NDC ASPECTS

Country Report

Transition pathways for Nigeria

August /2024

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NDC ASPECTS has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 101003866

Key messages

- Nigeria is a founding Party of the United Nations Framework Convention on Climate Change (1992) and has ratified the Paris Agreement since 2017. The country has submitted its Intended National Determined Contribution in 2015 and an updated version in 2021 retaining its original ambitious targets despite the initial overestimation of the baseline scenario.
- The electricity infrastructure of Nigeria is underdeveloped with frequent power outages and more than a third of the population does not have access to electricity and depends heavily on the use of traditional biomass.
- The decarbonization pathway of Nigeria relies on the uptake of renewable energy sources in the major emitting sectors of transportation and electricity supply.

Introduction and overview

Nigeria, officially the Federal Republic of Nigeria, is a west-African country with a diverse cultural and ethnic society distinguished by its large population growth. This developing country is characterized by significant inequalities. Around two-thirds of the total population are living below the poverty line and the country has one of the highest rates of energy poverty globally. Nigeria is extremely vulnerable to climate change due to its location and currently experiences a gradual increase of temperature and more frequent appearances of extreme weather events.

Key socio-economic figures and outlook

Nigeria is currently the most populous country in Africa and the 6th worldwide [1]. The population is expected to reach 350 million by 2050 and by the end of the century Nigeria is expected to become the second most populous country in the world after India surpassing China [2]. A developing country and one of the largest economies of Africa, Nigeria's economy has a strong agricultural sector (24% of the national GDP in 2022), a service sector which is gaining momentum (44% of national GDP) and an industrial sector which represents the 31% of the overall economy [3].

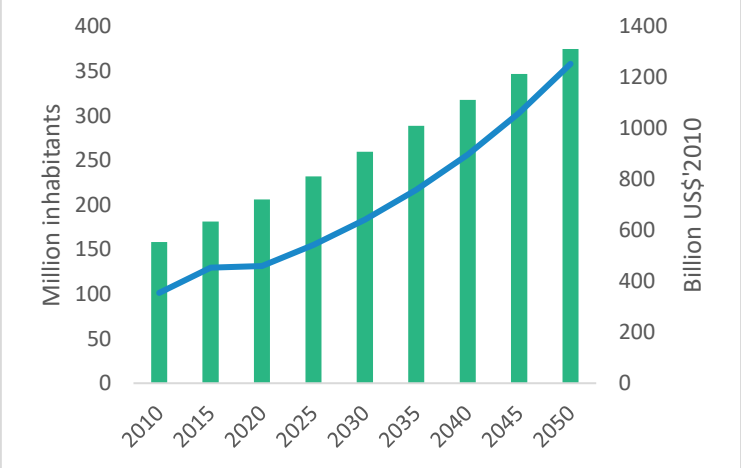

Figure 1: Nigeria's population and GDP development.

Favorable global conditions (e.g. no conflicts and limited trade restrictions) and macroeconomic and initial structural reforms enabled an extensive and consistent growth of the Nigerian economy in the period 2000-2014 with an annual average growth rate of 7%, well above the global average over the same period [4], However, In the following years, 2015-2022, various internal factors (monetary and exchange rate policy distortions, increased trade protectionism, etc.) and external shocks (COVID-19 pandemic) led to reduced growth rates. The

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economy is projected to steadily develop in the upcoming period mainly due to administration commitments to bold reforms to reestablish macroeconomics conditions for stability and growth. The GDP of Nigeria is expected to increase with an average annual growth rate of 3.4% over 2022-2050 and to reach 1.3 trillion US$'2010 by 2050. Nigeria has one of lowest GDP per capita, which is currently 2,230 US$'2010 and is projected to increase to 3,345 US$'2010 in 2050.

Current emission situation

Nigeria is the second biggest GHG emitter of Africa [5], following South Africa, with its GHG emissions standing at 359 $MtCO_2eq$ in 2015 and 410 $MtCO_2eq$ in 2022. Emissions are increasing with an average growth rate of 1.9% per annum and the contribution of sectors has remained relatively constant in the 2015-2022 period. The energy sector is the most carbon intensive sector due to its dependency on fossil fuels and energy related GHG emissions represent more than two thirds of total emissions. The agricultural sector contributes to 18% of emissions in 2022 followed by the waste and industrial sectors with 8% and 7% respectively.

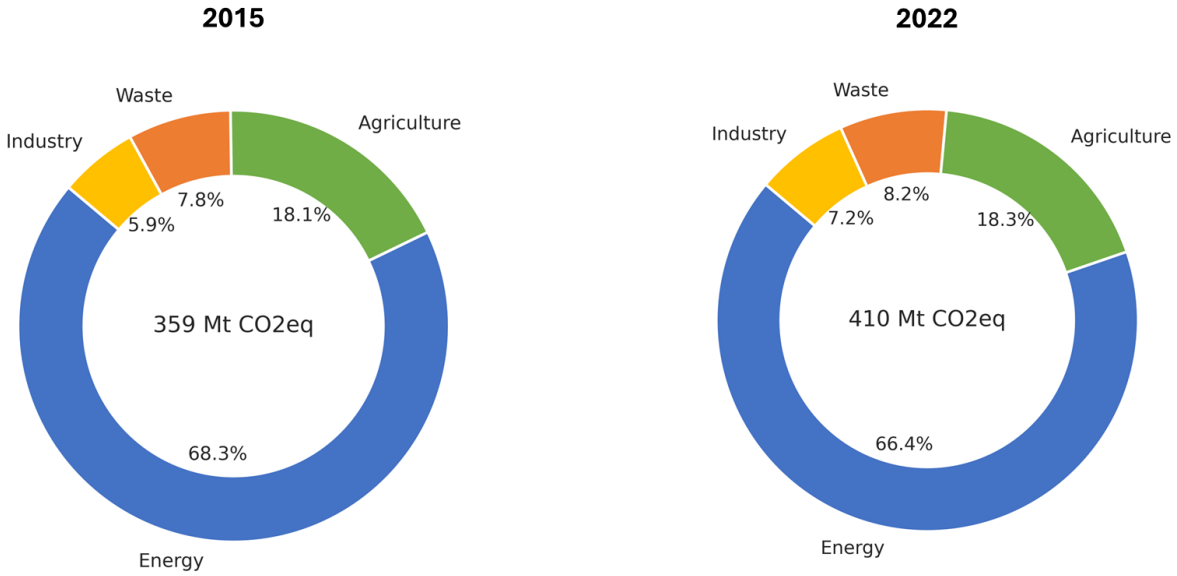

Figure 2: Nigerian GHG emissions by sector in 2015 and 2022 (source: PIK)

The level of CO_2 per capita in 2015 was 1.93 tCO_2eq and decreased marginally to 1.87 tCO_2eq in 2022. The GHG intensity of the Nigerian economy is estimated at 737.46 tCO_2eq/million $ GDP and increased to 893.88 tCO_2eq/million $ GDP in 2021 illustrating that the current way of economic growth is very carbon intensive and results to higher levels of GHG emissions.

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National targets (NDC) and programs/policies

Nigeria is a founding Party of the United Nations Framework Convention on Climate Change (UNFCCC) and one of the original signatories to the Convention when it was adopted at the Earth Summit in Rio de Janeiro in June 1992. The country's first version of Intended Nationally Determined Contribution (INDC) [6] was submitted in 2015 and an updated version [7] followed in 2021 along with the publication of the country's long-term strategy (2050 Long-Term Vision for Nigeria [8]).

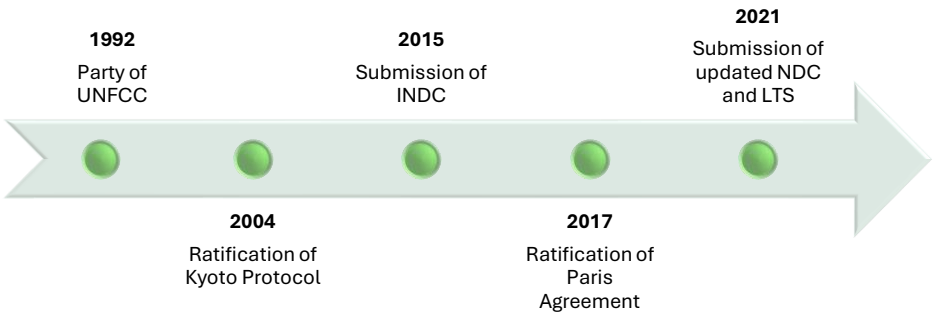

Figure 3: Timeline of Nigeria's climate pledges.

Nigeria remains committed to the original unconditional target set in its first INDC, aiming for a 20% reduction in GHG emissions by 2030 relative to the business-as-usual scenario, even though the initial baseline estimation of GHG emissions was significantly lower. The conditional target of Nigeria's NDC is currently set to 47% (previous target 45%) below business-as-usual emissions in 2030 given the appropriate support is provided to the country. Nigeria's NDC targets are highly ambitious and necessitate changes across all sectors, particularly in the energy sector which currently contributes to more than two thirds of overall emissions.

Nigeria's long-term targets include an unconditional 50% reduction of current emission levels by 2050 and a view of achieving net zero GHG emissions by 2060.

Key decarbonization pathways

The scope of the study is the exploration of a plausible decarbonization pathway for Nigeria in line with its NDC and long-term climate target and the analysis of its impacts on the energy sector as well as to provide detailed replies and measures on how these ambitious pathways can be actually implemented. The Nigerian baseline scenario represents the "business-as-usual" (BAU) pathway where no additional climate policies or measures are implemented beyond those already in place. The decarbonization scenario (NDC/LTT) is based on the emission reduction targets set in the country's NDC and aligned with the Nigerian net-zero target by 2060. The comparison of the NDC/LTT scenario with the Baseline scenario (BAU) allows us to better understand the effectiveness and impacts of the NDC and long-term climate targets of Nigeria. The projections of the two scenarios were based on the output of MENA-EDS model [9], which is a fully fledged energy demand and supply simulation model aiming at addressing energy system analysis, energy price projections, power generation planning and climate change mitigation policies.

CO_2 emissions and NDC & LTT targets

The projections of energy-related CO_2 emissions of the Baseline and NDC/LTT scenarios are depicted in Figure 4. In the business-as-usual scenario, annual CO_2 emissions of Nigeria are projected to continuously increase with an average growth rate of 4.8% per annum (p.a.) due to the increasing economic activity, rising population, and lack

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of strong climate policies. The annual CO_2 emissions in 2030 and 2050 are projected to reach 152 $MtCO_2$ and 292 $MtCO_2$ respectively increasing from the 95 $MtCO_2$ of 2020. The transport and energy supply are the most carbon emitting sectors and contribute to over 75% of energy-related emissions in the Baseline scenario (Figure 5).

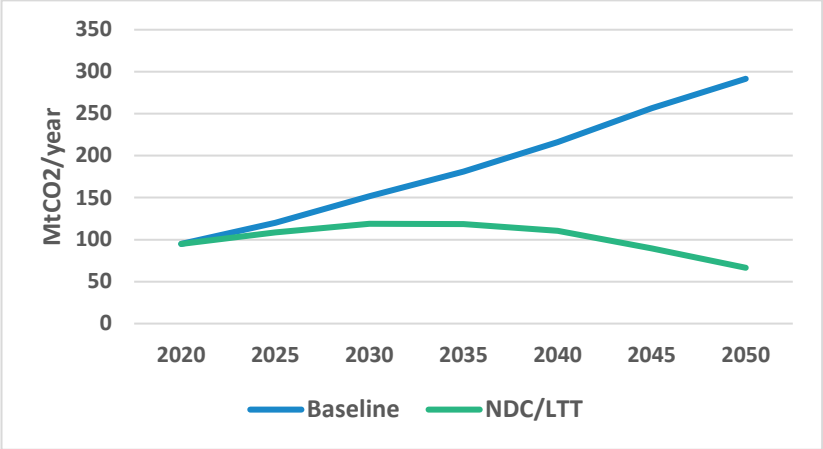

Figure 4: Energy-related CO_2 emissions in Nigeria

In the decarbonization scenario, strong climate policies are implemented to support the ambitious NDC & LTT targets for 2030 and 2050 respectively. CO_2 emissions are projected to reach a peak of 120 $MtCO_2$ in 2030-2035 achieving the unconditional NDC target of the country for 2030, namely 20% reduction of emissions relative to the Baseline scenario. In the period 2035 to 2050, energy-related CO_2 emissions steadily decline with an average decline rate of 3.7% reaching a projected level of 66 $MtCO_2$ in 2050 paving the way towards the country's net-zero target of 2060. In the decarbonization scenario, emissions are reduced in all sectors with larger emissions reduction achieved in the transport and energy supply sector due to the uptake of low-carbon technologies (electric vehicles, biofuels, solar PV, wind power).

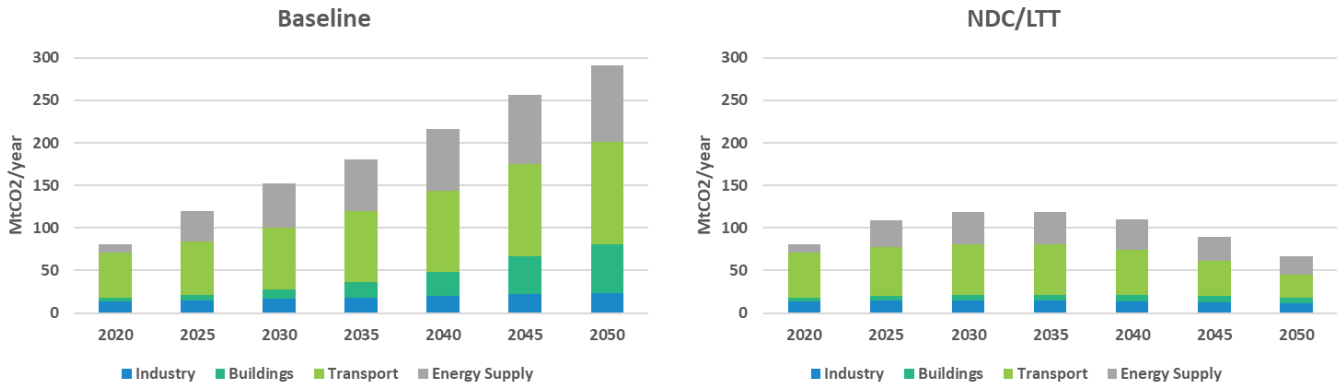

Figure 5: Energy-related CO_2 emissions by sector

Impact of Nigerian NDCs on Energy System Development

The final energy consumption projections of the baseline and NDC/LTT scenarios are shown in Figure 6. Energy Demand is rising in both scenarios driven by increased economic activity, population expansion and rising standards of living for consumers. The final energy demand in the decarbonization pathway however is notably lower in the

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NDC/LTT scenario, with a projected reduction of 25% compared to the baseline scenario in 2050. Biomass has a dominant role in the country's final energy mix due to economic factors (e.g. high level of poverty) and limited development of the electricity grid; traditional biomass is mostly used for cooking and heating in households. In the decarbonization scenario, an improvement of the electricity grid is required with increasing rates of electrification for Nigerian households, while oil and a small portion of biomass are replaced with electricity. Electricity can more efficiently provide useful energy and thus leads to the reduction of overall final energy demand. In the transport sector, electricity and biofuels are massively deployed to replace the use of refined oil products.

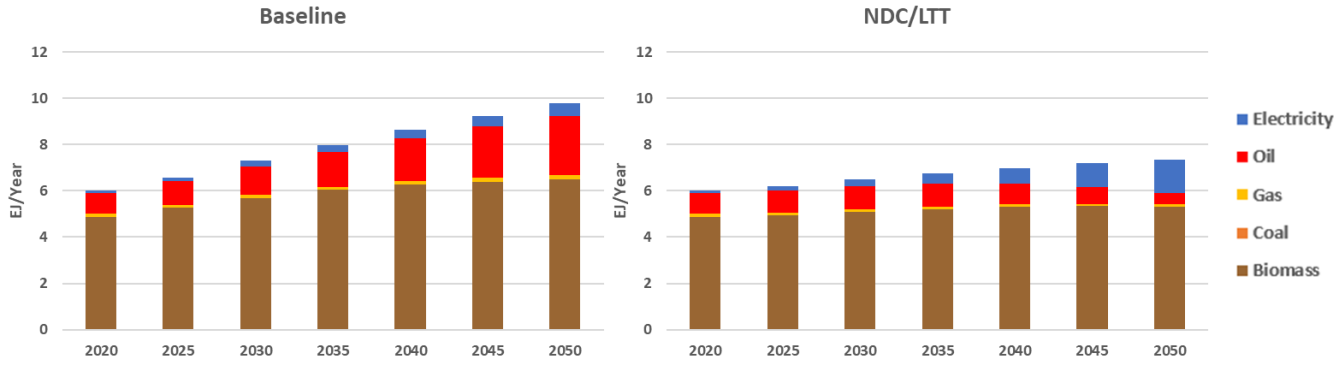

Figure 6: Nigeria's final energy consumption by fuel in Baseline and NDC/LTT scenarios

Figure 7 shows the scenario projections on primary energy consumption and the mix of fuels used. The total primary energy in the baseline scenario is continuously increasing driven by the population and GDP growth and the primary energy mix continues to be dominated by biomass followed by oil and gas, whose consumption increases massively over the 2020-2050 period. Low-carbon technologies (solar, wind and hydro) have negligible shares in the primary energy mix of the Baseline scenario following current trends in Nigeria with large challenges in the development of clean energy projects. In the decarbonization scenario, biomass remains the dominant energy form (with biofuels also gaining momentum for the decarbonization of transport), however the share of low-carbon technologies (solar, wind, hydro) steadily increases from 2030/2040 onwards replacing mainly the use of gas and oil. The use of solar, wind and hydro in the primary energy mix (with their high efficiency compared to fossil fuel use) and the increased electrification of the Nigeria economy based on renewable energy leads to a reduction of the overall primary energy consumption after 2030. The reduction in primary energy consumption in the NDC/LTT scenario is achieved primarily due to the enhanced energy efficiency measures in the end-use sectors (buildings, transport, industry) coupled with the gradual uptake of more efficient appliances, equipment, fuels and technologies (e.g. electric vehicles instead of conventional oil-fired cars, solar PV instead of gas-fired plants).

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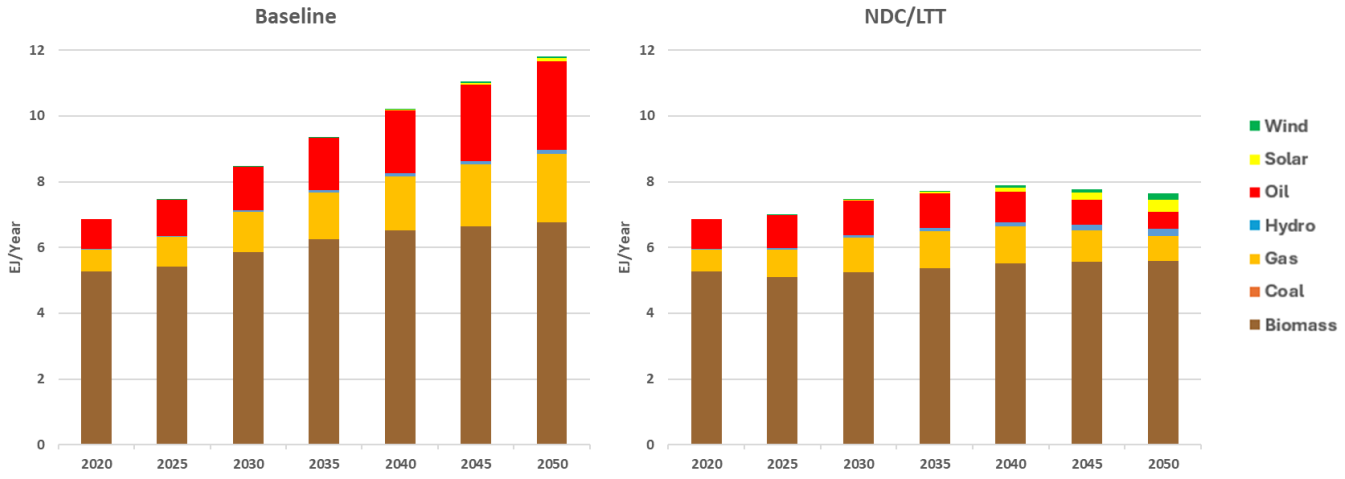

Figure 7: Nigeria's primary energy consumption by fuel in Baseline and NDC/LTT scenarios

Sectoral system transformations

Industry

Nigeria's industrial sector mainly comprises small-scale industries with relatively low energy intensity and the share of the sector in overall final energy demand is relatively low at around 5%. In both baseline and decarbonization scenarios, the industrial sector remains dependent on traditional biomass and gas with electricity steadily increasing its share in the fuel mix of industries. In the decarbonization scenario, the use of electricity increases as electricity replaces the use of natural gas and oil, an expensive and high-emitting fuel, which is almost completely phased out by 2050.

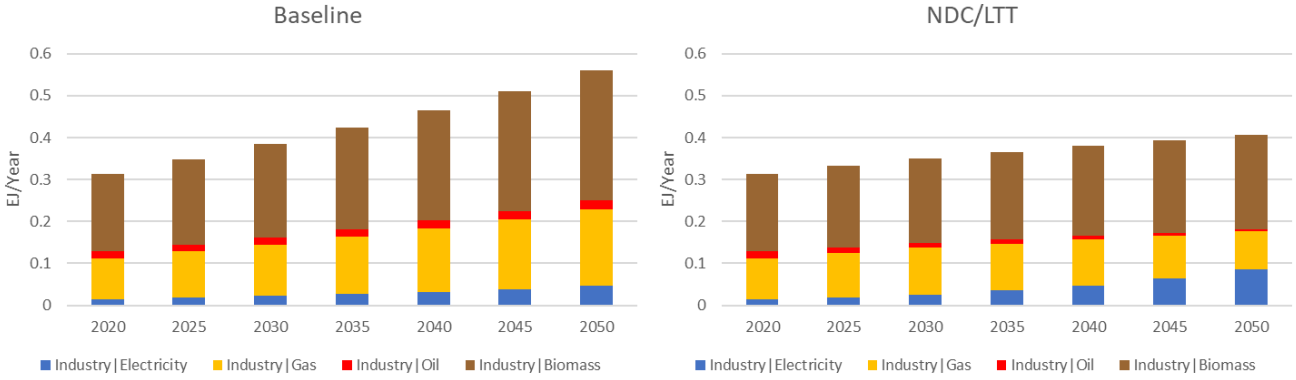

Figure 8: Final energy demand in the industrial sector by fuel

Transportation

The transportation sector currently depends solely on oil products. The dominance of oil is projected to continue in the baseline scenario in the absence of climate policies and cost-efficient alternatives, while in the NDC/LTT scenario, the decarbonization of the transport sector is achieved by a conservative increase of electric vehicles and

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by the use of biofuels given the large availability of biomass in Nigeria. The use of more efficient electric and hybrid vehicles would lead to an energy demand reduction of transport and a large reduction of emissions. In the decarbonization scenario, the emissions of the transport sector are reduced by almost 80% in 2050 compared to the Baseline scenario.

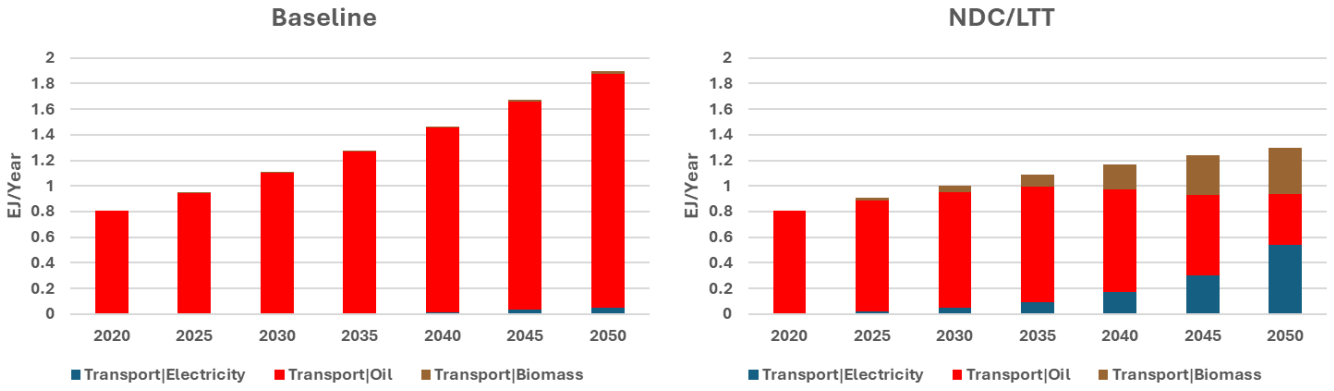

Figure 9: Final energy demand in the transport sector by fuel

Buildings

The residential and commercial sector has the highest share of final energy demand, with a share of over 75%, due to the usage of fuels with low efficiency (e.g. traditional biomass). The use of traditional biomass is extensive, and it accounts for more than 80% of buildings' energy consumption even by 2050, given also its very low efficiency. Almost a third of Nigerians do not currently have access to electricity and depend on wood and other forms of traditional biomass for heating and cooking. In the baseline scenario, electricity is introduced steadily in the mix increasing the electrification rate in the country, with this tendency becoming more prominent in the decarbonization scenario where electricity gradually replaces the use of oil products.

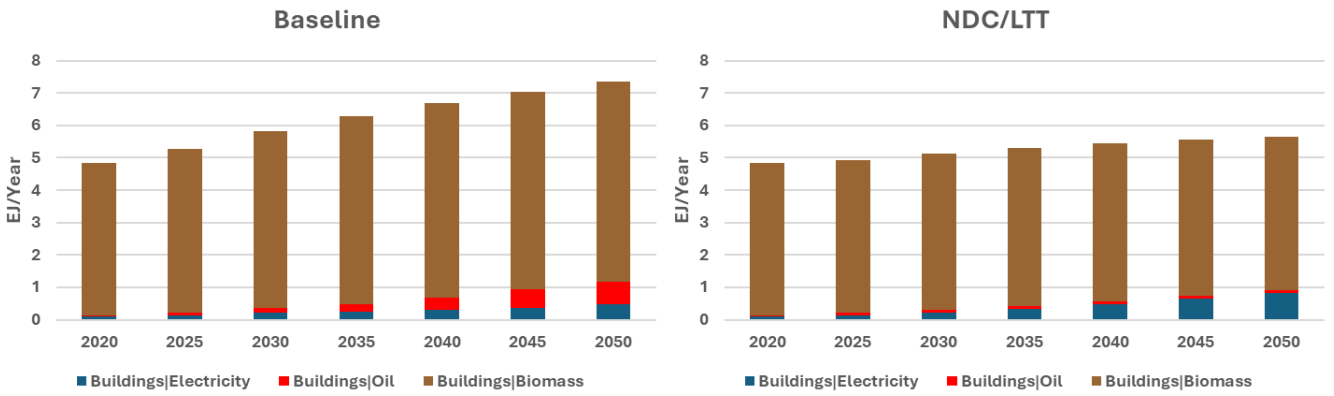

Figure 10: Final energy demand in the buildings sector by fuel

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Electricity Production

The projections of electricity production for the baseline and decarbonization scenario are shown in Figure 11. In both cases, the limited electricity infrastructure of Nigeria results in a modest use of electricity with most of Nigerian households currently not having access to the electricity grid. In the decarbonization scenario however, electricity production increases by 36% in 2050 compared to the Baseline scenario to cover the increasing electrification of demand sectors (industry, transport, and buildings). The mix of fuels used to generate electricity is significantly different in the two scenarios. In the Baseline scenario, gas-fired power plants are the main source of power generation leading to increased emissions from the electricity sector, but renewable energy sources are increasingly deployed and in 2050 they account for 45% of electricity production. In the decarbonization scenario, the uptake of renewable energy sources accelerates further, and they become dominant with a share of 50% in 2035 which continuously increases and reaches more than 90% in 2050. The substantial development of solar PV and wind power along with the increase of biomass and hydro capacities that replace the use of gas-fired power plants is projected to lead to a 67% emissions reduction in the power sector from the Baseline scenario.

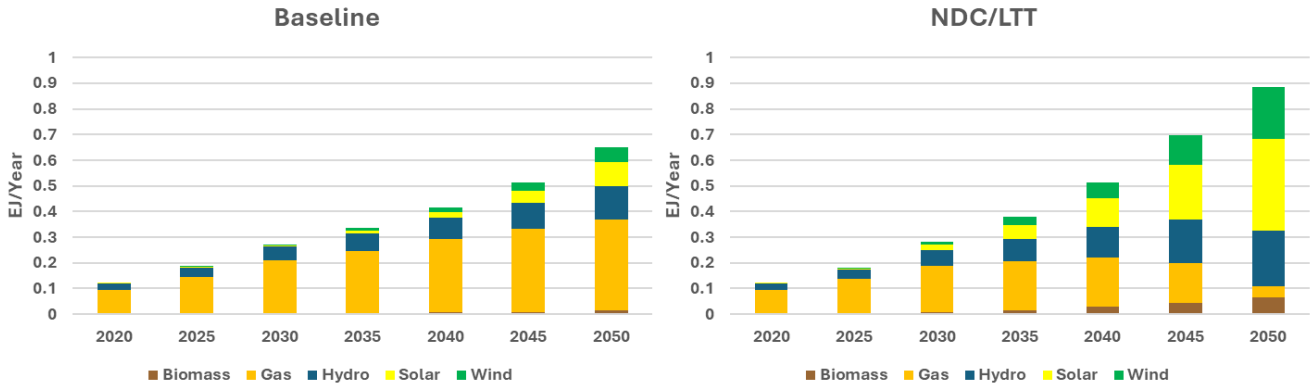

Figure 11: Electricity production in Nigeria by fuel in the Baseline and decarbonization scenarios

Conclusions

Nigeria's energy sector is a vital component of its economy and plays a significant role in the country's development and sustainable growth. A decarbonization pathway involves restructuring of Nigeria's energy system towards a cleaner energy mix with the uptake of renewable energy (solar PV, wind power, biofuels, hydro) and the enhanced use of efficient energy forms (e.g. electricity). Investments in renewable energy sources such as solar, wind, and hydropower are needed to improve energy efficiency and enable the achievement of the country's NDC and LTT emission reduction targets, especially mitigating emissions in the power supply and transport sectors which are the largest carbon emitting sectors in Nigeria.

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