current energy characteristics; ii) identify cost-effective approaches to renovations by building types; iii) propose incentives to the construction industry and commercial banks as debt providers; and iv) inventory the resulting energy savings in a national register.
- *Collect data to monitor and evaluate policy progress.*
- *Develop accessible, affordable and efficient public transport systems in urban areas* to encourage mode shifts from private vehicles to public systems.

Photo: Soumyabrata Roy

6 CROSS-CUTTING ISSUES

Several challenges cut across all segments of the energy sector, intersecting in different ways with the energy system and macro-economy as a whole.

6.1 Access to finance

Globally, private investment in electricity access has increased considerably over the past few years. Private investors provided the majority of funding in the sector for the first time in 2015/2016, accounting for 60% of total commitments. Yet these investments are still largely limited to grid-connected generation projects in a handful of countries. And at €27.2 billion per year, total global investment in electricity access falls short of SDG 7 targets, as well as the necessary funds to achieve the objectives of the Paris Agreement.

Public financing instruments need to catalyse private capital into Africa's energy sector, where financing gaps persist in nearly every segment. Large amounts of capital will need to be mobilised to attain three related aims: **strengthening** and **expanding the energy system** to achieve universal access to energy, **enabling a sustainable energy transition** based on rapid renewable technology deployment and energy and resource efficiency, and **underpinning sustainable economic growth** and job creation. Further funding needs to be mobilised through public channels, including national accounts as well as DFIs, but public sources alone will be insufficient to bridge the gaps. The private sector must play a major role—such as in catalysing uptake of off-grid solar solutions—given the enormity of the investment needed.

Current financing flows reveal not only the gaps, but also the uneven distribution of capital. Investment is still concentrated around grid-connected, generation projects, with less interest in transmission and distribution (including off-grid technologies).

Energy leaders should focus on setting up an enabling business environment, through planning, policy and regulatory frameworksthat support energy sector governance in line with the Paris Agreement, including necessary provisions for climate, social, and environmental governance. Policy and regulatory certainty are crucial to maintaining an attractive investment climate. Strong leadership commitment and political willingness have also proven to be important factors, for countries that have reached universal access. At a high level, strategic long- and medium-term energy and climate planning must clearly delineate the roles for grid and off-grid approaches, with specific targets in each segment to provide clarity to stakeholders.[132] Equal access-to-market rules must be developed, to avoid discriminatory actions so that both private and community-based investors can fully engage in the energy transition.

Creative sources of finance and climate-specific incentives must also be tapped to maximise the financing available to address energy sector bottlenecks. For example, long-term carbon pricing can provide a new source of public funds. Progressive reform of existing fossil fuel subsidies can also open up new opportunities for public spending.

The latest picture of global financing in the clean cooking sector shows about €36 million allocated to businesses for 2017, according to the Clean Cooking Alliance. This is far below the required threshold of €3.6 billion a year until 2030, including €1.8 billion in SSA, to reach universal access to clean cooking.[133] Local banks tend to consider the sector too nascent to invest in. At the same time, the sector's dependence on international finance exacerbates the financial risks associated with currency fluctuations.

Mitigating investment risks using public funding mechanisms

[132] The EU Energy Union and the National Integrated Energy and Climate Plans are a good example.
[133] Clean Cooking Alliance (2018) and IEA (2019)

Strategic use of public funds can attract additional sources of capital by leveraging private sector participation. Public institutions must work to remove barriers hindering investment from private actors, to meet the immense potential of RES in Africa (see chapters 1 and 2 for more detail). Innovative financing and de-risking mechanisms will be essential in this effort. Financiers' experiences show that investing in Africa today involves exposure to various risks, including related to off-taker reliability and currency exchange and transferability. Unclear contracts and regulations, long, complex tendering and enforcement processes, complex administrative and permitting procedures, and land issues compound these financing risks. Other major perceived risks for investing—based on research among leading IPPs and manufacturers in African markets—are linked to political scenarios, regulations and policy.

Numerous initiatives have been devised to de-risk investments, yet the level of risk coverage remains low along the investment lifecycle.[134] Most existing de-risking instruments offer only one risk mitigation mechanism, with fewer than 20% offering an aggregated package of guaranties plus insurances. More than two-thirds favour a specific technology (rather than benig technologically neutral). And few are valid across the entire continent: only a third apply to all African countries.

New instruments are being designed to leverage additional private capital and develop a financing ecosystem that is sustainable over the long term. A prominent approach involves blending concessional loans with funds from DFIs and entities investing on commercial terms, to improve the financial viability of projects and unlock private financing. The EU's EIP supports partner countries in mobilising finance for sustainable energy through the EFSD and blending. It also provides technical assistance to help prepare investment projects and develop a favourable investment climate and business environment. Facilities such as the Green Climate Fund and the Climate Investment Fund offer such concessional financing. They can absorb more risk than commercial investors and can be blended to leverage private sector financing.

The External Investment Plan (EIP) for Africa and the EU's neighbourhood plays a fundamental role in the operationalisation of the Alliance. The EIP provides finance, technical assistance and investment climate support, and has a specific investment window for sustainable energy and connectivity. Various initiatives have emerged recently to draw financing into renewable energy in Africa: . The EU Electrification Financing Initaitive (ElectriFI) finances early-stage companies focusing on electricity access and generation from sustainable energy sources in emerging markets. Other examples are Climate Investor One , the Africa Renewable Energy Scale-up Facility, and the World Bank Scaling Solar, are some examples. Others still in development phase include the Terrawatt and Desert to Power initiatives.[135] Project and business development support facilities such as the Private Financing Advisory Network and the EU funded GET.invest have started to offer valuable support. These programmes, varying in geographical and technological scope, have produced impressive results, with several projects online and others in development. But they have only scratched the surface of the opportunities and needs for renewable energy investments in Africa. Drawing from positive experiences in the energy market, the renewAfrica Initiative has been conceived as a new European industry-driven initiative addressing the market gaps and deepening the financial support to accelerate project development (see box 2, section 1.1.2).

MDBs and DFIs can play a key role in mobilising private sector investment, providing investment terms that a commercial lender would struggle to provide (notably given the regulatory provisions applicable to the financial sector such as Basel III and Solvency II). MDBs and DFIs should collaborate with commercial lenders by providing long tenor debt tranches and/or tenor extension products that enable commercial lenders to provide shorter tenor tranches. This in turn would help familiarise commercial lenders with the sector, and address some of the apparent inconsistencies between risk perception and risk reality, paving the way to increase commercial lender participation in future transactions. MDBs and DFIs need to shape their internal KPIs to consider both the amount of capital invested as well as assessing the leverage achieved.

Potential pitfalls of concessional financing

MDBs and DFIs will continue to play a critical role in facilitating universal access in places that remain too risky for commercial lenders. While credit enhancement is fundamental in those contexts, it is important to take a clear-eyed view of DFIs' need for sovereign counter-guarantees, especially considering the political problems

[134] RenewAfrica, 2018. RES4Africa Foundation, PwC.

[135] See https://opensolarcontracts.org/

they pose for cash-strapped governments. By creating an unsustainable burden on sovereign balance sheets, sovereign guarantees can impede progress in scaling up transactions.

The international development community must design its proposed de-risking instruments in collaboration with domestic and international private sectors to ensure they address the key risks identified by the private sector. For example, most de-risking instruments provided by DFIs and MDBs can only support state-owned enterprises; they would fall away if a national utility were to be privatised. This creates uncertainty about how durable the instrument will be, especially given conversations in the market about the restructuring and potential unbundling of vertically-integrated utilities to promote private investment in distribution companies. In this context, commercial lenders can struggle to rely on such instruments in their risk assessment and pricing.

Concessional financing needs to be additional, by supporting highly risky projects that would not otherwise be supported through commercial financing. Gaps in risk coverage that are not filled by existing de-risking packages should be assessed, and additional tools can be designed to fill such gaps. Such products must be based on feedback from commercial banks to understand how they can be structured, how commercial banks can provide support, and how end-customers can benefit. Flexible support mechanisms such as the Green Climate Fund and the EIP and the EFSD should be aware of the limitations inherent in working through partner institutions. For example, if they require an accredited entity or partner financial institution to invest on the same terms as them, they may limit their ability to fill the necessary funding gaps and achieve transformational change. Financial and de-risking support needs to focus on maximising socio-economic benefits, especially at the local community level, including through local job creation.

The continuity of support measures is also critical, to avoid long term dependence on international development support or concessional financing. The Africa GreenCo model, for example, is designed to overcome this problem by channelling development finance to start up a sustainable business. It demonstrates the ability of regional power markets to mitigate risk and acts as a pathfinder for other market participants.

Private sector insurance companies can absorb power sector risks by spreading them across a portfolio. MIGA and the African Trade Insurance Agency already pass on some of their risk exposure to private insurers. This can greatly increase insurance capacity while making use of DFIs and MDBs' relationships and reputations, which may still bear the risk as reinsurers.

Local private sources of capital

Local institutional investors and capital markets represent another significant source of potential finance and de-risking. Local currency lending has the added benefit of allowing PPAs to be denominated in local currency. This reduces the foreign exchange risks borne by off-takers, whose revenues are usually in local currency. However, local investors still have little experience with renewable energy investments. They also find it challenging to provide debt with a sufficiently long tenor, and are hampered by typically high local currency interest rates.

DFIs and MDBs can play a role in transferring knowledge by investing alongside such local institutions. International partners can lead on project due diligence until local institutions gain the internal capacities they need. While DFIs and MDBs are often reluctant to lend in local currency, organisations like GuarantCo and TCX can provide support in this regard.

Targeted technical assistance can also reinforce local commercial banks' interest and capacity to assess renewable energy and energy efficiency projects, and their associated risks. Leading European renewable industry players are ready to set the scene and share knowledge to establish an attractive framework for investors.

Distribution companies and off-taker viability

Cash-strapped distribution companies need innovative financing instruments to strengthen their financial viability—which underpins the creditworthiness of the entire power sector. Public financing instruments are needed that can fix ongoing debt problems and support distribution companies' transition towards long-term viability. Some countries in SSA have put in place reforms to increase private-sector involvement to improve operational efficiency and management, as well as to facilitate new investments in distribution. These reforms have had varying success. Approaches have ranged from management contracts, to long-term concessions and full privatisation. Each approach seems to lack some component that prevents the utility from achieving universal

electricity access. The proposed Integrated Distribution Framework tries to overcome these limitations. It proposes attracting blended public finance alongside majority private investment into the distribution segment. A private public partnership can then be set up between the incumbent utility and the new private investor, who must bring capital, advanced technology, managerial expertise, and a renewed approach to customer engagement.

In addition to providing capital, support for project preparation should also be provided to improve off-taker companies' bankability

6.2 Capacity Building

Africa's just transition to a sustainable energy model—that provides universal access and addresses climate change realities— is seriously constrained by a lack of well-trained professionals. Capacity building is urgently needed in a wide range of fields across the electricity, clean cooking and heating value chain.

African people will shape the sustainable energy transition, through forming the institutions they need, and through building and operating their infrastructures. Capacity building is low-cost compared to the capital and operating costs of energy infrastructures. Moreover, it encourages local empowerment and ownership through a clear domino effect, resulting in improvements throughout the entire supply chain. The ongoing digitalisation across sectors in Africa represents an opportunity to accelerate the capacity building momentum.

A recent report by the World Bank offers useful recommendations for capacity building actions in the energy sector:[136]

- *Diversified targets*. Capacity building should address different beneficiary groups, which may have different access to training opportunities at technical, vocational, or institutional levels.
- *Different skills*. Capacity building interventions should be diversified to address the different needs for skills existing at different levels of the energy supply chain and within different local contexts—and be aligned with the ability of the different target groups.
- A multitude of stakeholders. Due to the diverse nature of the required competences, a variety of local, national, and international stakeholders should be involved (even beyond the traditional players of the educational systems).
- *Life-cycle perspective*. People are the catalyst and the drivers of change. Their capacity needs to be developed all along the supply chain of the design solution. Within this approach, linking skills and work needs to be a guiding principle.
- *Comprehensive approach*. Capacity building for energy access should encompass a comprehensive approach based on human, scientific, organisational, and institutional capabilities.
- *National/regional and local strategies*. The need to strengthen national capacities should be shared by all countries and should be able both to drive national-based priority definition and regional coordination and to assure the support to project-based or specific local actions.
- *Teaching tools*. A mix of tools may be used, varying with the targets and the expected learning outcomes—including training, seminars, workshops, on-the-job tutoring, and site visits.

[136] Colombo et al. 2017. The power of human capital multi-level capacity building for energy access. State of Electricity Access Report. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/104731494940162971/The-power-of-human-capital-multi-level-capacity-building-for-energy-access. This is a useful document to be consulted for capacity building in energy access. http://documents.worldbank.org/curated/en/104731494940162971/The-power-of-human-capital-multi-level-capacity-building-for-energy-access

6.2.1 Capacity building needs

i) Many areas of expertise need targeted capacity building, focused across multiple levels of experience, types of job, and institutions. The following lists capacity building needs according to five categories: Executive capacity building, addressing high level professionals in the public sector (energy and finance ministries and regulators), the private sector (large energy corporations and small firms), civil society (consumer, environmental or industry associations), and research and academic institutions.

ii) Professional capacity building, offering certified technical training programmes to equip the upcoming workforce to build and operate energy generation and network infrastructures.

iii) Educational training, creating awareness among students at school and advanced degree level, and among the general public on the energy challenges in Africa and solutions to address them.

iv) Technical support activities, providing databases, handbooks, technical guides, and templates of commonly used documents for general use by practitioners.

v) Research and innovation capacity building, promoting local research skills for upcoming researchers by supporting postgraduate studies (such as doctoral or masters programmes) to strengthen the academic work force and national innovators/entrepreneurs. Young researchers will play a key role to embed local ownership and capacity in the long term to carry out technological research and innovation in the energy sector (favouring local over imported innovations in the long term).

Comprehensive training targeted towards energy sector professionals in categories i) and ii) will allow them to deepen their understanding of the complex questions at hand and to effectively contribute to producing solutions through their work. The following section expands on capacity gaps in the above categories, with a focus in the electricity sector.

Executive skills for energy and finance authorities, policy-makers, and planners.

Officials in energy and finance ministries must develop skills in a range of fields, on top of their specialised expertise in policy formulation, implementation and monitoring. They need to understand investors' requirements for participating in new energy projects, as well as how to put in place enabling factors to de-risk private financing. For example, they should be aware of investors' expectations, perceived risks and related implications of investing in renewable and off-grid technologies. Energy ministries also need to house a range of technical skills, spanning from long-term supply and demand planning to setting performance targets (such as in energy access, decarbonisation, supply reliability, losses, and costs). Other essential technical skills include resource forecasting (notably for climate change scenarios) and managing and using of energy modelling tools.

Regulatory commissioners need specific training to complement their capacities in tariff-setting, licensing, regulatory decision-making procedures, and implementing regulations. For example, regulatory board members should receive training on regulatory transparency, efficiency, and independence from political and financial affairs. The AfDB's Electricity Regulatory Index (ERI) assesses the quality of electricity regulatory frameworks of African countries on an annual basis, including the degree of independence and regulatory outcomes, and proposes areas to improve among those countries evaluated.[137] Regulatory bodies also need their technical staff to be equipped to set targets, standards, and monitoring measures to evaluate equipment quality (such as batteries and meters).

Utilities and rural electrification executives across Africa need capacity building to address their organisations' technical and financial weaknesses. This requires training in organisational management, as well as technical capacities to oversee least-cost integrated electrification plans. Staff of utilities or system operators need skills to carry out integrated power system planning across all segments, in coordination with other institutions. Utilities should train in-house legal counsel to understand PPA and PPP provisions and different types of contractual arrangements, and to draw up efficient procurement procedures.

Capacity building should review international best practices in structuring, investment, operation and management of distribution companies, focusing on the present weaknesses of many incumbent African

[137] The first edition of ERI was published in 2018 and the second edition will be published in November 2019. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Electricity_Regulatory_Index_2018.pdf

utilities. It should address approaches to designing and implementing concession agreements. This should cover methods to determine cost-reflective revenue requirements and tariffs, and incentive-based regulation for reliability and losses. Courses should review other utilities' successful experiences with customer engagement.

Distribution companies need training in implementing off-grid solutions and coordinating them with conventional distribution activities. Off-grid training should also review the different modes of interaction with independent off-grid developers, and how such interactions are regulated.

The four power pools in SSA would benefit from targeted capacity building opportunities in governance and operations. Such an initiative would align with the African Union's priority for regional integration through the AfCFTA. Flawed regulation can pose a serious barrier to cross-border transmission deployment and energy training in general. The EU offers longstanding experience in this field and could provide substantial know-how. Other international best practices could also contribute valuable insights.

Professional capacity building: staff in sustainable energy

Local electricity sector developers and entrepreneurs, in particular local SMEs, need more support to build capacity at the technical and managerial level. This is essential to allow them to participate in project tenders with high quality, well-structured project proposals that use optimised systems design (including for mini-grid and other off-grid projects). Training is also needed to help developers access finance and improve their project bankability. Electricity sector professionals need skills in conducting feasibility studies and forecasting project costs, including construction, operations, and maintenance. Business management skills, including developing business plans and models, and financial management are essential. For example, the African Network of Centres of Excellence in Electricity (ANCEE) has trained over 4000 engineers, technicians and managers in these areas to date. Regional centres such as RCREEE, ECREEE, EACREEE, and SACREEE will play a central role in these efforts.

Capacity building should focus on knowledge gaps at the institutional level (among utilities, regulatory agencies and energy ministries) in developing IPPs, especially for renewable technologies and for energy efficiency investments. Public institutional knowledge is needed in the following areas:

- Estimating capacity for public procurement
- Developing adequate licensing procedures for unsolicited and solicited project proposals
- Supporting project development across project phases
- Understanding risk mitigation options and instruments
- Integrated energy sector planning at ministry and utility level
- Evaluating grid absorption capacity for renewable energy integration.

Several areas of mini-grid and off-grid sector expansion need capacity building, including in planning, development impact, and government support mechanisms. For example, energy planning entities need to plan how to develop mini-grids alongside larger on-grid generation, and set electrification targets through mini-grids, including by specifying suitable locations for mini-grids. Energy ministries and electrification/planning agencies must understand how mini-grids contribute to local development, and what government support mechanisms can contribute to their expansion (such as site identification and pre-feasibility studies). Regulatory authorities need knowledge of the sector to better assess off-grid projects, and to design and implement appropriate rules and regulations.

Financial institutions need to develop in-house capacity to appraise renewable energy projects. Insurance companies, investor funds, and commercial local and regional banks also need staff skilled in structuring energy sector deals, especially for renewable technologies and energy efficiency.

Power pool designers at national and regional levels need to develop specialised understanding on international best practices in regional market design and operation. This requires an understanding of various political and technical matters, including:

- Shaping the necessary institutions and governance regimes.

- Setting market rules and monitoring frameworks.
- Treating bilateral contracts.
- Conducting transmission planning and cost allocation, and congestion management.

Educational training

Secondary and tertiary institutions can create the foundation for a skilled workforce for the energy sector by introducing students to the professional pathways and opportunities offered by the energy sector, as well as its role in the economic development of Africa. Targeted modules can be designed around the various aspects of the energy sector, to be offered at bachelor or master level in energy programmes across Africa. Women students in particular can be encouraged to enter into energy fields to increase and diversify the pool of talent. For example, the renewable energy and off-grid sectors offer new, dynamically growing, and high-impact fields for young women to enter the job market.

Technical support activities for private and public sectors

Various jobs in the energy sector require certified technical training. Developing and disseminating manuals, software tools, and guidelines—supported by training programmes—can support these technical activities, focusing on specific areas of weakness. Targeted instruction can support the creation of a local workforce to deliver solutions to Africa's energy challenges, and foster private sector growth in the sector.

Teaching materials and training should be provided in the following fields:

- Building renewable energy and off-grid installations.
- Manufacturing, construction, and maintenance of power system infrastructures.
- Electrification planning using geospatial computer-based tools.
- Conducting operations and maintenance of small off-grid systems.
- Mini-grid design and operation.

Regional and national electricity regulatory staff can benefit from handbooks and templates, such as for:

- Determining cost-reflective revenue requirements for electricity distribution (through both on- and off-grid systems) and tariff design.
- Applying performance-based regulation methods.
- Setting reliability targets and incentives, as well as loss reduction incentives.
- Producing templates and evaluating PPA contracts, as well as applying best practices for concession contracts and PPP agreements.

Research and innovation programmes

Local research capacities need to be constantly developed and upgraded to support the energy sector's long-term evolution in its national and regional context. This is a feasible and affordable objective. The *Long-Term EU-AU Partnership for Research and Innovation on climate change and renewable energy*[138] emphasises the need to foster and advance research and innovation in the energy sector as a pillar of the AEEP, supported by Horizon 2020, Europe's research and development programme.[139]

Research on renewable energy technology development is a major component to support Africa's sustainable energy transition, as highlighted in the EU-Africa High-Level Policy Dialogue Roadmap on Climate Change and Sustainable Energy. The EU recently launched the Research and Innovation Action to conduct a series of

[138] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-sc3-ja-5-2020

[139] Horizon 2020 Work programme
https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-intro_en.pdf

strategic and joint research activities, innovation workshops, and capacity building programmes for developing and adapting renewable energy technologies to address African challenges. These activities focus on innovating technologies that can be applied to Africa's specific environmental, social and economic conditions.

Researchers are exploring several areas to address generation questions, notably surrounding:

- Decentralised generation and stand-alone systems, including with energy storage solutions.
- The lifetime, behaviour and adaptation of renewable technologies in extreme conditions, as well as related maintenance factors.
- The environmental and social implications of renewable technologies (such as geothermal) in areas with existing potential for energy resource exploitation.
- The supply chain sustainability of generation technologies, and adaptation to local contexts.

Transmission and distribution are also important areas for research, especially to address grid integration of renewables. For example, innovative system designs are essential for wide deployment of smart hybrid mini-grids with RES, both for off-grid configurations as well as when considering their long-term integration within the national grid. This is an attractive area of research. Innovations can leverage the digital revolution taking place in the continent to help African regions leapfrog traditional grid structures.

Capacity building and local empowerment can also create enabling environments that ensure long-term, equitable local innovation. Research should focus on ways to harness different energy sources for off-grid or on-grid solutions, as well as on integrating heat applications (such as process heat, cooling) with decentralised systems and energy efficiency solutions.

Complementary strategies for skills development

- *Encourage staff development programmes of European utilities and large RES developers to second* to African utilities to build capacity at local level. For example, this could develop local skills on regulation, licences, contracts, documentation, and capacity building on technologies, business models, and financing.
- *Develop twinning programmes between international and local business and industry associations*. These can facilitate sharing knowledge and experiences, provide a platform for conducting management trainings, and organise secondments and joint activities. GET.invest, ARE and SolarPower Europe are preparing models of this type of initiative. European industry associations can provide capacity building on association management, policy and regulation, business development, and advocacy.[140]
- *Support youth and women entrepreneurship programmes* to empower the pioneers of the decentralised energy sector and to stimulate demand in rural villages. The 2017 Young Leader Awards carried out by ARE and AEEP set a good example of such an initiative.

6.2.2 Institutions and programmes in Africa and Europe

Various universities, research centres, and foundations in Africa and Europe are developing capacity building and research programmes on sustainable energy development and engineering. For example, the Pan-African University Institute for Water and Energy Sciences (PAUWES) at the University of Tlemcen, Algeria, offers graduate courses in engineering and policy for energy, and is implementing an online postgraduate programme on Mini-grids, Digitalisation and Entrepreneurship. Other African institutions offer capacity building for sector professionals on the continent, including:

- The Mediterranean Renewable Energy Centre (MEDREC) in Tunisia, which is reaching out to expand capacity building in SSA.[141]

[140] The European Solar PV association SolarPower Europe, via its Emerging Markets Task Force, is pursuing this approach by partnering with local associations in Africa. See Box 20.

[141] http://www.medrec.org/En/Staff_11_70

- The South African Renewable Energy Technology Centre trains solar technicians, mostly women, through local universities.[142] It can collaborate with other universities across Africa.
- The University of Cape Town Graduate School of Business offers courses on economics and regulation for African energy utility executives and government officials.[143]
- Clean energy corridors, incorporating major capacity building programmes, have been set up across SSA by ECOWAS, as well as by EAPP and SAPP (with development partners).
- The French École des Mines has a partnership with the South African Energy Training Foundation to offer courses on energy economics and regulation in francophone African countries.

In Europe, educational institutions and industry groups offer various courses for African professionals and students. The Florence School of Regulation is offering a 5-month training to African energy executives in collaboration with the ENEL Foundation. The FSR's on-line learning platform can also be adapted for almost any kind of educational material and course format. Also in Italy, Politecnico di Milano, Fondazione Eni Enrico Mattei (FEEM), and RES4Africa offer graduate courses and capacity building programmes for energy engineers. Politecnico di Milano manages the Emerging African Innovation Leaders[144] programme, promoted by the Italian Agency of Cooperation, to empower leaders in the energy, transport and digital sectors through a set of massive open online courses.[145] GIZ, Get Invest, and the EU TAF for SEforALL also offer capacity building programmes throughout Africa.

6.2.3 Empowering local SMEs and commercial banks

More than one-third of the global population is employed in formal micro, small, and medium scale enterprises. Thanks to their operational flexibility and their ability to respond rapidly to market needs, SMEs represent the backbone of modern economies. They have important social and economic development impact, thanks to their potential to create jobs quickly and to contribute to Agenda 2030 and Agenda 2063 targets.

Many SMEs throughout the African continent have understood the business opportunity that the renewable energy sector offers, notably in the off-grid sub-sector, but they face an unfriendly financing environment that slows progress. SMEs often lack the skills to draw up bankable business proposals. Even when they can, local lenders often cannot provide the support they need, due to a lack of financing instruments to support these types of activities. In addition, lenders generally lack understanding of the business proposition. Small-scale energy projects are especially suffer from a high-risk perception from lenders.

Existing initiatives that target the empowerment of African renewable energy SMEs and local commercial banks could help address this situation. This presents a high-impact opportunity. IRENA, in collaboration with ECREEE, launched the Renewable Energy Entrepreneurship Support Facility (REESP) in 2017. It has since been incorporated into the Regional Off-Grid Rural Electrification Project (ROGEP), covering ECOWAS countries as well as Cameroon, Chad and Mauritania. In the first two years of its implementation, REESP provided support to over 90 SMEs throughout West Africa, helping them raise over $1 million financing by building capacities of local commercial banks. It also contributed to the creation of a Regional Solar PV Association. ROGEP also offers credit lines through local commercial banks. Based on its success in ECOWAS, IRENA collaborated with SACREEE to launch the REESP initiative in the Southern African Development Community (SADC) region.

Empowering local SMEs and banks to develop renewables markets relies on local professionals, including qualified renewable energy technicians. IRENA, ECREEE, GIZ and ROGEP have supported the creation of a regional certification scheme for renewable energy technicians: the ECOWAS Certification for Sustainable Energy Skills (ECSES) Programme. The scheme's objective is to improve RE professionals' skills through standardised regional certification, to support market development. The scheme requires technicians to take regionally agreed exams to ensure a standard competency level across the region. To date, ECOWAS members have approved the creation

[142] https://www.saretec.org.za/
[143] https://www.gsb.uct.ac.za/power-reform-regulation
[144] http://community.africainlead.net/
[145] https://www.pok.polimi.it/

of certification materials for off-grid solar PV technicians in both English and French, including exam content and operational processes.

Several countries have successfully piloted the ECSES scheme. Practical and written exams were held at the Ecole Supérieure Polytechnique in Dakar, Senegal in January 2019, and at the Kwame Nkrumah University of Science and Technology in June 2019 in Kumasi, Ghana. The scheme is being rolled out in other ECOWAS countries, with exams scheduled in Burkina Faso, Cabo Verde and Nigeria in the third quarter of 2019. Work has commenced to develop exam materials for additional competencies, such as for grid-connected solar PV, solar PV mini-grids and solar PV inspectors.

6.3 Africa-EU B2B Partnerships, Matchmaking and Networking

African and European companies do not operate in similar macro-economic contexts and business climates. A large section of the African population has no access to basic services such as electricity and drinking water, and suffer from unequal and insufficient education and employment opportunities. European companies have access to cost-effective technologies, advanced policies and regulation, and wide access to digitalisation, as well as financing. At the same time, European companies understand the importance of running sustainable businesses, and the various impacts of business on job creation, gender equality, and environmental protection. African companies can provide support based on their understanding of local political and socio-economic contexts and business culture. European and African parties working together need to understand and address local and regional risks and barriers associated with conducting business in Africa. Combining their complementary knowledge and resources to overcome these barriers can help transform them into opportunities.

B2B relationships are essential to help businesses follow developments and share knowledge of new energy efficient and cost-effective technologies. They help to grow business activities and partnerships, encourage market developments, and support innovation in business models.

The EU, alongside other donors, promotes and supports various initiatives and events to strengthen B2B partnerships through dialogues, including at forums and high-level strategic meetings . The EU-Africa Business Forum, for example, presented discussions on digitalisation, and covered questions necessary to developing and strengthening business partnerships between EU and African companies, as well as the role of Governments in facilitating EU support. ARE, alongside development partners AfDB, ECREEE, ElectriFI, GET.invest, Swedfund and UNIDO, initiated the ARE Energy Access Investment Forum in 2019. But more action is required to create business opportunities aimed at achieving sustainable development.

Box 19 - Creating Partnerships between African and European companies

Ensol Tanzania Ltd provides convenient, affordable access to quality clean energy products and services in Tanzania. Spanish project developer Trama TechnoAmbiental (TTA) selected Ensol Tanzania as its partner to deliver clean energy solutions to East Africa.

Tanzania's the rural electrification rate is below 15%. The vast countryside is sparsely populated, making it favourable for off-grid electrification where grid extension remains infeasible. The 730 households in remote Mpale village have long depended on fossil fuels such as kerosene and diesel to provide lighting and electricity. Ensol Tanzania and TTA (both ARE members) joined forces with the United Nations Capital Development Fund to coordinate and finance a hybrid solar mini-grid project to deliver sustainable, reliable and cleaner energy services in Mpale. The mini-grid has 48 kW PV capacity with flooded lead-acid battery storage, backed up by a 50 kVA diesel generator. The electricity produced is distributed via a two-kilometre-long aerial line installed throughout the village. Consumers receive electricity via a service-based tariff scheme.

Mpale village now enjoys 24/7 access to reliable electrical power. Their health centre now provides uninterrupted service and students can study after sunset. The modern energy access stimulates the local economic and social development by creating local business opportunities. Noise and environmental pollution are significantly reduced. A further 15 villages have been identified to replicate the project.

See https://ensol.co.tz/; http://tta.com.es/; https://www.ruralelec.org/; https://www.uncdf.org/

6.3.1 Barriers

The main barrier to B2B partnerships is a lack of interaction between local and international market players. Local African SMEs and start-ups—especially those building small-scale projects such as mini-grids, but also larger wind and solar project developers—have limited capacity to access and meet international financiers, donors, technology providers and suppliers. Local companies often have in-depth knowledge about last-mile customers and local distribution chains.

6.3.2 Recommendations

- Organise investment forums and workshops bringing together international and local stakeholders in the energy sector, government institutions, private sector, technology suppliers, NGOs and investors to enable collaborations that can fast-track off-grid and on-grid projects on the ground. Investment forums can help increase understanding of synergies between African and European partners, shine a light on complementary functions and potential for cooperation, and offer space to share experiences of African and European business cultures.
- Set up local help desks in selected markets or activities to increase interaction and knowledge transfer between local and international players. A good example is the donor support, with local development partners (GN-SEC network), that has encouraged creating or strengthening African industry associations, following the model of European associations.
- Create an evaluation framework to assess the impact of initiatives in terms of B2B creation and development under specific programmes. For example, the AEEP's Pan-African Programme studies how to improve governance to facilitate business development between large international companies and local players in Africa.
- Strengthen dialogue at the political level to discuss potential areas for cooperation between EU and African Governments, the type of support needed, the role of EU Delegations in facilitating B2B activities in African countries, and the role of digitalisation in strengthening B2B (such as through online financial platforms for access to crowd-funding).

Box 20 - SolarPower Europe Emerging Markets Task Force

The European solar PV industry association SolarPower Europe set up its Emerging Markets Task Force in 2018. The task force identifies business and cooperation opportunities in emerging markets. This contributes to the energy transition outside Europe, with a focus on Africa. Its working group of over 100 experts from 50 companies has produced a series of market reports (including on Ivory Coast, Tunisia, Senegal, and Mozambique) and other technical reports developed by directly engaging local stakeholders through meetings, site visits, and conferences. The task force aims to develop structured partnerships with local associations in Africa (such as the newly-funded AMER in Mozambique) to maximise B2B networking opportunities, share best practices on policy and regulation, and encourage business development.

- Design marketing and communication strategies and programmes to share information on technological innovation with African counterparts, and on how such technologies can create business opportunities.
- Improve B2B opportunities and linkages between private companies and industry players, for example between European and African trade associations.
- Provide quality information about business opportunities and potential partners to market actors, for example through market analyses. This can inform and help structure B2B opportunities, as well as making them more effective.

6.4 Gender mainstreaming

Over 40% of the population of sub-Saharan Africa lives in extreme poverty, of which 70% are women and children. The gender equality landscape is complex, and shows a strong overlap between gender equality and access to energy. Most of the rural population in SSA lack access to clean and sustainable energy for lighting, cooking and heating, as well as for productive uses such as agricultural processes. This is compounded by limited access to water and public services (see section 6.6 on the water-energy-food nexus).

Women are heavily constrained by slow progress in the energy sector. Women are still the main users of energy at a household level, and suffer most under energy poverty. Women also tend to shoulder most of the (unpaid) extra labour when their community lacks easy and reliable access to clean water or cooking and heating fuels. On average, women spend four hours daily collecting fuel to produce fuelwood and charcoal in poor countries such as Sierra Leone and Niger, with associated health consequences.[146] Similarly, women represent half the agricultural workforce as small-holder farmers in sub-Saharan Africa and often bear primary responsibility for growing food for household use. These challenges also affect women living in peri-urban areas.

The predominant means of acquiring and using energy create a heavy economic and health burden for rural households in SSA. Charcoal, kerosene lights and candles, which remain primary or secondary energy sources in rural Africa, produce harmful air pollution. According to the WHO, the smoke caused by cooking with these unclean fuels affects 860 million people in Africa, and is responsible for over 4 million deaths globally each year. Wood fuels such as charcoal are also major drivers of deforestation, which has harmful impacts on food security, water availability, and climate change.

Women have an active stake in bringing solutions to the energy sector, and can be agents of change in all aspects of energy value chain development, especially when they have access to microfinancing schemes.[147] As household managers, women tend to be more sensitive to, and willing to adopt, sustainable consumption practices, including using energy saving appliances like cookstoves, solar appliances, public transport, and recycling. As consumers and users of energy, women directly benefit from clean, efficient energy solutions, and use these to their advantage.

[146] IEA (2019).

[147] International Labour Office, 2007. Small change, Big Changes: Women and Microfinance. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---gender/documents/meetingdocument/wcms_091581.pdf

As sales agents, women can more easily engage with other women consumers, who are the direct users of improved stoves, solar appliances and other household products. When women do take up energy business activities, however, they face various challenges. In poor rural regions, women typically do not formally own household assets, and so cannot access credit from banks. If they do engage in business they stay in the informal sector and rely on informal sources of credit, so their businesses tend to stay small. The challenges women entrepreneurs face also encompass operational issues and lack of technical skills and training. Moreover, they lack role models and professional networks to represent their collective interests in energy markets and value chains.

In the public sector and in private energy companies, women are significantly underrepresented at the senior management level. This affects companies' recruiting decisions and strategies. Greater engagement of women in the energy sector and gender mainstreaming will help expand the talent pool. Women professionals bring diverse skills and perspectives that can make a difference to sustainable energy development.[148]

Any investment directed to reduce energy poverty must explicitly focus on empowering women. Solutions should follow a dual track: i) supporting women to establish clean energy businesses, and ii) mainstreaming gender-sensitive approaches across all energy sector interventions, especially in areas like clean cooking, SHS, and mini-grids with productive uses (where women's role has largely been overlooked).[149] Women should be actively encouraged to enrol in training to work as technicians, salespeople, or engineers for supply, installation and maintenance of energy appliances. They should be among the main beneficiaries of education, capacity building and training programmes focusing on sustainable energy within local or international companies.

6.5 Technological research and digitalisation

Over half of the African population is under 24 years old, a trend that is likely to continue until 2030. African youth play a central role in shaping the development of the continent, especially in the energy sector. In this regard, The Agenda 2063 of the African Union has placed youth at the centre of the continental drive for transformation, promoting their participation in all sectors, including energy.

The global changes in information and communications technology (ICT) have contributed to innovations in various sectors. A recent World Bank report highlights that ICT has the potential to drive entrepreneurship and innovation, especially in Africa. Several innovations have enabled new business models to emerge on the continent, including mobile money transfer and mobile merchant services such as M-PESA and Kopo Kopo in Kenya.

ICT is playing a key role in the global shift from traditional centralised energy systems to distributed renewable energy-based systems. Digital technologies present tools for improving energy access levels across Africa. They have underpinned the design of new financing schemes tailored to rural communities' needs. For example, they allow rural customers to pay in instalments for off-grid stand-alone power systems. Iinnovative and flexible payment methods for energy services have emerged thanks to ICT, including prepaid and mobile payments.

The growing interest in mini-grids in Africa opens new spaces to apply digital technologies. Renewable and hybrid energy-based systems need smart and digital technologies to balance demand and supply, and to ensure efficient system operation. Digital innovations can address a wider scope of challenges in the mini-grid sector, such as optimising project development processes, improving the design and planning of mini-grids, as well as maintenance, management, and customer service processes.

Frontier technologies in the last decade have opened up new possibilities for African youth to drive innovation and transform the socioeconomic landscape in Sub-Saharan Africa. Promising new areas of research and development are emerging in technologies such as artificial intelligence, big data, advanced computing, and the Internet of Things. Combined with cost reductions of sensors and microcontrollers and mobile devices, these create ideal conditions to renovate the energy products and services. A recent GIZ study shows several

[148] ECOWAS, 2017. Regional Policy for Gender Mainstreaming in Energy Access
[149] Ibid.

youth-based digital innovations have led to the creation of start-ups, including in the energy sector. Youth empowered with digital and entrepreneurship skills can both strengthen the smart-grid sector and harness it to produce structural change. New digital business initiatives can facilitate the movement of workers from lower to higher productivity employment. On the other side of the coin, digital exclusion can have severe repercussions including to widen socio-economic disadvantages, disproportionately impacting young people. This presents high costs for governments and society as a whole.

PAUWES is creating a dynamic framework for research and innovation, to use digital technologies to address the challenges in the mini-grid value chain, including generation, distribution and operation. Frugal innovation and research in the ICT sector offer a model for building a research and innovation framework for solving African power sector challenges. PAUWES is working with actors and stakeholders of entrepreneurial ecosystems in the continent—including tech hubs, incubators, and start-up investors—to build such an innovation and entrepreneurship framework, linking with academic research institutions.

Developing Africa's technological research and innovation capabilities requires support from development partners. For example, funding is needed for applied research and capacity building to support demand growth estimation and research on the potential for electricity access to foster economic development.

Support is also essential to encourage technology transfer for sustainable industrialisation. Well-established, efficient and sustainable power systems, with widespread or near-universal electricity access, help catalyse sustainable industrialisation, as in North African countries. The EU can support industrialisation and foster related job creation by facilitating technology transfer between Europe and Africa.

6.6 The water-energy-food (WEF) nexus

Water, energy and food are the building blocks of economic, societal and sustainable development. Despite Africa's vast resources, over 600 million Africans lack access to energy, 737 million have no access to safely managed drinking water, and 374 million experience severe food insecurity.[150] As African societies and economies grow, urbanise, and evolve their lifestyles, the demand for basic resources will multiply. Meanwhile, Africa's vulnerability to climate change will further stress resource scarcity. This section discusses the Water-Food-Energy (WEF) Nexus approach, and presents some recommendations in light of the need to integrate strategies for water, energy, and food security.

The WEF Nexus describes the multiple interrelations between energy, water and food, highlighting that:

- Water is central to all human needs, to energy generation, and every phase of agricultural production, and is also vulnerable to climate change.
- Energy is needed to extract, process and distribute water and treat waste water, as well as to power agricultural and agribusiness processes. Transforming the energy sector is fundamental for climate action.
- Food and agriculture require vast amounts of water and energy for production, processing, distribution, storage and disposal of food products; food supplies chemical energy for human and animal consumption, as well as biomass by-products. Agriculture is also vulnerable to climate change, while producing high GHG emissions, pollution and environmental degradation.

Land use and allocation between climate, energy and food production create another overlap between these sectors. This tension is reflected in the interface between soil management, agricultural techniques (notably agrochemical production and use) and groundwater pollution.

The WEF Nexus approach focuses on these connections to offer an innovative perspective in designing strategies to increase access to clean energy, combined with water and food sector development. The approach considers trade-offs between the sectors, and promotes resource management techniques to improve productivity,

[150] IEA (2017), FAO (2018a), UN SDG Indicators (2019)

efficiency, resource security, and sustainability in water, energy and food value chains. The idea is to kickstart virtuous development cycles by helping rural and peri-urban users gain access to previously lacking resources. Access to basic resources brings people and communities into the economy and spurs socioeconomic development.

Harnessing productive uses of energy to underpin sustained economic growth in Africa through agricultural development and water security can create widescale development impact. This approach aims to advance water security alongside growth of the agricultural sector, which is a source of employment and income generation at the heart of Africa's economy.[151] However, these sectoral interdependencies are particularly challenging for Africa, where widespread resource infrastructure is still lacking. This hampers progress in agricultural productivity, industrial development, and poverty reduction.[152]

PAUWES, in their scientific contribution to the AU Agenda 2063, recommend taking an inter- and trans-disciplinary approach to address the WEF Nexus.[153] Agenda 2063 organises the nexus into three main pillars: Energy – Water; Energy – Climate; and Water – Climate. It analyses the current status and relevance of each sub-nexus for the continent, as well as challenges and recommendations for further research.

The WEF Nexus offers various pathways to deliver sustainable impact (see Annex B).[154] WEF-based approaches can help create captive markets by sustaining productive uses of renewable energy, which then diversify local economies. Taking agriculture and water sectors into account in energy investments can help accelerate last-mile connectivity and stimulate energy demand among poor users in rural and peri-urban communities. This enhances the market attractiveness of energy access. Especially when powered with clean sources, WEF Nexus approaches reduce carbon footprints and pollution across sectors. This creates additional environmental and socio-economic benefits and contributes to advancing the SDGs.

Innovations stemming from the WEF Nexus can attract a broad range of investments which need viable business models to work at scale. These would foster local demand growth, open new market possibilities, and increase the private sector's willingness to invest in African markets. Largescale investments in the WEF Nexus can stimulate demand for energy access and build new access markets, which would increase economic productive capacity. WEF Nexus case studies remain limited, however. More research and trials on business models are needed to reveal their potential for scale and replicability.

In order to meet the daunting global challenges related to water, energy and food security and maintaining ecosystems health, the EU is also developing the water-energy-food-ecosystems (WEFE) Nexus. The strain on ecosystems resulting from unsustainable single-sector planning increases poverty, inequality and instability. The WEFE Nexus incorporates the main drivers of climate change (water, energy and food security) and the main sectors affected (water and the environment). It is difficult to imagine solutions to climate change problems that are not built on a form of Nexus approach.[155]

6.6.1 Recommendations

Sector policy, capacity building and markets need to adapt to catalyse further development of WEF Nexus applications:[156]

[151] Ensuring long-term development and poverty eradication partly depends on growing and industrialising the agricultural sector and advancing development in rural areas. WEF Nexus initiatives can create opportunities to support the expansion of agricultural and agri-food production cycles (e.g. farming, poultry and fishing value chains), which drive agricultural and industrial development. The WEF Nexus offers an innovative perspective on overcoming Africa's energy access gaps by considering how energy can both enable development and solve resource challenges.

[152] In this perspective, energy acts as an enabler of increased food security, agricultural productivity and improved access and management of water resources for human and productive uses.

[153] http://pauwes-cop.net/documents/PAUWES_Research_Agenda_Final.pdf

[154] Energy can become truly transformative when it endows other pillars of sustainable development, such as water and food: RE can play a significant role in leading the water and food sectors towards greater sustainability.

[155] See Position Paper on Water, Energy, Food and Ecosystem (WEFE) Nexus and Sustainable development Goals (SDGs) at EU Science Hub. https://ec.europa.eu/jrc/en/publication/position-paper-water-energy-food-and-ecosystem-wefe-nexus-and-sustainable-development-goals-sdgs

[156] RES4Africa and Enel Foundation, 2019. Africa's Future Counts. https://www.res4africa.org/wp-content/uploads/2019/06/RES4Africa_flagship_2019.pdf

- *Integrate the WEF Nexus as a strategy* for market discovery, resource management, and sustainable (business) development. Energy sector actors in Africa and Europe, including public and private sector entities, should take advantage of the linkages and opportunities in the WEF Nexus. The WEF Nexus approach should be part of overall energy sector planning and cross-sector planning. This requires a stronger coordination between national institutions. The development and business agenda, as well as associated actors, should also adopt the WEF Nexus to increase impact, in line with their capacity, mandate, and expertise.
- *Shape an inclusive and supportive business environment for the WEF Nexus*. Policy and regulatory frameworks should be designed to recognise the importance of the WEF Nexus as a driver of sustainable development. They should promote the WEF Nexus approach for off-grid and on-grid energy investments (such as hydro plants also used for irrigation). Development partners should support African governments to ensure that reliable and enabling business conditions are set to enable WEF Nexus approaches.
- *Create adequate and dedicated financing* schemes to support the promotion of WEF Nexus approaches, and to scale up implementation. For example, agri-food and water sector projects mobilise large resources and funds from targeted financing instruments, which still fail to recognise the need for renewable energy supply to optimise operations in those sectors. Renewable energy investors are left without access to those financing sources. Financing programmes and support instruments need to recognise and address the cross-sectoral connections between water, energy and food sectors.
- *Dedicate efforts to capacity building* to ensure the longevity of projects and markets. Training programmes should integrate the WEF Nexus to raise awareness and anchor WEF Nexus thinking into development strategies at government and corporate level. Actors engaged in capacity building programmes should include the WEF Nexus in ongoing capacity building strategies, programmes and plans.
- *Integrate cross-sectoral collaboration between energy*, water and agricultural sector players as well as other key stakeholders, including public and private sector actors across industries, and financial institutions. Energy, water, and agricultural sectors need to break free from silo-based action and mainstream WEF approaches. Collaboration would help strengthen policy dialogue, produce viable, scalable business models that can be replicated across contexts, and design adapted financing mechanisms. Applications of the WEF Nexus should be trialled to explore their potential for scale and creating development impact.
- *Close information gaps in WEF sectors*, which impede development and implementation of WEF Nexus business models. Applying WEF Nexus business models at larger scales requires access to reliable market and customer information, as well as data on case studies and best practices to build on. Experience-based knowledge is key to offer examples and refine business models.

6.6.2 A framework to mainstream environment, biodiversity and climate change

The energy sector's interactions with the biophysical and social environment can have unintended or unwanted effects, including harmful social and environmental impacts. At the same time, clean, sustainable energy services underpin responsible production and consumption, and efficient use of natural resources.[157] Three core questions can reveal the main environmental and social concerns linked to renewable energy interventions:

A. How does the sector impact on the environment? This considers the **environmental and social impacts** of energy sector interventions.

B. How does the sector depend on the environment? This considers the **energy sector dependency** on ecosystem services provided by the environment.

C. What risks does the environment impose on the sector? This considers the energy sector's **resilience to environmental and climate risks** and **disaster risk** preparedness and/or reduction.

[157] A good summary overview is provided in the Sector Note: Mainstreaming Environment and Climate Change – Energy by the environment and climate mainstreaming facility. It is structured according to entry points for mainstreaming of environment during programme and project identification, formulation, implementation and evaluation.

Environmental and social impacts. Energy sector development requires infrastructure that interacts with people and the environment. Building energy infrastructure commonly entails land use change, with potential impacts on biodiversity and ecosystem services. It also can lead to competition or conflicts over resources. Construction, operation and decommissioning of energy infrastructure can cause air and water pollution. These may impact natural processes, with effects reaching far beyond the construction site. These questions are addressed by 'conventional'[158] environmental and social impact assessment (ESIA) of projects.

Environmental dependency lies at the heart of renewable energy production. Environmental conditions determine what kind of energy can be produced and at what costs. Availability of wind, sunshine, water, biomass, geothermal sources and suitable space provide the opportunities for energy generation. Space is an increasingly limiting factor, both on land and on water. This creates an overlap between energy sector planning and spatial planning or regional development planning. Strategic environmental assessments (SEA) should be used to assess regional and national energy plans and policies to find an optimal balance between economic, social or environmental uses of space and resources, taking into account long-term climate change scenarios.

Environmental risks. The environment imposes risks on energy projects, mostly through geological (such as earthquakes and landslides) and weather-related events (such as floods, drought, hurricanes, heat waves, and wildfires). Climate change can increase these risks. Climate resilience, adaptive capacity, early warning systems and risk reduction strategies are part of climate risk assessments and climate risk management plans.[159] ESIAs and SEAs can integrate climate risk assessments and management plans for projects, policies, plans and programmes, where relevant.

Going beyond a "do no significant harm approach", energy sector strategies and planning should identify opportunities where energy investments can also contribute to achieving environmental objectives, such as promoting and protecting biodiversity, water quality and ecosystem services. More detailed information on integrating environment and climate change in the sustainable energy sector can be found in annex E.

[158] Where early impact assessment was focused on impacts resulting from project activities, nowadays, environmental dependencies and risks are considered to also be part of good practice ESIA.

[159] Further detailed information provided in "Integrating the environment and climate change into EU international cooperation".

7 ACTION AGENDA FOR SUSTAINABLE ENERGY INVESTMENTS

Achieving inclusive, environmentally sustainable, reliable, affordable, and climate-resilient access to energy should be a priority in the short-term. This final chapter presents the SEI Platform's priority recommendations and practical actions for implementation.

This action agenda requires concerted political dialogue and the active participation of the private sector, civil society, academia, and public and international institutions with a common interest in sustainable development to foster prosperity. In this context, it is recommended that the AU and the EU maintain this cooperation platform and expand it to more stakeholders, while following up on the implementation of these recommendations.

These recommendations contribute towards achieving African leaders' aspirations in the Agenda 2063, the New Deal on Energy for Africa, the Cairo Declaration and Action Plan, as well as the United Nations' 2030 Agenda and Paris Agreement.

Substantial investment in capacity building and technical assistance support is needed to carry out most of these recommendations. At the same time, realising the stated objectives requires that partner countries make strong political commitments through adopting appropriate policies and regulations.

The priority recommendations are structured in the following 10 categories:

A. Adopting policy and regulatory measures to facilitate sustainable energy investments.
B. Promoting best practices in project identification, preparation, and procurement.
C. Adapting financial and fiscal systems to meet potential investors' and projects' needs for maximising benefits to African partners.
D. Launching a comprehensive capacity building programme.
E. Investing in the distribution segment.
F. Expanding mini-grids and standalone systems.
G. Investing in generation, with a focus on renewables.
H. Advancing regional integration of national power sectors and strengthening transmission
I. Improving energy efficiency.
J. Encouraging market development, consumer demand, and investments in the clean cooking sector.

A. Adopt policy and regulatory measures to facilitate sustainable energy investments	
Objective	Adopt policy and regulatory frameworks that ensure a level playing field, favourable to local and foreign private sustainable investment, including for the establishment of PPPs.
	Action
A.1 - Policies	Design and implement a technical assistance and capacity building programme to support energy and corresponding line ministries to develop national policies and targets for all segments of the energy sector. Policies should focus on i) expanding access to electricity and clean cooking, wider deployment of renewable energy, and energy efficiency, ii) promoting and increasing local and international private sector investments in sustainable energy, including through phasing out fossil fuel subsidies and decommissioning thermal plants, and iii) integrating climate change and environmental considerations across all measures.
A.2 - Regulations	Design and implement a technical assistance and capacity building programme to support energy regulatory authorities in regulatory review processes, and in drafting and promoting a framework to implement the above policies. The framework must address weaknesses (such as those identified in the Electricity Regulatory Index— regulatory independence, tariff design, operation of wholesale markets).[160] The aim is to strengthen the regulatory framework for all segments of the energy sector with a focus on access to electricity, off-grid/mini-grid systems, clean cooking, deployment of renewable energy, and energy efficiency.

B. Promote best practices in project identification, preparation, and procurement	
Objective	Get more sustainable energy projects done in Africa by enabling a favourable environment for renewable energy investments, by ensuring the processes for infrastructure project development are efficient, sustainable, simplified, and standardised, and that donors' instruments are deployed coherently and efficiently.
	Action
B.1 - Identify a pipeline of effective and impactful projects	Develop a technical assistance programme for specifying project pipelines, starting from the existing project pipelines of PIDA, AREI, SEforALL and other sources' investment prospectuses that have been identified based on agreed selection criteria for all energy projects.
B.2 - Streamline the process of implementation of sustainable energy projects	Develop a technical assistance and capacity building programme, reinforced by political dialogue through energy diplomacy engaging with African governments to support public authorities (governmental entities, utility companies, rural electrification agencies and energy ministries, and regulatory authorities) in standardising: i) tendering, procurement and licensing processes, including environmental and social impact assessment procedures; and ii) transaction documents (such as land and water permits, land rights documents, PPAs, and Environmental and Social Impact Assessments). Avoid retroactively and unilaterally changing the rules of procurement and compensation for IPPs, as such actions risk destroying market and investor confidence.
B.3 - Design de-risking measures in the process of project preparation	Recommendations C (Financing and fiscal systems), F (Off-grid and mini-grids), and H (Generation) describe these de-risking measures in more detail.
B.4 - Streamline Africa-Europe support activities and harness synergies for effective implementation procedures	Appoint a task force to review current instruments and processes, to i) reduce potential overlaps or duplications of instruments applied; ii) standardise diverse procedures; iii) unify potentially fragmented programmes under an operational one-stop-shop, iv) fine-tune coordination of existing tools; v) reinforce simultaneous support from three channels: finance, technical assistance/capacity building, policy dialogue; and vi) ensure effective follow-up, inter alia by adopting monitoring standards to increase the effectiveness of current and future actions within the purview of the SEI Platform.

[160] See the African Development Bank's Electricity Regulatory Index (ERI), https://www.afdb.org/en/news-and-events/african-development-bank-launches-first-electricity-regulatory-index-for-africa-18250 (accessed in October 2019)

C. Adapt financing and fiscal systems to meet potential investors' and projects' needs, for maximising benefits to African partners	
Objective	Enhance the economic viability of energy projects and their attractiveness to potential investors, along the entire project chain with the aim of maximising benefits for African partners. Risk mitigation is critical in this respect.
	Action
C.1 - Enhance cooperation among DFIs and between DFIs and commercial lenders	Encourage DFIs to attract local commercial lenders by co-investing, sharing risk and leveraging DFIs' ability to provide longer tenors and lower interest rates.
	Encourage IFIs to support the implementation of wider risk mitigation strategies, including packages of de-risking tools (e.g. political risk insurance, off-taker guarantees and currency risk hedging mechanisms, in addition to advisory services and technical assistance). These strategies should be designed in collaboration with the private sector.
	Support the scale-up and replication of funding structures with a track-record of delivery, and develop new funding structures to address market gaps not covered with existing instruments.
	Set up a standardised monitoring and evaluation framework to evaluate the effectiveness of existing financing and de-risking tools through an enhanced multi-stakeholder dialogue. Improve coordination among IFIs on existing instruments. Promote a multi-stakeholder dialogue for sharing best practices for addressing key bottlenecks to private investments in the sector of sustainable energy (e.g. capitalising on platforms such as the Africa Energy Market Place).
C.2 - Design de-risking packages for tendered projects	Provide technical assistance for appropriately solicited project preparation prior to tender launch.
	Support multi-project tenders, for example using services offered by existing instruments (e.g. Get.Invest, GMG Helpdesk) to reinforce early stage support/handholding for project developers. These instruments help de-risk financing in renewable investments and create a market friendly to renewable investments.
	Provide capacity building/training to local commercial banks to conduct due diligence and risk assessment on clean sustainable energy projects.
	Encourage local commercial banks by providing incentives for lending to women entrepreneurs (through special lending programmes).
C.3 - Empower local banks and local institutional investors to invest in the sustainable energy transition	Encourage DFIs to attract local commercial lenders by co-investing and sharing risk of sustainable energy projects.
	Provide credit lines, including supportive funding and de-risking instruments, to local banks to lend to clean sustainable energy projects or of SMEs, to support the growth of local SMEs in the energy sector, in particular for women entrepreneurs.
	Encourage local institutional investors and pension funds to shift their portfolios in support of clean sustainable energy projects.

See chapters 1 to 4 for recommendations specific to each segment of the power sector segment, clean cooking and energy efficiency.

D. Launch a comprehensive capacity building programme	
Objective	Invest in human resources, particularly technicians, engineers, sector managers, and regulation professionals, to support the sustainability of the sector. Capacity building is urgently needed across the sustainable energy sector, for electricity, heating, and clean cooking.
	Action
D.1 - Create knowledge sharing platforms and capacity building programmes	Launch an ambitious capacity building programme spanning a portfolio of topics and professional levels, and for all energy sector stakeholders building on previous successful experiences and existing centres of excellence in Africa (e.g. African Network of Centres of Excellence in Electricity, ANCEE) and Europe for Africa (e.g. Florence School of Regulation at the European University Institute).
	Foster cooperation between European regional institutions and counterparts in Africa (such as through twinning) for exchange of knowledge and capacity building on energy access and clean cooking, energy management, sustainable energy and energy efficiency.
D.2 - Promote Africa-Europe joint innovation, research and development	Support and strengthen initiatives, like Pre-LEAP-RE, that support long-term collaborative AU/EU joint research and innovation activities in renewable energy and energy efficiency.
	Support the creation of and provision of technical assistance to digital and energy start-ups to facilitate the entry of innovative technologies on the African market. *This can be achieved through partnerships with EU start-ups.*
D.3 - Promote B2B partnerships and networking between companies, industries and associations across sectors	Organise forums to convene international and local stakeholders in the energy sector, including public and private sector, technology suppliers, and civil society organisations to enable synergies and fast-track off-grid and on-grid projects on the ground.
	Organise and/or facilitate B2B partnerships, matchmaking and networking through African energy associations and African countries' EU Delegates, which can serve as information desks on specific or targeted business opportunities (e.g. under EU supported investment programmes).

E. Invest in the distribution segment	
Objective	Transform the presently dysfunctional power distribution segment into a viable business model that can attract the investment it needs, to ensure reliable, affordable, and sustainable electricity access for consumers.
	Action
E.1 - Develop national integrated GIS-based electrification plans	Provide technical assistance to the Ministry of Energy, incumbent utilities or rural electrification agencies to develop new and/or review existing electrification plans and investment criteria, alongside beneficiaries, project developers, industry and investors. Learn from those countries that have already developed and are implementing National Electrification Programmes.
	Provide technical assistance to outline investment programmes or prospectuses consistent with electrification plan.
	Strengthen and capacitate national rural electrification agencies through training, network building and knowledge/experience exchange.
E.2 - Promote the adoption of the integrated distribution framework (IDF) adapted to countries' specific conditions	Convene a high-level multi-stakeholder dialogue to promote the IDF for grid and off-grid electrification.
	Provide technical assistance to perform in-depth analysis of the potential application of the IDF to a small group of countries based on a transparent call for proposals, and subsequent implementation.
	Provide technical assistance to support integrating electricity supply through a range of electricity services, emphasising productive uses and promoting women's participation.
E.3 - Review / develop / improve regulations for the specific activity	Provide technical assistance to design performance-based incentives for distribution operators to improve reliability and customer commercial service, augment connections, roll out advanced metering systems, and reduce technical and commercial losses.
E.4 - Create loss-reduction programmes	Support utilities to elaborate a network losses reduction programme to reduce network losses with a well-defined action plan and investment strategy.

** See chapter 3 of the complete report for a more detailed description of the integrated distribution framework.*

F. Expand mini-grids and standalone systems	
Objective	Expand off-grid sector with appropriate regulations and subsidies. Mini-grids and standalone systems form part of the distribution segment, and prior recommendations for distribution also apply to off-grid solutions. Off-grid solutions are being deployed with novel business models and largely without being subject to conventional regulation. Standards and regulations for off-grid solutions must protect consumers and developers, establish conditions for the interaction among the different electrification modes and create a level playing field for all of them.
	Action
F.1 - Support the deployment of mini-grids and standalone systems through sensible administrative procedures, regulations, subsidies, and risk-mitigation	Launch a technical assistance programme to simplify and standardise the administrative processes to identify, fund and implement mini-grid projects, eliminating the current fragmentation and gaps in funding cycles.
	Create portfolios of projects to attract and facilitate financing (including for standalone systems, where applies).
	Explore support for a standardised, multinational (even pan-African) subsidy programme to facilitate mini-grid deployment at scale. In principle, this could be based on RBF.
	Support initiatives to develop electricity demand, such as through productive uses, alongside new supply systems. Including women's work and employment opportunities is essential in this sphere.
F.2 - Develop standards and inspection procedures for mini-grid and standalone system components	Provide technical assistance to design and/or review the regulatory framework for mini-grids performance standards, making use of existing quality assurance frameworks.[161]
F.3 - Support consumer finance for rural electrification using standalone systems	Cooperate with microfinance institutions in funding, de-risking, and technical assistance, notably to design new lines of credit or dedicated funds and/or scale up existing initiatives to facilitate access to finance by rural households.
F.4 - Adopt the Integrated Distribution Framework as a medium and long-term guide to develop the distribution segment for inclusive and sustainable electricity access	*See recommendations and actions in E (Distribution segment). Mini-grids and standalone systems must play a key role in the deployment of the IDF, adapted to the situation of each country.*

G. Invest in generation, with a focus on renewables	
Objective	Close the deficit in generation to supply the large, still unelectrified population, and to underpin sustainable industrialisation. Africa needs to harness a broad mix of low-carbon technologies in its transition to decarbonise the energy system, to deliver least-cost affordable energy and protect economies from vulnerability, including for coping with the variability of solar and wind.
	Action
G.1 - Define actionable guidelines and tools to facilitate Africa's transition to decarbonise the power sector	Enhance dialogues at high institutional level (e.g. in the context of PIDA) to define guidelines and instruments for sustainable generation investments.
	Explore instruments that support African countries to expand the use of renewables for addressing baseload requirements, such as by offering technical assistance to national power system planning and optimisation for increasing the share of variable renewable energy in the power system and deploying energy storage solutions.

[161] See https://www.nrel.gov/docs/fy17osti/67374.pdf

G.2 - Support approaches for reducing risks in generation investments, especially for renewable projects, including by improving the creditworthiness of off-takers	Provide technical assistance to assess the market potential for introducing creditworthy intermediaries in specific countries/regions, based on defined criteria and in different electricity market configurations; design and/or adapt the regulatory framework to allow the introduction of intermediaries; consider combining the following measures: increase the liquidity of national markets or power pools; strengthen the guarantees associated to the supply contracts; allow the introduction of creditworthy intermediaries to diversify risk.
	Transform the presently dysfunctional distribution segment into a viable business model to make a creditworthy off-taker (see the proposed IDF in section E (distribution)).
	Reduce T&D losses (technical and commercial), through i) technical assistance support for an enhanced regulatory framework, e.g. linking electricity tariffs with performance on energy efficiency;[162]ii) designing smarter distribution grids with effective monitoring, advanced metering, fault rectification, and supply improvement; and iii) capacity building for utility companies or distribution entities in using smart meters to improve collection rates.
G.3 - Design de-risking packages for tendered generation projects	Plan generation projects in harmony with necessary development and expansion of T&D networks. Procurement procedures and technical specifications should align with country regulations where they will be deployed, as well as the power pool rules if the project has an impact at regional level
	Create regulations to facilitate extending connection lines between new generation plants and appropriate substations, with the aim of accelerating the deployment of renewable energy into the grid. The grid code must clearly define the conditions and process for connecting third parties to the existing grid.

*See recommendations **C** (Financing and fiscal systems) for general purpose recommendations on de-risking packages.*

H. Advance regional integration of national power sectors and strengthen transmission	
Objective	Integrate regional power systems and build up transmission investments to support the continent's growth agenda, in line with the AfCFTA initiative. Despite its many potential benefits, regional integration is hampered by the absence of strong regional institutions and frequently inadequate enabling regulations. In addition, existing power pools lack sufficient executive powers. The transmission segment, a backbone of regional integration, continues to face a critical investment gap: a major bottleneck for further system integration.
	Action
H.1 - Strengthen regional institutions: regulator and system operator	Prepare a draft protocol agreement with options to strengthen the functions of the regional and system operators of power pools. Discuss successful international experiences in the context of a high-level AU conference, including African energy ministries, regional institutions and relevant EU organisations.
	Support initiatives like the Africa Clean Energy Corridor (ACEC) that supports indigenous and cost-effective renewable power options, selecting suitable deployment areas where adequate transmission capacity could be efficiently provided, and meaningful trade could happen.
H.2 - Adapt and adopt international best practices in market rules	Launch a technical assistance programme to share best international practices in power pool regulation, including efficient economic dispatch in the presence of bilateral contracts, open cross-border access, open and transparent membership, and transmission cost allocation. The experience gained in the implementation of the EU Internal Electricity Market will be valuable. Include specific capacity building activities at political, executive, and technical levels.
H.3 - Support comprehensive planning with regional scope to inform transmission investments	Provide technical assistance for transmission regulation and planning questions, in particular those with high potential for meaningful cross-border trade, such as cost-benefit analysis of transmission network infrastructure, transmission cost allocation, and congestion management approaches.

[162] For example, by refusing a tariff increase to the distribution utility if losses are not reduced by a certain degree.

I. Improve energy efficiency	
Objective	Strengthen the ability of African countries to implement energy efficiency (EE) policies and investments to bolster economic growth and industrialisation decoupled from growing energy use.
	Action
I.1 - Formulate, review and strengthen EE regulations	Provide technical assistance to support regulatory authorities and/or energy ministries to review existing EE regulations, and to propose new/improved regulations.
I.2 - Identify and assess EE savings potential across selected African countries	Provide technical assistance to energy ministries or dedicated institutions to design and launch studies analysing energy savings potential, including in cogeneration, industrial, buildings, electricity, and transport sectors.
I.3 - Design regional and national EE action plans and programmes	Support regional organisations and national public sector authorities to design EE action plans and programmes in buildings, industrial, and transport sectors.
J.4 - Improve the institutional framework for EE	Begin dialogue among EU and African energy ministries and/or regulatory authorities to set up or strengthen dedicated EE and energy conservation institutions, as implementing agencies for EE policies, programmes and action plans.
	Provide technical assistance to set up the legal and regulatory framework for EE institutions and train staff.
I.5 - Provide capacity building to public institutions to implement EE policies, programmes and action plans, and to support EE investments, respectively	Design and/or build on existing capacity building programmes to support regulators with design, implementation and monitoring of EE measures.
	Provide support to enhance technical expertise of institutions and local private sector companies for installation, maintenance and control of EE products and services.
	Provide Technical Assistance and capacity building to utility companies to design and implement maintenance programmes for improved EE in power systems.
	Provide technical assistance to establish Super ESCOs for government facilities and to assist in putting in place all required components for operation, financing, capacity buildings and private ESCO market development.
	Provide technical assistance to develop and replicate an on-bill financing scheme, notably for the residential sector.
I.6 - Create information sharing platforms and awareness raising campaigns to promote the benefits of EE	Provide technical assistance to design communication strategies across all sectors and involving key stakeholders (policy makers, businesses, finance, consumers) to highlight the importance and potential and benefits of EE products and services, notably in terms of cost, environment, health, and job creation.

J. Encourage market development, consumer demand, and investments in the clean cooking sector	
Objective	Shape a policy, regulatory and business climate with supportive social drivers that can expand access to clean cooking solutions across the continent.
	Action
J.1 - Prioritise access to integrated clean cooking solutions in national development plans and policy documents	Launch an integrated multi-year clean cooking technical assistance and awareness programme supporting a coordinated approach to regulations, social drivers, finance, manufacturing and distribution of cookstoves and efficient appliances, and addressing firewood and charcoal, biofuels, gas and electricity (for electric cooking) value chains. This could be led by multi-sectorial taskforces (such as energy, health, gender, finance).
	EU and AU leaders to jointly call on governments to prioritise access to clean cooking solutions in national development plans and climate action programmes.
J.2 - Create regulatory and policy environment to support market development and rapid technology deployment for clean cooking solutions	Enhance political and technical cooperation between the health and energy sectors through a multi-stakeholder platform of action (governments, civil society, UN, private sector), such as the new Health and Energy Platform of Action (HEPA) launched at the 2019 UN Climate Summit.
	Support African countries to adopt policies and laws to support and incentivise investments in the clean cooking solutions value-chain, treating the clean cooking sector as an integral part of the wider energy system.
	Provide capacity building and business advisory support to key value chain actors to scale-up production and build out fuel, stove and appliance distribution.
J.3 - Support research and data collection at country level	Support analysis and data collection to identify proven policies, and regulatory and business models that encourage market development, paying attention to safety practices, consumer acceptance, health, gender and economic viability.
	Support research to adopt a synergistic approach to electricity and clean cooking access, to analyse co-benefits in planning, cost of energy, electricity delivery business models, and the role of utilities.
J.4 - Support innovative financing to attract public and private investment into clean cooking solutions	Introduce results-based financing to use public resources to incentivise market development in a set of pilot countries.
	Facilitate up-front financing needed by clean cooking supply-side entrepreneurs, especially for women entrepreneurs.
	Facilitate financing to establish and stimulate the demand side affordability challenges, including by expanding pay-as-you-go models.
	Leverage funding from multilateral development banks (MDB) and institutions to attract private sector investments in the clean cooking sector including through supporting dedicated fund structures, such as Spark+.
	Provide targeted subsidies linked to health and climate impacts, particularly for poor communities and low-population-density areas.
J.5 – Create consumer demand for clean cooking	Fund national social campaigns to raise awareness on clean cooking and gender norms, and facilitate behavioural change interventions to support uptake of clean cooking technologies through working with relevant line ministries.

ANNEX A. Key principles for reliable, affordable and sustainable distribution of electricity

Universal energy access cannot be achieved without an in-depth rethinking of electrification policy at distribution level. Finding viable business models for rural distribution in low-access African countries presents a major challenge from a political, social, and regulatory perspective for decision makers. Responding to this challenge requires meeting four key principles:

- *Inclusiveness (leaving nobody behind).* Inclusive electrification within a designated region requires there to be a responsible distribution entity that assumes real – not just formal – responsibility for serving all customers, irrespective of their level of demand under basic quality conditions. Power sector regulation in most countries requires the incumbent distribution utilities to provide universal service but, given the existing difficulties, this legal requirement is not enforced. By contrast, inclusiveness is at the core of the integrated distribution framework (IDF). For instance, it can be included as a hard condition in a territorial concession contract.
- *Mixed electrification modes*. Distribution should take advantage of all possible delivery modes in order to fulfil their universal electrification objective and selectively consider grid extension, mini-grids and solar home systems (SHS). Geospatial planning tools have shown great promise in providing decision-makers with cost-efficient electrification strategies exploiting all three modes of electrification.
- *Permanence (continuity in time).Distribution* policy should be planned for the long term, based on financially and socially sustainable business models that can last for decades. This indispensable component of sustainability requires a long-term vision and commitment as well as strong, continuous political support.
- *Flexible partnerships*. Distribution companies should be open to developing partnerships with public or private structures capable of providing adequate technical, managerial and financial support. External support will be decisive to achieve both universal energy access and a high quality of service for all.

The IDF is designed to enable meeting these four requirements and attracting private capital into viable distribution activities. Different versions ofIDF can be implemented depending on the particular conditions of each country. The IDF has the following key features:

- For any geographical area there must be an entity with the explicit obligation of providing universal electricity supply, through any electrification mode, and with the aim and ability to ensure continuity. The entity that holds these responsibilities must play a central role in the future power sector, and holds an important place in its structure. This entity does not necessarily have to supply all customers, but it would have the default obligation of supply, with some required minimum level of performance.
- The necessary managerial, financial, and operational changes in the incumbent distributor will be achieved through some form of partnership with an external entity. In most cases the partnership would adopt the format of a concession with a private sector entity, with some financial guarantee support from a DFI, and the explicit agreement of government and regulatory authorities to create the appropriate legal and regulatory conditions. Local companies, mini-grid developers, and standalone system vendors could also be involved. Other options are possible under the IDF umbrella. Each country will need a tailor-made design.
- The remuneration scheme should recognise the differences between the traditional distribution company's *physical network assets and operation* activities (strict distribution network activity or "carriage") and its consumer interaction activities (the retail activity or "content").
- Consumer engagement is a critical component of the IDF, which will change public perception and customer mindsets regarding the electricity supplier. A satisfactory quality of service is a necessary condition for any attempt to introduce cost-reflective tariffs and to address unpaid bills and illegal connections.
- Rural distribution will depend on some form of subsidy. The economic viability of rural distribution in developing countries is unachievable, and has never been achieved in any developed or developing country, without any form of subsidy. There are multiple strategies for reducing the required subsidies:
  - Planning for least-cost electrification modes;
  - Improving consumer satisfaction and increasing prepaid metering to reduce illegal connections and unpaid bills

- Cross-subsidising tariffs of lower-income households by other loads that can absorb some price increases, such as high-consumption residential, commercial, and industrial customers
- Bringing back to the grid those C&I customers that defected because of poor reliability or excessive cross-subsidisation
- Standardising supply equipment and demand appliances with an emphasis on efficiency
- Creating activities around electricity access to stimulate additional residential demand, plus productive uses and community activities that need electricity, which would increase useful demand and prosperity, and reduce per-unit supply cost.

ANNEX B. Capacity building resources and programmes

The following presents an inventory of the educational institutions and EU-Africa collaborative agreements on capacity building programmes in the energy sector, and potential initiatives at academic, corporate and institutional levels.

The Florence School of Regulation (FSR) brings over 15 years of experience in training on energy sector regulation for professionals of regulatory commissions and energy companies. It currently runs several presential, on-line and hybrid courses, ranging in duration from 9 months to a few days, as well as workshops and other short-term high impact events. The FSR's online learning platform can be adapted for almost any kind of educational material and course format. The FSR has an experienced team of instructors and strong connections with other institutions around the globe. The FSR, in collaboration with the **Enel Foundation**, is organising and financing a 5-month capacity building hybrid course for executives of the African power sector, starting in the first semester of 2020. Among their flagship courses, the FSR proposes: Fundamentals of the power sector (Regulation for SDG7; Regulation of the power sector); Fundamentals of the gas sector; Regulatory delivery; Highlights of the energy sector in Africa for senior energy professionals.

The MEDREC[163] **association** has experience with Capacity Building and attempts to expand associated activities in SSA countries.

The ENEL Foundation has a programme called Open Africa addressed to young professionals in the energy sector, in collaboration with the FSR.

The South African Renewable Energy Technology Centre (SARETEC)[164] trains solar technicians, mostly women. SARETEC's programme is embedded in universities and can be involved with other universities across Africa.

The École des Mines, France, and **the Energy Training Foundation**[165] in South Africa have been teaching courses in economics and regulation in francophone African countries.

Politecnico di Milano (PoliMI) is conducting several educational and leadership training activities for energy sector professionals and students, including: 1) An Energy and Development track, with a focus on energy system in Africa, in the Master of Science in Energy Engineering, since 2011, 2) The Emerging African Innovation Leaders programme (alongside PoliTO), has developed a set of online MOOCs, are available alongside others on PoliMI's Open Knowledge platform. 3) EU-AU joint Ph.D. programme to promote native research and coordination within the Horizon2020 Long Term EU-AU Partnership on renewable energy, 4) Specific training on energy planning, impact evaluation for energy projects and energy scenarios have been delivered in a number of African countries.

The Energy Charter Secretariat develops a Technical Assistance programme for ministry officials to conduct 3-month trainings about the Energy Charter Treaty. The Treaty involves 54 signatories and offers predictable and transparent investment framework for the energy sector, leading all signatory countries to share a minimum level of policy principles.

Various donor institutions offer technical assistance, such as **Get.Invest Finance Catalyst, GIZ** to specific programmes such as NESP in Nigeria, ARE with AfDB on rural electrification, among others.

The EU, through the Technical Assistance Facility of the SEforAll initiative has also provided technical assistance to government institutions (Ministries, utilities, etc.) on policy, legal, regulatory aspects. Complementary or additional capacity building programmes are needed based on existing and recently accomplished donor-led initiatives. **The AEEP** has also indicated it has the mandate and ability to provide/support capacity building programmes.

The University of Cape Town has been running a training course on power sector regulation for professionals of African utilities and institutions for several years.[166]

In West Africa, **the ECOWAS Commission through ECREEE, WAPP and ERERA**, launched the **West Africa Clean Energy Corridor** (WACEC), which aims to promote RE generation but also support cross-border trading of RE power. It has a strong capacity building component. Currently this component focuses on building the technical

[163] http://www.medrec.org/En/Staff_11_70
[164] https://www.saretec.org.za/
[165] https://energytrainingfoundation.co.za/

capacities of utilities, regulators and Ministries of issues related to grid integration of variable renewable energy, PPA design, resource assessment, national and regional generation and transmission planning.[167] Similar efforts are also being conducted in the **EAPP** and **SAPP** regions under the **Africa Clean Energy Corridor** (ACEC). Both Corridors have received political endorsement at the highest level, notably by the **African Union**.[168] These capacity-building efforts need to be deepened with the support of other partners, to cover more areas and to go on for longer. At the moment, the implementation of the Clean Energy Corridors is done in partnership with other development partners including **IRENA** and **GIZ**, including the regional utility centres of excellence as a way to ensure long-term sustainability.

RES4Africa leads capacity building trainings and executive seminars in African countries that include theoretical and hands-on courses on technical, economic, policy, and business-related aspects of large-scale and decentralised renewable technologies. Through its capacity building activities, RES4Africa Foundation offers participants a multi-disciplinary knowledge across the renewables value chain (investors, EPCs, engineering service, consultancies, academia, etc.) which also includes comprehensive insights on how to foster RE investments in Africa. RES4Africa capacity building activities include: 1) The Advanced Training Course on technical, regulatory and financial RE topics 2) The Micro Grid Academy (MGA), a new capacity building platform located in the KPLC Institute of Energy Studies & Research.

Fondazione Eni Enrico Mattei (FEEM) has various research and training programmes devoted to sustainable and affordable energy for all, especially in developing countries. Promoting awareness and supporting local policies is part of its mission. FEEM carries out training sessions, hands-on workshops, theoretical and practical lectures in sub-Saharan African countries (such as in Kenya and Ghana) with the aim of promoting growth, ownership and empowerment in the energy sector. Eni has promoted the Eni Award since 2008 to encourage scientific research within the international scientific community, promoting research and technological innovation in the fields of energy and environment. Young Talents from Africa Prize is intended to support the research of four young African researchers, offering them the opportunity to attend a PhD course in an Italian university.

The Pan African University Institute for Water and Energy Sciences (PAUWES)[169], is one of the five hubs of the Pan African University (PAU), hosted at the University of Tlemcen in Algeria. PAUWES, as academic and scientific arm of the African Union, holds a unique position in understanding the Pan-African dimension of scientific problems, and it gathers excellent know-how to tackle the challenges faced in different African countries with regards to water, energy and climate change. Consequently, PAUWES is developing strategies for tapping into the advantage of its Pan-African perspective without losing focus of specific national and regional problems. PAUWES' mandate includes among others the replication and dissemination of best practices on the continent while developing strategic networks on the continent and beyond. PAUWES educational and research programmes in energy include: Two masters' programmes in energy (engineering and policy tracks) that cover different aspects of the energy access value chain with a focus on renewable and clean energy technologies and an online postgraduate programme on Minigrid, Digitalisation and Entrepreneurship (MDE), delivered in partnership with the Global e-Schools and Community Initiative (GESCI).[170]

The PAUWES Mini-grid Digitalisation Entrepreneurship Learning Alliance (PAUWES – MIDELA) is a further component of the programme built on the open content model of the courses and curriculum and provide a framework allowing universities and training institutes joining the alliance to have free access to courses and modules of the programme, and adopt the entire curriculum or individual modules in their respective curricula or replicate the programme in their respective institutions.

SolarPower Europe's Emerging Markets Task Force focuses on developing structured partnerships with local associations in Africa (such as newly-funded AMER in Mozambique) to promote the strengthening of strong local industry platforms and support capacity and skills on association management, policy and regulation, and advocacy.[171]

[166] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=15&cad=rja&uact=8&ved=2ahUKEwjA0Iroh5fkAhVcVBUIHRk5DVgQFjAOegQIARAB&url=https://www.gsb.uct.ac.za/power-reform-regulation&usg=AOvVaw23eTH9fG2YUO3Md93kl3OU

[167] http://www.ecreee.org/procurement/development-strategy-solar-energy-corridor-under-west-africa-clean-energy-corridor-wacec

[168] https://au.int/sites/default/files/newsevents/workingdocuments/33313-wd-africa_clean_energy_corridor_west_africa_clean_energy_corridor_e.pdf

[169] http://pauwes.dz

[170] https://gesci.org/

[171] See https://www.solarpowereurope.org/priorities/emerging-markets/

ANNEX C. The Africa-Europe High Level Platform for Sustainable Energy Investments in Africa

The SEI Platform brings together stakeholders from the public and private sectors, as well as from academia and think thanks, to provide recommendations on how to leverage public and private investments in sustainable energy in Africa for human development and sustainable growth

In the continuous quest to achieve the aspirations of its Agenda 2063, based on inclusive and sustainable growth, the African Union resolutely commits to engage its partners to address challenges of energy to "harnessing all African energy resources to ensure modern, efficient, reliable, cost effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions, through building the national and regional energy pools and grids".[172]

The SEI Platform simultaneously aligns with key objectives contained in Agenda 2063, the strategic, fifty-year vision produced by the African Union in 2013, called "The Africa we want".[173] Moreover, the recommendations from the "Cairo declaration" resulting from the AU-STC meeting in April 2019 are also taken into consideration.

Honouring this vision, the African Union Commission in its engagements with the SEI Platform underlined the following aspects as requiring particular attention:

- "One Africa" – working towards regional integration;
- Address challenges of implementation of the electricity markets (technological, economic, financial);
- Investigate new models of de-risking projects with financial partners;
- Work with a constant appreciation of how electricity contributes to economic and human development.

Three working groups with experts from the public and private sector and from both Africa and Europe, more than 50 people in total, were constituted to carry out the work of the SEI Platform and produce a report to be released at the Africa Investment Forum in Johannesburg in November 2019.[174] These working groups had the following respective mandates:

- Make assessments and recommendations regarding the impact of different business models for sustainable energy investments in job creation and inclusive sustainable growth, prioritising access to electrification in rural areas and clean cooking (WG1);
- Provide recommendations on policies, regulatory, market and business climate improvements, and reforms for removing barriers to scaling-up sustainable energy investments, to adopting technological advancements, and to supporting pan-African sustainable energy integration (WG2); and
- Strengthen business to business partnerships and networking in support of sustainable investment. aiming at boosting internal growth, intra-African trade and exports from African countries.

Additionally, each Working Group´s mandate included the investigation of two cross-cutting issues which affect each of the group's overarching topics:

i. Access to finance.
ii. Skills along the energy value chain.

The working groups gathered physically on four occasions, three in Europe and one in Africa. These meetings allowed in-depth, facilitated discussion within the working groups and jointly in plenary meetings. A series of electronic meetings linked the physical meetings.

The Platform worked under the leadership of Dr Kandeh Yumkella, custodian of the process, as assisted by DG DEVCO and DG ENER officials from the European Commission. The Africa-EU Energy Partnership (AEEP) lent support on liaison, planning, drafting and management of the Working Groups. A secondary group of experts provided peer review.

[172] https://au.int/sites/default/files/documents/33126-doc-04_the_key_agenda_2063_flagship.pdf

[173] See https://au.int/agenda2063/sdgs

[174] A list of all experts appears in Annex D

ANNEX D. Members and participants to the SEI Platform meetings

The members of the working groups of the platform were:

African Development Bank (AfDB), Africa Europe Energy Partnership Secretariat (AEEP), Africa GreenCo, African Union Commission, Alliance for Rural Electrification, Bakulu Power, Conseil de Coopération Economique, ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), EDP Renewables, ENEL SpA, ENI SpA. Entsol Tz Ltd, Energy Charter Secretariat, European Bank for Reconstruction and Development (EBRD), European Commission (EC), European Investment Bank (EIB), Eurochambers, Florence School of Regulation, Fondazione Eni Enrico Mattei, French Environment and Energy Management Agency (ADEME), Giraffe BioEnergy, Global Off-Grid Lightning Association (GOGLA), Global Solar Private Limited, GIZ/ Get Invest, GVE Projects, Iberdrola Renewables, International Energy Agency (IEA), International Renewable Energy Agency (IRENA), Kreditanstalt für Wiederaufbau (KfW), Mediterranean Association of National Agencies for Energy Management (MEDENER), Moroccan Agency for Sustainable Energy (MASEN), Pan African University PAUWES, Pan African Chamber of Commerce and Industry (PACCI), Politecnico Milano, Regional Centre for Renewable Energy and Energy Efficiency (RCREEE), Res4Africa Foundation, Renewable Energy and Energy Efficiency Partnership (REEEP), Siemens Gamesa, Solar Power Europe, Women's Entrepreneurship in Renewables (wPower Hub)

With the participation of:

African Association for Rural Electrification (Club-ER), Africa Finance Corporation (AFC), African Forum for Utility Regulators, Akuo Energy, Africa Renewable Energy Initiative (AREI) IDU, BASF New Business GmbH, Clean Cooking Alliance, ENTSO-E, Energy Commission of Nigeria (ECN), Hivos, International Solar Alliance, International Initiative for Sustainable Development (IISD) – GSI, Konexa, Ministry of Petroleum and Energy of Senegal (MPE), Ministry of Energy of The Gambia, Modern Energy Cooking Services (MECS), National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Nigerian Electricity Regulatory Commission (NERC), Tony Blair Institute (TBI), Universitad Politecnica de Madrid, World Bank, World Health organisation (WHO)