Supporting Development of Energy Sector GHG Emission Projections Under Different Scenarios (without measures, with measures, with additional measures)

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Report of Projections

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Executive Summary

Nigeria's energy sector is the mainstay of the country's economic development and a major contributor of greenhouse gas (GHG) emissions. With increasing population, urbanization, and industrialization, energy demand is projected to rise significantly, making it critical to understand future emissions pathways and the impact of policy interventions. This report develops energy sector GHG emission projections under three scenarios Business as Usual (BAU), With Measures (WM), and With Extra Measures (WEM) to support national climate planning, policy alignment, and international reporting.

The analysis is based on Nigeria's evolving climate policy framework, including the Third Nationally Determined Contributions (NDC 3.0), the Energy Transition Plan (ETP), and the Long-Term Low Emissions Development Strategy (LT-LEDS). Using the Long-range Energy Alternatives Planning (LEAP) model and a 2018 baseline, the study ensures methodological consistency with national and international reporting systems while capturing the full complexity of Nigeria's energy system, including grid and off-grid electricity, industrial energy use, transport demand, household energy consumption, and oil and gas emissions.

Under the BAU scenario, emissions are projected to increase significantly due to continued reliance on fossil fuels, persistent diesel generator usage, limited clean energy penetration, and rising energy demand. This scenario represents a continuation of historical trends and serves as the baseline for assessing mitigation impact.

The WM scenario reflects the implementation of existing commitments under NDC 3.0, including renewable energy expansion, energy efficiency improvements, reduction of fugitive methane reduction in oil and gas operations, and clean cooking initiatives. While these measures slow emissions growth, they do not fully offset the effects of economic and population expansion.

The WEM scenario presents a transformative pathway aligned with the ETP and LT-LEDS, incorporating accelerated renewable energy deployment, electrification across sectors, large-scale clean cooking adoption, industrial fuel switching (including biomass), and elimination of gas flaring and methane emissions. This scenario reflects Nigeria's long-term net-zero ambition.

Results show a clear divergence in emissions trajectories. Under BAU, emissions could rise to approximately 1.5 billion tonnes of CO_2 equivalent by 2060. Under WM, emissions are reduced but may still reach around 850 million tonnes due to continued development pressures. In contrast, the WEM scenario demonstrates that deep decarbonization could reduce emissions to near-zero levels by 2060, highlighting the scale of transformation required.

Sectoral analysis indicates that the power sector, oil and gas operations, transport, industry, and household energy use are critical to achieving emissions reductions. Key mitigation opportunities include renewable energy expansion, reduction of diesel-based generation, methane mitigation (including flare elimination and LDAR), electrification of transport, industrial energy efficiency, and widespread adoption of clean cooking solutions.

The report also assesses the alignment between NDC 3.0, ETP, and LT-LEDS. While the frameworks are broadly consistent in ambition, gaps remain in implementation timelines, coordination, and underlying assumptions. Strengthening alignment is essential to ensure policy coherence, optimize investments, and enhance Nigeria's credibility under the Paris Agreement.

The report concludes that achieving Nigeria's net-zero target requires moving beyond incremental measures toward a coordinated and integrated approach. Key recommendations include harmonizing policy frameworks, strengthening monitoring, reporting and verification (MRV) systems, clarifying institutional responsibilities, aligning investments with transition priorities, and establishing feedback mechanisms to continuously refine targets and implementation strategies.

Overall, the findings demonstrate that while current commitments provide a strong foundation, only a fully aligned and ambitious implementation of additional measures can deliver the deep emissions reductions required for Nigeria's sustainable and low-carbon future.

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Abbreviations and Acronyms

BAU	Business as Usual
BRT	Bus Rapid Transit
BTR	Biennial Transparency Report
BTR1	First Biennial Transparency Report
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilization and Storage
CH_4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DCC	Department of Climate Change
ETP	Energy Transition Plan
EVs	Electric Vehicles
FMEnv	Federal Ministry of Environment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GST	Global Stocktake
GW	Gigawatt
ICAT	Initiative for Climate Action Transparency
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
LDAR	Leak Detection and Repair
LEAP	Long-range Energy Alternatives Planning
LT-LEDS	Long-Term Low Emissions Development Strategy
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry

$MtCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
N_2O	Nitrous Oxide
NCCC	National Council on Climate Change
NDC	Nationally Determined Contribution
NDC 3.0	Nigeria’s Third Nationally Determined Contribution
PA	Paris Agreement
POME	Palm Oil Mill Effluent
SHS	Solar Home Systems
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
WEM	With Extra Measures
WM	With Measures

1.0 Introduction

Nigeria stands at a critical intersection of development imperatives, energy security challenges, and climate policy commitments. As Africa's most populous nation and largest economy, Nigeria's energy demand continues to grow rapidly, driven by population expansion, urbanization, industrial development, and increasing economic activities. Energy remains central to achieving national development aspirations; however, the structure of Nigeria's current energy system is also a significant contributor to GHG emissions, particularly from fuel combustion in power generation, industry, transport, households, and oil and gas operations.

Over the last decade, Nigeria has steadily strengthened its engagement with the global climate regime under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. Through successive updates of its NDC, the development of its ETP, and the elaboration of its LT-LEDS, Nigeria has articulated a progressively more ambitious climate pathway. Central to the credibility and effectiveness of these commitments is the availability of robust, transparent, and analytically grounded GHG emission projections, especially for the energy sector, which is the backbone of both economic development and emission mitigation potential.

This report responds directly to Task 4.1 on Supporting the development of energy sector GHG emission projections under BAU, With Measures , and With Additional Measures scenarios. The objective is to develop well-structured projection frameworks, supported by a credible methodological approach and policy context, to enable Nigeria to:

- Understand how emissions are likely to evolve under a no-intervention or limited-intervention future,
- Quantify the potential mitigation impact of currently adopted and ongoing policy measures, and
- Assess the enhanced emission reduction opportunities arising from transformational policy actions envisaged in the ETP and LT-LEDS.

1.1 Background and Rationale

The energy sector is the single largest source of Nigeria's GHG emissions, encompassing electricity generation, fuel combustion in industries, transportation energy use, household energy consumption, and emissions arising from oil and gas production systems. Historically, Nigeria's reliance on fossil-based energy, coupled with low efficiency levels and limited access to modern energy, has resulted in a combination of high emissions, energy poverty, and economic inefficiencies.

Despite having one of the largest proven natural gas reserves in the world, electricity generation remains insufficient to meet national demand. A significant share of the population and businesses rely on small-scale decentralized diesel and petrol generators, which contribute substantially to both GHG emissions and local air pollution. At the industrial level, sectors such as cement manufacturing, refining, and other manufacturing subsectors rely on fossil fuels, although emerging opportunities now exist for substitution with agricultural biomass and industrial by-products, as highlighted in existing expert analyses.

At the household level, a large proportion of Nigerians still rely on traditional biomass for cooking, particularly fuelwood and charcoal, with limited penetration of truly efficient and sustainable clean cooking technologies. This not only contributes to emissions but also has severe implications for health, deforestation, and gender equity. Nigeria's oil and gas sector also presents both challenges and opportunities. While historically contributing methane emissions from gas flaring and production processes, it also holds immense mitigation potential through flare reduction, methane capture, and improved operational efficiency.

Given these realities, Nigeria's evolving climate commitments are inherently tied to transformation within the energy sector. Thus, developing credible emission projections is critical for:

- Evaluating policy effectiveness,
- Informing investment prioritization,

- Enhancing transparency under the Paris Agreement,
- Supporting evidence-based decision-making,
- Guiding national and international climate finance engagement.

1.2 Nigeria's Climate Policy Commitments and the Role of Energy

Nigeria's climate policy architecture has matured significantly in recent years, through the submission of NDC 3.0 in September of 2025. Nigeria reaffirmed its commitment to global climate action, explicitly recognizing the centrality of the energy sector in meeting national emission reduction targets. Importantly, Nigeria's revised NDC establishes 2018 as the baseline year, providing a consistent reference against which progress and projections are to be assessed.

Complementing the NDC is the ETP, which articulates a long-term national strategy toward a cleaner, more resilient, and sustainable energy future. The ETP outlines pathways for electricity sector reform, large-scale renewable energy deployment, natural gas optimization as a transition fuel, reduction in self-generation dependence, industrial energy restructuring, and accelerated clean cooking transitions.

Furthermore, Nigeria's Long-Term Low Emissions Development Strategy provides a strategic framework for deep decarbonization over several decades, aligning long-term climate ambition with development objectives such as energy access, industrialization, economic diversification, and job creation. Collectively, these frameworks reinforce Nigeria's intent not only to meet immediate emission reduction obligations, but also to strategically position the country for a low-carbon development trajectory.

The alignment between these policy instruments is important. While the NDC provides mid-term commitments, ETP offers an operational reform vision, while the ETP and LT-LEDS provides a long-term transformation outlook. A credible GHG projection exercise therefore becomes essential to ensure consistency, identify policy synergies, assess ambition gaps, and define realistic emission pathways.

1.3 Purpose and Objectives of this Report

This report has been developed to support national climate planning and reporting, particularly in preparation for:

- Nigeria's Biennial Transparency Report (BTR),
- The 2025 NDC update, and
- Ongoing national policy implementation monitoring.

The core objectives are to:

1. Develop structured and credible energy sector emission projection scenarios, including:
    - BAU,
    - With Measures (reflecting NDC-aligned actions),
    - With Additional Measures (reflecting enhanced ambition mostly under ETP and some from the LT-LEDS);
2. Assess the GHG implications of Nigeria's key energy transition strategies.
3. Highlight the mitigation potential of emerging sectoral opportunities such as biomass utilization, improved cookstoves, sustainable charcoal production, reduced diesel generator dependence, renewable energy expansion, and methane control.
4. Provide analytical insights that support policy refinement, institutional coordination, and alignment across Nigeria's climate frameworks.

1.4 Report Scope and Focus

While Nigeria's emissions arise from multiple sectors, this report focuses explicitly on the energy sector, recognizing its dominant role in national emissions and its critical position in mitigation planning. The scenarios developed herein consider:

- Electricity generation and supply dynamics,

- Fuel combustion in industries,
- Transport energy use,
- Household energy consumption patterns,
- Oil and gas system emissions relevant to energy use,
- Biomass energy and non-traditional energy substitution opportunities.

The analysis takes 2018 as the baseline year, consistent with NDC 3.0, using the LEAP model which was previously used in Nigeria's national modelling exercises.

1.5 Structure of the Report

The remainder of this report is structured as follows:

- **Section 2** defines the three projection scenarios and presents contextual overviews of Nigeria's NDC 3.0, ETP, and LT-LEDS.
- **Section 3** details the methodology for developing GHG projections, including modelling structure, data sources, and analytical considerations.
- **Section 4** presents the GHG impact assessment, describing results under BAU, With Measures, and With Additional Measures, and discusses alignment considerations across Nigeria's climate frameworks.
- **Section 5** provides conclusions and recommendations.

2.0 Definition of BAU, With Measure Scenario and With Extra Measure Scenario

This chapter defines the analytical scenario framework used in this report and elaborates in detail the policy and strategic contexts that underpin each scenario. It provides an in-depth exposition of the BAU scenario, the With Measures (WM) scenario aligned primarily with Nigeria's NDC 3.0, and the With Extra Measures (WEM) scenario, which draws more extensively from the ETP and some areas from the LT-LEDS especially when they are outside the ETP scope.

In addition to defining these scenarios, this chapter also explains their conceptual relevance to GHG projection modelling, highlights how each scenario fits into Nigeria's evolving climate policy architecture, and establishes an analytical foundation for the quantitative and qualitative assessments presented in subsequent chapters.

2.1 Scenario Frameworks

Scenario development is a core component of national mitigation analysis. It enables policymakers, analysts, and stakeholders to understand how emissions may evolve under different policies, technological, and socio-economic conditions. For Nigeria, where energy demand is expanding rapidly while climate commitments are simultaneously deepening, scenario analysis is not merely a technical exercise; it is an essential strategic tool that supports decision-making, resource prioritization, international transparency obligations, and the pursuit of sustainable development objectives.

In alignment with international good practice particularly UNFCCC technical guidance and methodologies commonly applied in Biennial Transparency Reports (BTRs), Nigeria's approach is structured around three principal categories of scenarios: BAU, With Measures, and With Extra Measures. Each scenario progressively reflects increasing levels of climate ambition, policy depth, and structural transformation, and together they provide a spectrum through which Nigeria's possible energy future can be examined.

2.1.1 Business as Usual (BAU)

The BAU scenario represents a projection of energy sector GHG emissions assuming no significant deviation from historical development patterns and policy practices beyond those already in place prior to 2018, which is the established baseline year for Nigeria's NDC 3.0. It can be described as the most conservative analytical scenario, illustrating what Nigeria's emissions trajectory will look like if existing structural challenges persist, energy demand continues to expand without major intervention, and no transformative climate mitigation initiatives are introduced beyond those already embedded in historical trends. For the purpose of this task, the Nigeria Agenda 2050[1] provides a clear pathway for the Nigeria BAU scenario.

Under this scenario, population and economic growth continue to exert upward pressure on energy demand across all sectors. Electricity generation remains heavily dependent on fossil fuels, with gas-fired power and diesel-based self-generation continuing to fill the gap created by inadequate centralized grid supply. The widespread use of small-scale diesel and petrol generators, estimated in multiple studies to provide between 8,000–14,000 MW of decentralized power capacity continues to be a dominant feature of Nigeria's energy landscape.

In the industrial sector, manufacturing processes such as cement production, refinery operations, and other energy-intensive industries largely continue to rely on conventional fossil fuels, with only marginal efficiency improvements.

At the household level, traditional biomass fuels such as fuelwood and charcoal play a major role in cooking energy consumption, with limited penetration of clean cooking solutions. The transport sector experiences continual growth in fuel demand driven by increasing vehicle numbers, ageing vehicular stock, and limited structural shifts towards electrified or alternative-fuel mobility systems. Within the oil and gas sector, methane releases associated with gas flaring, venting, and fugitive emissions persist at high levels in the absence of accelerated control programs.

In essence, the BAU scenario illustrates a future in which Nigeria's emissions profile grows steadily, reflecting a combination of increasing energy use and limited systemic reform. It serves a critical analytical function by providing the benchmark or counterfactual against which the emission reduction impacts of planned and additional mitigation measures can be quantified and compared.

[1] https://faolex.fao.org/docs/pdf/nig217433.pdf

2.1.2 With Measures (WM) Scenario

The With Measures (WM) scenario describes a more progressive emissions pathway by incorporating the effects of mitigation actions and policy measures that Nigeria has already adopted and formally committed to implement, particularly those articulated in the NDC 3.0. Unlike the BAU scenario, which assumes limited deviation from historical trends, this scenario reflects an intentional national policy effort to moderate emissions growth and initiate measurable progress toward decarbonization while maintaining development objectives.

This scenario therefore assumes effective implementation of the mitigation initiatives explicitly identified in NDC 3.0. These include Nigeria’s renewable energy expansion commitments, planned improvements in electricity access using lower-carbon and more efficient generation systems, and measures to reduce dependency on highly polluting decentralized diesel and petrol generators. The scenario also integrates ongoing efforts to enhance industrial energy efficiency, promote fuel switching where feasible, and improve process energy performance in key sectors such as cement, iron and steel, and manufacturing.

Within the household energy domain, the WM scenario incorporates policies designed to support clean cooking transitions, recognizing not only their mitigation benefit but also their strong co-benefits for health, livelihoods, and environmental sustainability. In the transport sector, measures related to fuel efficiency improvements, development of regulatory standards, and gradual uptake of cleaner vehicle technologies are included. Oil and gas methane reduction efforts, such as gas flare elimination initiatives, improved monitoring, leak detection, and repair (LDAR) programs, are also embedded in this scenario, reflecting current national policy intentions.

The With Measures scenario is particularly important because it demonstrates what Nigeria can realistically achieve if existing commitments are implemented effectively. It provides an evidence-based illustration of the potential emission reductions achievable under already established obligations, thereby supporting accountability and transparency under the Paris Agreement.

2.1.3 With Extra Measures (WEM) Scenario

The With Extra Measures (WEM) scenario represents the most ambitious and forward-looking projection pathway. It extends beyond the commitments outlined in NDC 3.0 to include a more transformative suite of actions aligned with Nigeria's ETP and LT-LEDS. This scenario captures a future where Nigeria undertakes proactive, comprehensive, and accelerated climate action, leading to deeper and more structural decarbonization across the energy system.

Under this scenario, Nigeria is assumed to undertake significant power sector reform and large-scale adoption of renewable energy technologies, including accelerated deployment of solar power, expansion of grid infrastructure, and substantial reduction in diesel-based self-generation. Clean cooking transitions advance rapidly and at a broader scale, encompassing large-scale adoption of LPG, electric cooking, sustainable biomass solutions such as briquettes, and advanced stove technologies, drawing from successful experiences documented in countries such as Kenya, Tanzania, Zambia, and others as highlighted in expert commentary such as that provided by NDC, LT LED and ETP alignment done by Ricardo with support from Prof. Okereke's team in Society of Planet and Prosperity.

Transport sector transformation becomes more aggressive in this scenario, including deeper electrification initiatives, alternative fuel uptake, and structural shifts in urban mobility. Industrial decarbonization efforts expand significantly, including the use of agricultural residues such as palm oil mill effluent (POME), sugar bagasse, wood waste, sawdust briquettes, and other biomass fuel alternatives to substitute coal and other high-emission fuels. Methane mitigation becomes substantially more rigorous, with complete elimination of routine flaring, improved technological deployment, and strengthened compliance structures.

This scenario therefore not only reflects enhanced emissions reduction ambition but also portrays Nigeria's potential pathway toward achieving long-term climate neutrality objectives, consistent with its declared net-zero aspiration.

2.2 Overview of Nigeria’s NDC 3.0

Nigeria’s Third Nationally Determined Contribution (NDC 3.0) represents a significant advancement in the country’s climate ambition under the Paris Agreement. Building upon the initial submission in 2015 and the revised NDC in 2021, this latest update introduces a more data-driven, transparent, and actionable approach to achieving greenhouse gas (GHG) emission reductions. The NDC 3.0 aligns Nigeria’s climate priorities with its long-term development agenda, as articulated in the Climate Change Act (2021) and the Nigeria Energy Transition Plan (ETP, 2022), while reaffirming the country’s commitment to achieving net-zero emissions by 2060.

A major innovation in NDC 3.0 is the transition from relative reductions against a Business-as-Usual (BAU) trajectory to an economy-wide absolute emission reduction framework, using 2018 as the national baseline year. This approach enhances transparency, comparability, and alignment with the Enhanced Transparency Framework (ETF) under Article 13 of the Paris Agreement. Furthermore, the NDC 3.0 is addressing 19 IPCC source categories compared to 11 in the NDC 2.0 while increasing the number of measures/actions from 24 in the NDC 2.0 to 39 by 2035 in the NDC 3.0. This enhanced ambition has been worked out to align with the Paris Agreement (PA) temperature goal, as per paragraph 37 of the Global Stocktake (GST) and taking into consideration the country’s national circumstances

The NDC 3.0 document was developed through an inclusive, participatory process involving the Federal Ministry of Environment (FMEnv) through its Department of Climate Change (DCC), the National Council on Climate Change (NCCC), line ministries, subnational authorities, civil society organizations, and the private sector.

2.2.1 Emissions Baseline and National Reduction Targets

Mitigation targets in the NDC 3.0 are set against the 2018 baseline emissions (573.5 million tonnes of CO_2 equivalent ($MtCO_2e$)) and with a transition from an emission reduction % relative to the BAU scenario to an economy-wide absolute emissions reduction, Nigeria is now targeting net zero by 2060. Intermediate targets are absolute emissions reductions of 168.2 Mt CO2 e in 2030 and 184.9 Mt CO2 e in 2035 from base year 2018 towards net zero by 2060.

These economy-wide absolute emissions reductions represent 29% and 32% of net national emissions of 2018, in 2030 and 2035, respectively. Nigeria maintains its 20% unconditional objective and views the conditional reduction at 80% of the 29% and 32% reduction of the estimated 2018 emissions in 2030 and 2035, respectively[2].

These targets represent an evolution from earlier NDCs that relied on BAU projections, signifying Nigeria's strengthened data and institutional capacity to adopt an inventory-based, measurable, and verifiable framework. The targets are aligned with the net-zero by 2060 objective and the national carbon budgeting approach stipulated under the Climate Change Act (2021).

The updated targets also benefit from the methodological consistency of the national GHG inventory submitted alongside the first Biennial Transparency Report (BTR1), ensuring that tracking and reporting processes are harmonized with international best practice under the UNFCCC (UNFCCC, 2023).

2.2.2 Key Mitigation Measures and Actions

The NDC 3.0 identifies 23 priority mitigation measures across key sectors, each supported by quantified emission reduction potentials and implementation pathways. These 23 measures were selected from a broader set of 39 actions considered during the NDC 3.0 technical update, but only those with robust data and defined mitigation estimates were adopted as official NDC measures. Each measure is defined with expected emission reduction potentials, timelines, and implementing agencies.

The Energy sector comprising fuel combustion and fugitive emissions contributes over 60% of national GHG emissions. Within this sector, the NDC targets the elimination of routine gas flaring by 2030 and a 60% reduction in fugitive emissions by 2035, delivering a combined mitigation potential of 29.4 $MtCO_2e$. In the fuel-combustion component, the NDC also aims to

[2]https://unfccc.int/sites/default/files/2025-09/Nigeria%20NDC%203.0%20%20Transimission%20Version%202.pdf

achieve a 52% renewable energy share in national electricity generation by 2030 through expanded hydro, solar, and demand-side management investments.

In the Transport sector, the NDC introduces an ambitious plan on adoption of cleaner fuel to replace diesel with 50% of locomotives using compressed natural gas (CNG) and to transition 30% of the national vehicle fleet to electric vehicles (EVs) and 20% to compressed natural gas (CNG) systems by 2035, representing a mitigation potential of 44.3 $MtCO_2e$. These measures are supported by public transport upgrades, such as Bus Rapid Transit (BRT) systems, and urban planning reforms aimed at reducing vehicle congestion and emissions (FMEnv, 2024).

The Industrial Processes and Product Use (IPPU) sector focuses on improving energy and material efficiency, promoting low-carbon cement production, and introducing carbon capture and utilization (CCU) technologies. This sector contributes a mitigation potential of 14.0 $MtCO_2e$.

In the LULUCF sector, the principal goal is to reduce the national deforestation rate by 60% by 2030, with a mitigation potential of 304.8 $MtCO_2e$, complemented by afforestation and reforestation programmes with an additional 34.4 $MtCO_2e$ potential. These interventions also support biodiversity conservation, watershed protection, and rural livelihoods.

The Waste sector targets integrated waste management, recycling, composting, and landfill methane capture, contributing 12.5 $MtCO_2e$ in mitigation. The agriculture sector contributes a relatively modest 2.1 $MtCO_2e$, through the adoption of climate-smart agriculture, efficient fertilizer use, and improved livestock management practices.

2.3 Overview of the Energy Transition Plan

Nigeria’s Energy Transition Plan serves as an operational and strategic roadmap designed to guide the country toward a cleaner and more sustainable energy future, while simultaneously addressing pressing development priorities such as energy access, industrialization, poverty reduction, and employment creation. Unlike the NDC, which primarily serves as a climate commitment instrument, the ETP is explicitly designed as a development-climate hybrid framework, linking emissions reduction strategies directly to national socio-economic objectives.

The ETP takes a holistic view of Nigeria’s energy system, covering the power sector, transportation, oil and gas value chain, industrial processes, and household cooking energy. It recognizes that decarbonization efforts must be carefully designed to ensure fairness, equity, and inclusiveness, ensuring that no population group is disproportionately burdened by the energy transition. It also emphasizes that Nigeria’s transition must be just, well-sequenced, and adequately financed.

By setting sectoral pathways toward 2030, 2035, and ultimately 2060, the ETP translates abstract emission reduction commitments into tangible sector transition plans. It highlights how Nigeria can significantly reduce emissions in the power sector, dramatically transform transport emissions through electrification, almost completely decarbonize household cooking through widespread adoption of clean fuels, reduce methane-intensive oil and gas activities, and progressively shift industry toward low-carbon energy use.

Nigeria's aim with the ETP is to eradicate gas flaring by 2030, a target that has persistently been set but not been accomplished since 1979.

According to the net zero ETP, the Nigerian oil and gas sector accounts for approximately 11 % of in-scope emissions, which are attributed to activities such as fuel use, venting, fugitives, and flaring in upstream operations. The plan drives for a decrease in emissions primarily caused by the global response to climate change, and a reduction in flaring and fugitive emissions also supports decarbonisation. The itemised actions steps for the Oil and Gas include:

I. Improvement of flaring efficiency.
II. Exportation and redefining of gas utilisation.
III. A ramp-up of refinery activities, and
IV. Utilisation of Carbon Capture Utilisation and Storage (CCUS).

The ETP will necessitate an investment of over $400 billion throughout the Nigerian economy. Under normal circumstances, this amount exceeds the projected expenditure over the next three decades. The expenditure breakdown is $155 billion for generation capacity, $135 billion for distributing facilities, $79 billion for structures, $21 billion for the sector, and $12 billion for transports. Nigeria intends to include an extra capacity of 7 gigawatts annually into the power grid to accomplish this goal. As part of plans for energy transition, the country announced a decade of gas from 2020 to 2030 to rapidly utilise gas as a bridge in its energy transition plan.

Notable emissions reduction objectives embedded in the ETP include:

- **Power sector decarbonization:** Significantly reducing emissions as solar and renewables increasingly replace thermal and diesel generation, while using natural gas as a transitionary supporting fuel.
- **Transport emissions:** Major uptake of electric vehicles could reduce transport sector emissions by up to -97% relative to the baseline.
- **Cooking transitions:** Rapid adoption of cleaner fuels (LPG, bioenergy, electricity) could decrease cooking sector emissions by -98%.
- **Oil and gas emissions:** Reduction of flaring and fugitive emissions by 87% through efficiency, electrification, and decarbonization of operations.
- **Industrial decarbonization:** Near-complete shifts to zero-emission fuels for heating and processing energy.

2.4 Overview of the Long-Term Low Emissions Development Strategy (LT-LEDS)

Nigeria's LT-LEDS establishes the pathway for achieving net-zero GHG emissions by 2060, while ensuring that climate action remains fully aligned with the nation's broader development priorities. These priorities include universal energy access, economic competitiveness, industrial growth, poverty reduction through employment creation, food security, improved sanitation, innovation advancement, and sustained economic growth. The LT-LEDS therefore positions decarbonisation not as a constraint but as a strategic driver of sustainable development.

The Strategy is underpinned by the LEAP-NGA modelling framework, which was used to develop baseline scenario and two alternative decarbonisation scenarios (with measures and with extra measures) that reflect varying levels of policy ambition, technological deployment, and structural transformation of Nigeria's energy and economic systems. These scenarios provide a robust analytical foundation for understanding Nigeria's potential emissions trajectories to 2060 and for identifying the mitigation pathways capable of supporting national development and climate objectives.

The BAU scenario reflects a future in which emissions rise significantly across all sectors as population and economic growth continue without substantial mitigation interventions. The BAU scenario which is developed from the National Agenda represents implementation of national economic plans absent NDC, ETP, LT LEDS. However, the NDC and particularly the ETP envisions a system where by 2060 renewable energy supplies over 90% of power generation, electric vehicles dominate road transport (around 85% of car and bus fleets), industries apply Carbon Capture and Storage (CCS), energy efficiency significantly improves, and gas flaring ends by 2030.

The ETP in its early phase can be considered as the Gas Economy Scenario (GES) which emphasizes Nigeria's aggressive utilization of natural gas as a transition fuel, with gas expected to account for roughly 58% of power generation by 2060. While the Nigeria Agenda 2050 also envisages use of gas for a long time, it doesn't include the mitigation pathways as detailed in the NDC 3.0 and ETP. The NDC and ETP pathway incorporates widespread efficient appliance use, cleaner cooking solutions, CCS deployment in industry, strong modal shifts to public transport, and substantial nature-based sinks through large-scale reforestation (approximately 5% annually), supported by REDD+. Renewable Energy utilization represents the most ambitious pathway, centred on large-scale renewable deployment complemented by nuclear power, achieving a near-carbon-free power sector (about 98% carbon-free electricity), extensive electrification across end-use sectors, transport transformation, reductions in agricultural emissions (including reductions in enteric fermentation), and moderate reforestation supported through REDD+.

From a quantitative perspective, the LT-LEDS demonstrates clear differentiation in emissions outcomes across these scenarios. By 2030, emissions are projected to reach approximately 514 $MtCO_2e$ under BAU. Overall, the LT-LEDS provides Nigeria with a clear, analytically grounded, and development-oriented blueprint for long-term decarbonisation. It demonstrates that while emissions growth under BAU is inevitable in the absence of intervention, strong policy action, technological transition, and sustained investment can significantly bend Nigeria's emissions trajectory toward an ambitious net-zero future.

2.5 Summary and Policy Alignment Perspective

The BAU, WM, and WEM scenarios create a structured analytical spectrum reflecting increasing levels of ambition and policy intervention. The BAU scenario captures Nigeria's emissions future under a continuation of current trends. The With Measures scenario represents emissions under successful implementation of NDC 3.0 commitments. The With Additional Measures scenario reflects a more transformative pathway aligned with the ETP and LT-LEDS, advancing Nigeria toward its long-term net zero vision.

Critically, ensuring alignment across these policy frameworks strengthens Nigeria's credibility, enhances strategic planning efficiency, and supports evidence-based dialogue with international partners, financiers, and stakeholders. This scenario framework therefore provides the foundation for the methodological modelling and emission assessments presented in subsequent chapters.

Table 1: Summary of BAU, With Measure Scenario and With Extra Measure Scenario

Scenario	Policy Base	Primary Features
BAU	Historical trends; no new interventions	Continued fossil dominance; limited renewables; persistent diesel reliance

With Measures	NDC 3.0 commitments	Full implementation of existing NDC targets (electricity access/renewables, zero flaring/methane reduction, transport, clean cooking)
With Additional Measures	ETP + LT-LEDS	Stronger decarbonization; transformational power sector reform; deep clean energy transitions; accelerated methane elimination

3.0 Methodology for GHG emission projects under different scenarios

This chapter presents the methodology adopted for developing the GHG emission projections for Nigeria's energy sector across the three analytical scenarios defined in this report, BAU, WM, and WEM. The methodology is centrally based on the application of the LEAP model, which serves as the primary analytical platform for structuring the energy system, simulating sectoral energy demand and supply dynamics, and quantifying the resulting GHG emissions. All other methodological elements, including data inputs, scenario construction, and analytical interpretation, are developed within the conceptual and computational framework of LEAP.

3.1 Rationale for Applying the LEAP Model

The decision to utilize the LEAP model as the core methodological tool is grounded in both international best practice and Nigeria's established climate planning experience. LEAP is one of the most widely applied national energy system and emission projection models globally and has been specifically designed to support:

- national GHG inventory enhancement,
- climate policy analysis,
- mitigation scenario development,
- long-term energy transition planning.

Nigeria has previously applied LEAP in the development of earlier national climate planning exercises, including NDC updates, sectoral mitigation analysis, and broader energy transition assessments. Its continued application therefore ensures:

- methodological consistency across reporting cycles,
- comparability with past modelling outputs, and
- institutional continuity for analysts and agencies already familiar with the tool.

Critically, LEAP's structure is particularly suitable for Nigeria's context because it can realistically reflect the complexities of Nigeria's energy system, including:

- centralized and decentralized electricity generation,
- widespread diesel generator reliance,
- industrial and transport fuel consumption diversity,
- extensive biomass and traditional cooking energy systems,
- oil and gas methane emission characteristics.

This makes it uniquely capable of capturing Nigeria's real-world energy dynamics in a scientifically robust yet practically usable manner.

3.2 Conceptual Structure of LEAP as applied in this Study

The LEAP model functions as a fully integrated energy system accounting and simulation platform. It allows the analyst to build a representation of the national energy system and then simulate how it evolves into the future under different assumptions and policy environments.

LEAP incorporates IPCC-aligned methodologies for estimating GHG emissions. Within each branch of the demand and transformation modules, energy consumption of each fuel type is multiplied by corresponding emission factors to derive emissions in CO_2, CH_4, N_2O, and aggregated CO_2-equivalent (CO_2e).

Emissions are calculated by:

- Estimating energy consumed per sector and technology.
- Applying fuel-specific emission factors.
- Aggregating emissions across all branches to derive total sector and national emissions.

Nigeria-specific emission factors are applied where available. Where national values are unavailable, internationally recognized IPCC default factors are used, ensuring methodological credibility.

3.3 Data Requirements and Sources for LEAP

The robustness of LEAP outputs depends heavily on the quality of data used. The model integrates data from multiple sources including:

a.) National Data Systems

- Nigeria's National GHG Inventory Reports,
- Official national statistics,
- Energy Commission of Nigeria datasets,
- Power sector operational data,
- Ministry of Petroleum and NUPRC oil and gas data,
- Transport and industrial sector consumption records.

b.) Policy Documents and Strategic Frameworks

These guide scenario inputs and assumptions:

- Nigeria Agenda 2050
- Nigeria's NDC 3.0
- Energy Transition Plan (ETP)
- Long-Term Low Emissions Development Strategy (LT-LEDS)
- Climate Change Act implementation frameworks.

3.4 Construction of the Three Scenarios in LEAP

After the LEAP model structure is established and base year is calibrated, the next step is scenario development. LEAP allows each scenario to branch from the same baseline but evolve differently based on policy, technology, and behavioural assumptions.

a.) BAU in LEAP

The BAU scenario in LEAP is constructed by extending historical trajectories while assuming:

- no additional intervention beyond already existing measures,
- persistent diesel generator dependence,
- continuation of fossil fuel-led electricity generation,
- limited clean cooking penetration,
- ongoing growth in industrial, transport, and household energy demand,
- continued flaring and fugitive methane emissions in oil and gas operations.

This provides the counterfactual emissions pathway against which mitigation actions are assessed.

b.) WM in LEAP

The WM scenario overlays policy-measures explicitly included in NDC 3.0 onto the BAU trajectory. This includes:

- renewable energy expansion targets,
- electricity sector efficiency improvements,
- methane reduction measures in oil and gas,
- clean cooking transition initiatives,
- selected transport efficiency improvements,

- and industrial sector policy commitments.

LEAP models these changes by:

- adjusting fuel shares,
- modifying efficiency inputs,
- altering technology penetration rates,
- applying emission reduction factors where appropriate.

This produces an emission pathway representing successful implementation of current commitments.

c.) WEM in LEAP

The WEM scenario includes more transformative measures derived from:

- Energy Transition Plan (ETP),
- LT-LEDS long-term strategies,
- advanced mitigation opportunities.

In LEAP, this scenario involves:

- substantial shifts in power generation to renewables,
- drastic reduction in decentralized diesel generation,
- rapid clean cooking penetration beyond NDC scope,
- expansion of biomass substitution in industry (including POME, bagasse, sawdust briquettes),
- deep transport transformation,
- and near elimination of routine methane emissions.

This scenario represents the highest level of ambition and illustrates Nigeria's trajectory toward long-term net zero objectives.

4.0 GHG Impact Assessment

This chapter presents a comprehensive assessment of the GHG impacts of key national mitigation frameworks within the energy sector, NDC 3.0, the ETP, and the LT-LEDS. The assessment evaluates how each framework influences the trajectory of energy sector emissions relative to a BAU pathway and examines the degree of alignment and coherence among these mitigation instruments.

The analysis adopts a scenario-based modelling approach, implemented using the LEAP model, to project energy demand, fuel supply, technology deployment, and associated GHG emissions over the assessment period. The LEAP model enables the quantification of emissions under alternative policy pathways while ensuring consistency in assumptions, data sources, and methodological treatment across scenarios.

4.1 Business as usual Scenario

The BAU scenario represents the reference case against which all mitigation impacts are assessed. It describes the evolution of energy sector GHG emissions in the absence of additional climate mitigation policies beyond those implicitly embedded in historical trends and current structural conditions.

Under the BAU scenario, future energy demand is driven primarily by:

- Population growth and urbanization.
- Economic expansion and industrialization.
- Rising electricity demand from households, services, and industry.
- Continued reliance on fossil fuels as the dominant energy source.

The BAU pathway assumes:

- No explicit carbon pricing or emissions constraint.
- Limited improvements in energy efficiency beyond historical averages.
- Continued dominance of fossil fuel-based electricity generation.
- Persistence of current oil and gas operational practices, including methane leakage and routine flaring at prevailing intensities.

- Gradual but insufficient penetration of renewable energy technologies.

4.2 Fuel Mix under the different Scenario

It is assumed under the scenarios considered that fossil fuels will continually be used for a long time. While this is more extensive under the BAU scenario, it is expected that it will drastically reduce under the With Measures and With Extra measures scenarios.

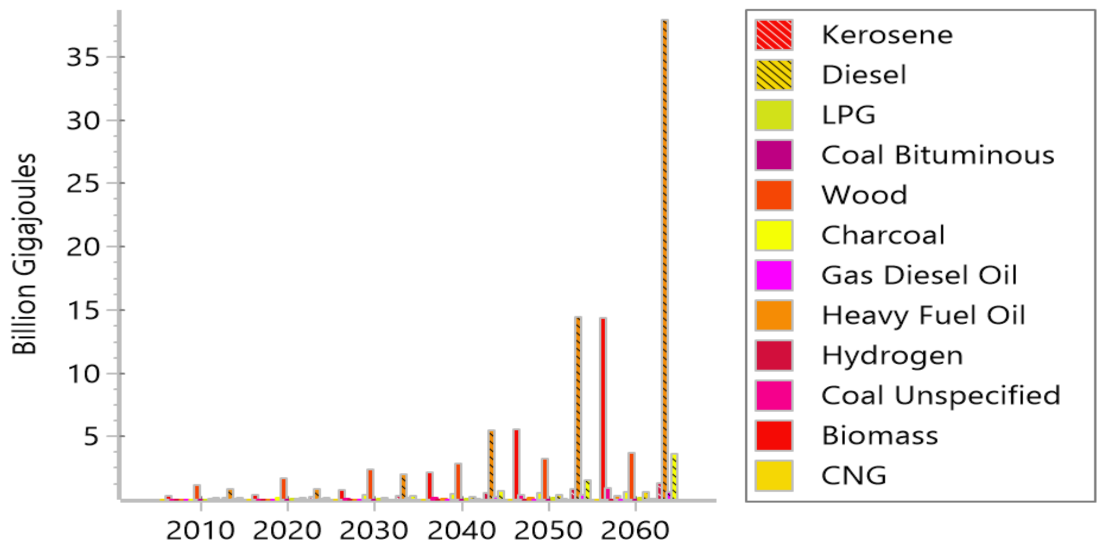

Figure 1: Final Energy Demand Scenario: Business as Usual (Fuel Mix)

The energy demand scenario under the business-as-usual scenario expects that the off-grid power generation using diesel will be increased and peak around 2060. Fuels such as kerosene, are expected to be out of use completely for cooking before 2030 and will be replaced by efficient biomass stoves in rural areas and use of LPG which is expected to grow due to the ongoing national concept of 'decade of gas'. It is expected that natural gas will also be utilised as identified under the business as usual as the transition fuel.

Within the LEAP modelling framework, the BAU scenario is constructed using:

- Sector-specific activity growth projections.
- Existing technology stocks and replacement rates.
- Constant or slowly improving efficiency parameters.
- Fuel shares extrapolated from historical patterns.

GHG emissions under the BAU scenario are expected to increase steadily over the projection period, reflecting the strong coupling between economic growth, energy demand, and fossil fuel consumption. This scenario establishes the counterfactual against which the emissions impacts of policy interventions under the NDC, and ETP are measured.

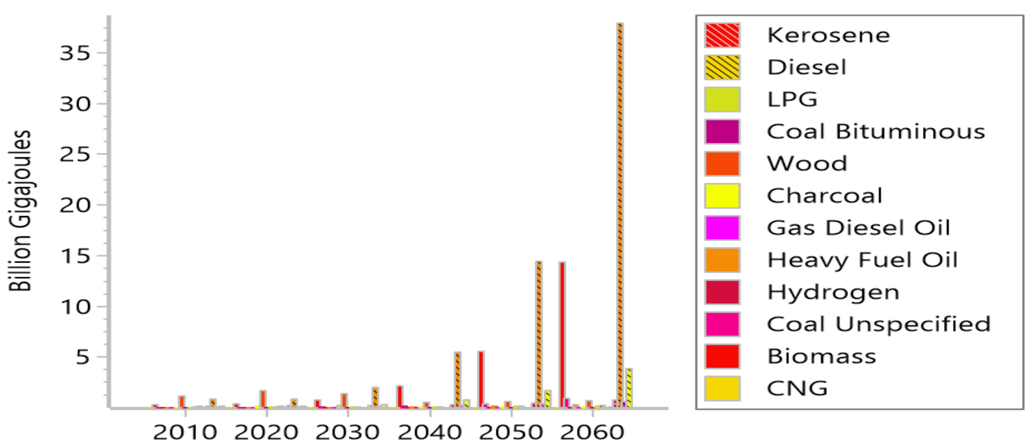

Figure 2: Final Energy Demand Scenario: With Measures (Fuel Mix)

The energy demand scenario under the With Measures scenario expects that the use of natural gas for power generation and LPG for cooking will be increased up till 2035 as gas is identified under the business as usual as the transition fuel. Nevertheless, diesel will also continue to be used for off-grid power generation. Growth in Energy demand under the WM and BAU are about same considering that NDC time overview is 2035 and the BAU was based on the Nigeria Agenda 2050.

Within the LEAP modelling framework, the WM scenario is constructed using the same approach as the business as usual. GHG emissions under the WM scenario are expected to reduce over the projection period till 2035 and beyond. However, it should be noted that considering the country is continually expected to develop reflecting increasing economic growth, energy demand, and fossil fuel consumption, the difference in the GHG emissions under the BAU and WM reduces over the years even when the mitigation actions under the WM are sustained.

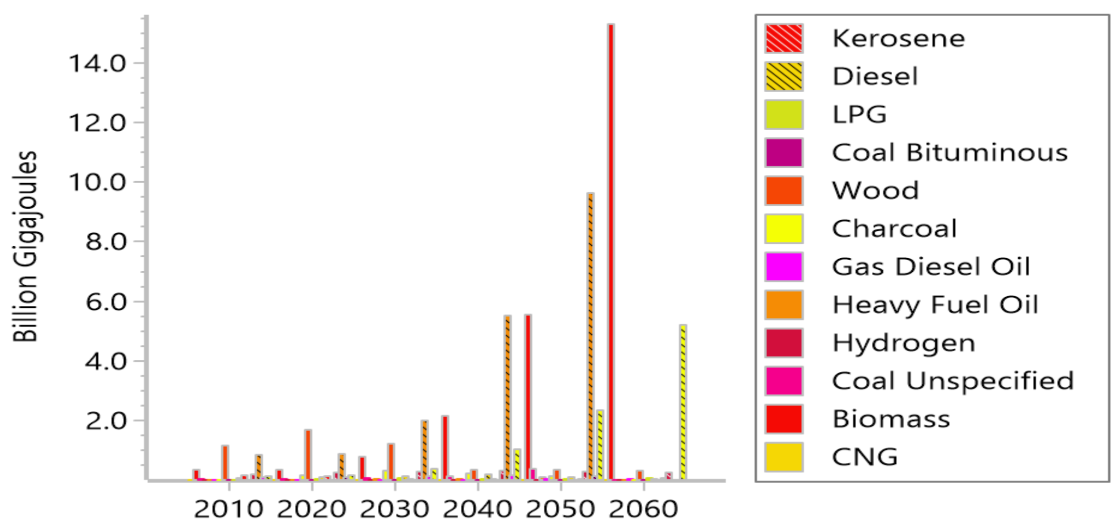

Figure 3: Final Energy Demand Scenario: With Extra Measures (Fuel Mix)

The energy demand scenario under the With Extra Measures scenario expects that the use of natural gas for power generation will peak around 2040 to 2045. Hydrogen is expected to play a role in the energy mix starting from 2045. LPG use for cooking will peak around 2050 and electricity for cooking will become more popular. Most electricity consumed in the country is expected to come from Renewables and Hydrogen as two main sources of energy. The consumption of diesel be increased up till 2035 as gas is identified under the business as usual as the transition fuel. Nevertheless, diesel will also continue for off-grid power generation.

Within the LEAP modelling framework, the WEM scenario is constructed using the same approach as the business as usual and WM. GHG emissions under the WEM scenario are expected to reduce drastically over the projection period till 2060 and beyond. However, it should be noted that the country is expected to drive its mitigation action largely due to drop in use of fossil fuels and significant increase in consumption of renewable energy technologies and hydrogen as fuel source. Residential, Industrial and Transport is expected to be driven by electricity that is produced from significantly renewable energy especially solar. It is expected that with expected increasing economic growth and energy demand, off-grid power generation using solar will dominate the country and the difference in the GHG emissions compared to the BAU and WM is expected to be highly significant.

4.3 GHG Impacts Assessment under the various Scenarios

Emissions under the business as usual in the country could hit high levels of about 1.5 billion tons of CO_2 equivalent should the development plan of the country go as planned without mitigation action considerations. The GHG emissions is expected to continue to grow as much as the economic growth and energy demand rise that takes place in the country.

Also, NDC action plan implementation without any further action beyond 2035 is likely to lead to about 850million tonnes of CO_2 equivalent by 2060. This is due to the fact the country is still in its expected developmental stages and access to energy is expected to increase drastically, especially post NDC 3.0 implementation stage. However, the ETP plan is expected to lead to significant emission reduction which could be less than 80,000 tons of CO_2 equivalent by 2060 should all mitigation action plans stated in ETP and LT LEDS be implemented.

It should be noted that the considerations described above and shown in figure 4 are based on the energy-related activities in the country. It excludes emissions from all other sources and sectors in the country.

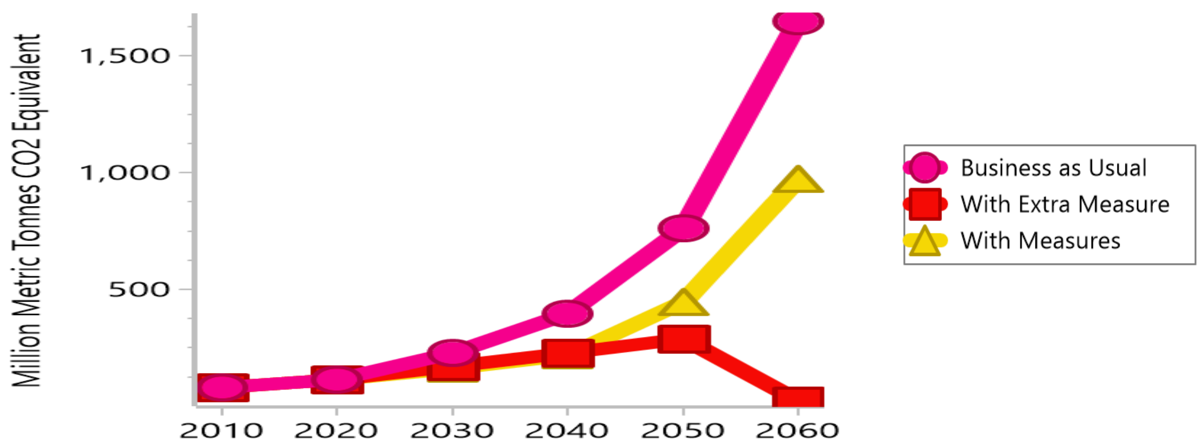

Figure 4: Emission Scenarios under BAU, WM and WEM

4.4 Alignment of the NDC and ETP

Energy demand under the three scenarios assumes that the fundamental key drivers are the GDP and population growth rates remain the same regardless of the scenario option. It is assumed that while the key assumptions remain the same, various energy policies and measures related to the NDC 2030 target and ETP by 2060 determine the energy demand and supply growth. The more communities and rural areas are urbanised in the next 20 years the more energy is consumed.

With increasing urbanisation, more energy is expected to be consumed, especially for cooking, power, industries, services, and agriculture. While energy demand for transportation under the business-as-usual scenario is expected to increase, energy requirements for transportation is likely to be reduced should modern forms of transportation be introduced as indicated under the NDC and ETP mitigation measures.

Nigeria's available electricity generation capacities hover around 3.5 – 5 GW of electricity with installed generation capacity in Nigeria as of 2026 is about 15 GW. The NDC and ETP has described expected growth in electricity generation to increase significantly and the ETP suggests it will hit significant growth of about 297GW by 2060. The historical trend suggests otherwise considering the several technical, commercial, and cultural issues that have made it impossible to increase available capacity.

Off-grid power generated for homes, industries, and commercial buildings under both the NDC 3.0 and ETP are expected to grow. While under the BAU the major driver is expected to be diesel, natural gas and solar. The NDC suggests the growth will be driven by natural gas and some solar installations whereas the ETP suggests growth in off-grid power driven by mostly renewable energy technologies especially solar. It is assumed that off-grid generation will increase rapidly beyond 2030, constituting about 50 % of the electricity consumed in homes before the country experience massive growth in the areas of grid-based power generation. This assumption is supported by the pace of mini-grids, Solar Home Systems (SHS) and interconnected mini-grids experienced in the country in almost all sub-nationals in the country.

The key driver for cooking has been the use of LPG and efficient stoves. While the NDC presents more of efficient biomass stoves and LPG types of stoves in urban areas. The ETP considers this only as temporal situation and expects electricity power generation to replace the LPG stoves and biogas to replace biomass stoves in the rural areas.

The output of production of crude oil in Nigeria currently can be considered to have nosedived owing to several factors, which include divestment of assets by the international oil and gas companies, security challenges and activities of vandals, lack of funding opportunities for fossil fuel to accelerate drilling campaigns. Crude production has hovered between 1.4 and 1.8 million barrels per day for the past four years (2020 – 2023), against the average of 1.8 to 2 million barrels per day in 2016 – 2020. The NDC expected flare to end by 2030 which is in alignment with the ETP. The ETP suggests production will peak before 2040 and this is contrary with the Nigeria Agenda that consider oil to peak by 2040.

Natural gas is aimed to peak around 2045 according to National Agenda, 2050 and supported by both the ETP and corroborated by NDC 3.0 which considers natural gas as transition fuel. The trajectory of gas production in the country shows expected increase drastically by 2030. However, this is possible only if the country is committed to the policies on massive gas utilisation for industries, transportation, power, and households.

4.4.1 Approach: Implementation framework for the Alignment of the three mitigation actions

Table 2: Sectoral Mitigation Actions and Alignment with NDC 3.0 and ETP

Sector	Mitigation Action	NDC 3.0	ETP	Alignments
Power / Electricity	Renewable energy expansion	52% RE share by 2030	Accelerated solar, hydro, and grid expansion; 7 GW annual addition and use of hydrogen around 2045.	All frameworks promote RE; LT-LEDS provides long-term decarbonization pathway
	Fossil fuel reduction / efficiency	Efficiency improvements in gas plants	Reduced diesel generator reliance, gas optimization	ETP operationalizes mid-term efficiency and fuel shift; LT-LEDS long-term view
Transport	Vehicle fuel efficiency / electrification	30% EVs, 20% CNG vehicles by 2035	Urban transport reform, public transport upgrade	NDC sets near-term targets; ETP operationalizes; LT-LEDS sets horizon goal
	Modal shift & urban planning to reduce emissions	Limited	BRT, traffic management, congestion reduction	Reinforces integrated mobility approach across policies

Household energy / cooking	Clean cooking transitions	Promote LPG and efficient stoves	Rapid adoption of LPG, bioenergy, electric cooking	All frameworks emphasize health and emissions co-benefits; WAM / LT-LEDS most ambitious
Oil & Gas	Gas flaring reduction	Eliminate routine flaring by 2030	87% reduction in flaring & fugitive emissions	ETP bridges NDC commitment with LT-LEDS long-term net-zero trajectory
	Methane leak reduction	60% fugitive reduction by 2035	Strengthened monitoring, LDAR programs, efficiency	Strong alignment; ETP operationalizes NDC ambition

5.0 Conclusion & Recommendations

5.1 Conclusion

This report demonstrates that Nigeria's future emissions trajectory is highly dependent on the level of ambition, coherence, and effectiveness of policy implementation within the energy sector. The scenario analysis clearly shows that while the BAU pathway leads to a significant increase in GHG emissions driven by economic growth and rising energy demand, the implementation of existing commitments under NDC 3.0 (With Measures scenario) is only sufficient to moderate, but not reverse, this trend.

The analysis further highlights that achieving substantial and sustained emissions reductions requires a transition beyond incremental improvements toward a more transformative approach as represented in the With Extra Measures (WEM) scenario. This pathway, aligned with the ETP and LT-LEDS, demonstrates that deep decarbonization of Nigeria's energy system is technically feasible but highly dependent on accelerated deployment of renewable energy, significant reduction in fossil fuel dependence, elimination of methane emissions, and large-scale electrification across key sectors.

Importantly, the report underscores that Nigeria's climate policy frameworks NDC 3.0, ETP, and LT-LEDS are broadly aligned in ambition but require stronger integration to avoid overlaps, inconsistencies, and implementation inefficiencies. The effectiveness of these frameworks will ultimately depend on coordinated execution, realistic planning assumptions, and sustained investment.

In conclusion, while Nigeria has established a strong strategic foundation for transitioning to a low-carbon energy system, the realization of its net-zero ambition by 2060 will depend on its ability to move from policy design to effective implementation, ensuring that mitigation actions are not only well-defined but also practical, scalable, and fully aligned across all sectors of the economy.

5.2 Recommendations

Effective alignment requires an integrated implementation framework that ensures policy coherence, institutional coordination, and consistent monitoring.

There is need to adopt the NDC 3.0 blended with ETP and LT LEDS for the purpose of achieving the following:

- Projected future planning – allows peeking into the future when planning investments.
- Proactiveness – to guide the country in tracking its implementation processes to avoid or reduce the potential of not meeting the target due to uncontrollable factors, ensuring the country aggressively prevents worst-case scenarios.
- Avoiding risk and failure—Poor investment decisions are avoided while implementing mitigation projects.

In summary, the key elements of the proposed framework include:

- Harmonized modelling assumptions and data systems.
- Integrating MRV mechanisms to track progress across all frameworks.
- Clear institutional roles and responsibilities to monitor the mitigation actions and activities.
- Reconciling the various mitigation actions in the NDC, ETP, LT LEDS to ensure sustainable growth under similar mitigation actions
- Phasing implementation and aligning with investment cycles to ensure that the various actions are not just based on design but implementable actions.
- Need for a feedback loop to update NDC targets based on ETP and LT-LEDS outcomes.

When aligned effectively, the three frameworks will reinforce one another therefore enabling a transition from incremental emissions reductions to structural decarbonization of the energy sector.

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