African Development Bank
Power, Energy, Climate and Green Growth Complex

CHALLENGES AND OPPORTUNITIES FOR A NET-ZERO FUTURE IN AFRICA

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Responsible and Sustainable Natural Gas: Challenges and Opportunities in Africa (virtual workshop)
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Human activity has warmed the climate at a rate that is unprecedented in thousands of years, leading to widespread, intensifying and rapid changes in the world’s weather patterns.

- **CO₂ CONCENTRATION**
  - Highest in at least 2,000,000 years

- **SEA LEVEL RISE**
  - Fastest rates in at least 3,000 years

- **ARCTIC SEA ICE**
  - Lowest level in at least 1,000 years

- **GLACIERS RETREAT**
  - Unprecedented in at least 2,000 years

- **EXTREME HEAT**
  - More frequent
  - More intense

- **HEAVY RAINFALL**
  - More frequent
  - More intense

- **DROUGHT**
  - Increase in frequency in some regions

- **FIRE WEATHER**
  - More frequent
  - More intense

- **OCEAN**
  - Warming, acidifying and losing oxygen

Source: Intergovernmental Panel on Climate Change Report, 2021
African countries need to prepare for significant shifts in their ecosystems and biodiversity, which will negatively impact the economic sectors and livelihoods that depend on them.

Source: Intergovernmental Panel on Climate Change Report, 2021

Mediterranean (MED)
- **Observed** increases in aridity and droughts
- **Projected** decrease in rain
- **Projected** increases in fire weather

Sahara, including parts of the Sahel (SAH)
- **Projected** increases in heavy precipitation and flooding

West Africa (WAF)
- **Observed** increases in river flooding and agricultural droughts
- **Projected** increases in droughts in seasonal timescales and pluvial flooding

Central Africa (CAF)
- **Observed** decreases in precipitations
- **Observed** increase in agricultural and ecological droughts
- **Projected** increases in pluvial and river flooding

West Southern Africa (WSAF)
- **Observed** increase in heavy precipitation and pluvial flooding
- **Observed** and **projected** increases in aridity, agricultural and ecological droughts
- **Projected** increases in dryness, mean wind speed and fire weather conditions

North Eastern Africa (NEAF)
- **Observed** decreases in precipitation
- **Observed** and **projected** decreases in snow and glaciers
- **Projected** increases in heavy precipitation and pluvial flooding

South Eastern Africa (SEAF)
- **Observed** and **projected** decreases in snow and glaciers
- **Projected** increases in frequency and/or intensity of heavy precipitation and pluvial flooding
- **Projected** increase of average tropical cyclone and associated heavy precipitation of the proportion of category 4-5 cyclones

Madagascar (MDG)
- **Observed** increases in aridity
- **Projected** increases droughts, pluvial flooding and average tropical cyclone

East Southern Africa (ESAF)
- **Observed** decreases in mean precipitation
- **Observed** increase in meteorological drought
- **Observed** and **projected** increases in heavy precipitation and pluvial flooding; aridity, agricultural and ecological droughts
- **Projected** increases in fire weather conditions; tropical cyclone and associated heavy precipitation of the proportion of category 4-5 cyclones
At the same time, Africa’s energy needs are urgent and growing, with structural transformations projected to drive energy consumption over the next decades.

- People will live in Africa in 2040, up from 1.3bn in 2020 (2.1B)
- 59% of the population will live in urban areas by 2050
- 43% increase in investment in manufacturing by 2030
- 2.3% growth in household consumption by 2030
- 100% increase in electricity demand by 2040

858TWh of electricity generated by all 54 African countries in 2019, i.e., 5x less than what the US generated that year.

Africa’s energy production must grow by 150% to reach universal access by 2030.

Sources: Tracking SDG7 database; International Energy Agency database; UN World Population Prospects 2020; Medium Variant Scenario; US Energy Information Administration; AfDB analysis.
Africa’s emission profile is different to the rest of the world: it has marginally contributed to global GHG emissions and presents an energy sector that is not as polluting.

Africa accounts for only 3% of global emissions, with 81% of its emissions driven by 4 countries.

Breakdown of global GHG emissions per region (%)

The energy sector contributes to only 40% of Africa’s emissions, while natural gas contributes to 19% of Africa’s emissions.

Breakdown of GHG emissions per sector and fuel combustion (%)

Sources: Climate Analysis Indicators Tool database; AfricaScoping Study, ClimateWorks Foundation, 2020; Global Carbon Atlas Database, Climate Watch Database; AfDB analysis.
Although renewables will play an important role in Africa’s pathway to net-zero, African countries cannot rely solely on variable renewable energy to power their economies.

African countries can rely on abundant and cheaper RE sources of power, with a generation potential 100x higher than current levels.

<table>
<thead>
<tr>
<th>Region</th>
<th>Solar PV</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>109,033</td>
<td>130,316</td>
</tr>
<tr>
<td>Western</td>
<td>103,754</td>
<td>40,846</td>
</tr>
<tr>
<td>Central</td>
<td>61,153</td>
<td>12,395</td>
</tr>
<tr>
<td>Eastern</td>
<td>219,481</td>
<td>165,873</td>
</tr>
<tr>
<td>Southern</td>
<td>162,817</td>
<td>108,236</td>
</tr>
</tbody>
</table>

However, the degree to which solar and wind can be deployed is constrained by their inherent intermittency and integration cost.

LOAD BALANCING AND BATTERY STORAGE

Switching to renewables can cause load balancing challenges for a grid system that does not have a reliable baseload. In the case of the use of battery storage, even though their cost decreased by 87% between 2020 and 2019, their storage capacity is still limited. Furthermore, a flexible use of storage requires high-resolution forecasting capacity for both supply and demand that most utilities in Africa do not have.

LEVELIZED COST OF ELECTRICITY

System costs associated with managing Variable Renewable Energy are not included in LCOE and not paid for by the developers (mostly Independent Power Producers) of RE projects: in Kenya for example, the contribution of VRE to the national installed capacity rose from 0.3% in 2013 to 14.6% in 2019, with system costs requiring an additional USD 50 million per year.

Sources: IRENA Database; Decarbonizing Africa’s grid electricity generation, CDC, 2021; AfDB analysis
Gas technologies present promising options to accelerate Africa’s sustainable development agenda, offering ways to improve people’s lives and support the industrialization of the continent.

**INDUSTRIAL**
- Fuel for process heating in combined heat and power systems
- Raw material (feedstock) to produce chemicals, fertilizers and hydrogen

**LOGISTICS**
- Fuel to operate compressors that move natural gas through pipelines
- Vehicle fuel in the form of compressed natural gas and liquefied natural gas

**COMMERCIAL**
- Heat buildings and water
- Operate refrigeration and cooling equipment
- Clean cooking
- Outdoor lighting

**RESIDENTIAL**
- Heat buildings and water
- Clean cooking
- Power appliances such as air conditioners and heaters

Sources: AfDB analysis
Natural gas pairs very well with variable renewable energy and has historically facilitated the integration of renewable energy into the power system of developed markets.

Unabated natural gas: gas power stations that have not been fitted with carbon capture and storage technology to stop carbon emissions

- Meets energy demand growth
- Good substitute for higher-carbon fuels such as coal
- Supplies hydrogen feedstock

Abated natural gas: gas power stations that have been fitted with carbon capture and storage technology to stop carbon emissions

- Hydrogen and ammonia
- Renewable natural gas (biomethane)
- Synthetic natural gas

- Natural gas generators can ramp up quickly when variable renewable energy resources are not available
- Lower natural gas prices help make renewables more affordable for consumers: when natural gas is used as a “backstop” for renewables, the overall costs of electric power decrease
- Gas technologies for power generation have become more flexible and cost-efficient: CCGT ramp times have improved by 44% while capital costs have fallen by 25%
- Construction time is cut by half compared to geothermal and hydropower plants, with lower upfront capital investment and better profitability when not used (low fixed cost/high variable-cost)
- In the US, there is a correlation between the adoption of natural gas and renewables for electric generating capacity: for every 1% increase in natural gas capacity, renewable power generation increases by 0.88%

Sources: A Role for Fossil Fuels in Renewable Energy Diffusion, US National Bureau of Economic Research; A Sustainable Flame: The Role of Gas in Net-Zero, HIS Market; AfDB analysis
Natural gas has greatly contributed to the decarbonization of some of the most polluting power systems in the world and therefore represents a promising transition fuel for Africa.

CO₂ emissions from the combustion of natural gas are 40% to 57% lower than coal.

Coal-to-gas switching has avoided more than 500 million tons of CO₂ emissions between 2010 and 2018.

Recent discoveries in natural gas represent a turning point for Africa to support countries’ industrial growth whilst accompanying their energy transitions.

40% of global natural gas discoveries between 2011 and 2018 were found in 6 African countries.

Based on current known reserves, 9 countries hold the potential for around 16 GW of new gas-fired power generation by 2030.

In limited circumstances, Development Financial Institutions will support the development of natural gas as a transition fuel to facilitate the pathways of African countries towards net-zero emission targets.

### POSSIBLE ROLES FOR DFIs

- **Long-term planning**, e.g. economy-wide Long-Term Strategies and associated Least Cost Integrated Resource Plans
- **Program planning**, e.g. second phase of SADC’s Regional Gas Master Plan, potential expansions of the West African Gas Pipeline and the Mozambique-South Africa Gas Pipeline, etc.
- **Capacity building** for regulators and government officials to undertake required sector reforms and ensure affordable, cost-reflective and sustainable tariff/subsidies policies, while considering carbon pricing in planning
- **Project preparation and project investments**, e.g. production and liquefaction facilities, gas-to-power along with related transmission and distribution infrastructure, clean cooking, gas-based products such as petrochemicals and fertilizers, along with technical assistance to increase linkages between large projects and local economies and to minimize and avoid leakage and flaring of methane

### POTENTIAL GAS-BASED PROJECTS

- Gas-to-power plants, midstream (e.g. transportation, storage, gasification) and downstream (e.g. NG, LPG, CNG) where it is demonstrated that the underlying projects are aligned with the Paris Agreement by being consistent with their Nationally Determined Contributions and/or Long-Term Strategies
- Gas-based projects where it is demonstrable that they will lead to improved energy access, improved energy security, have positive economic impacts while promoting appropriate technologies/business models and maximizing local content

Sources: AfDB analysis
Thank you

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