GREEN PROTOCOL GP

NIGERIA ENERGY

ENERGY PATHWAY ANALYSIS

Foreword

The spectre of climate change looms large, presenting a challenge that transcends borders and generations. Every corner of our planet, including the very lands and waters that cradle Nigeria, is at risk, rising sea levels, shifting weather patterns, increasingly erratic climate phenomena and global geo-political uncertainties have made their presence felt, signaling the need to swift decision action.

Nigeria stands resolute in joining the international community in combating this existential threat. Our motivation is twofold: it is both our ethical responsibility to safeguard our planet and the unique prospect to refine our nation's trajectory towards sustainable growth and prosperity. We can chart a course that intertwines economic growth with environmental stewardship by harnessing the vast potential of the renewable energy sources.

Context & Objectives

Nigeria, with its diverse economy and abundant natural resources, faces significant energy challenges and opportunities. According to the country's NDCs, the agriculture, industry, oil and gas, power, transport, waste, and water sectors each play a crucial role in the country's energy landscape. To address these challenges and harness opportunities, a comprehensive energy scenario analysis is essential. This analysis will evaluate possible future pathways of Nigeria's energy systems under various assumptions and conditions, aiding in the formulation of robust, sustainable energy policies and strategies.

Objectives:

1. **Assessment of Current Energy Landscape**: Evaluate the current state of energy consumption, production, and distribution across the specified sectors in Nigeria.

2. **Development of Energy Scenarios**: Develop and analyze multiple energy scenarios for Nigeria up to 2050, considering technological, economic, environmental, and social factors.

3. Sector-Specific Analysis: Oil and Gas Sector: Examine scenarios for managing reserves, reducing flaring, and transitioning to renewable energy.
Power Sector: Evaluate the potential for expansion of renewable energy sources, grid improvements, and electrification rates.
Transport Sector: Analyze the impact of electrification, biofuels, and efficiency improvements on energy demand.

4. Policy and Strategy Recommendations: Provide recommendations for energy policies and strategies that support sustainable development, energy security, and environmental sustainability in each sector.

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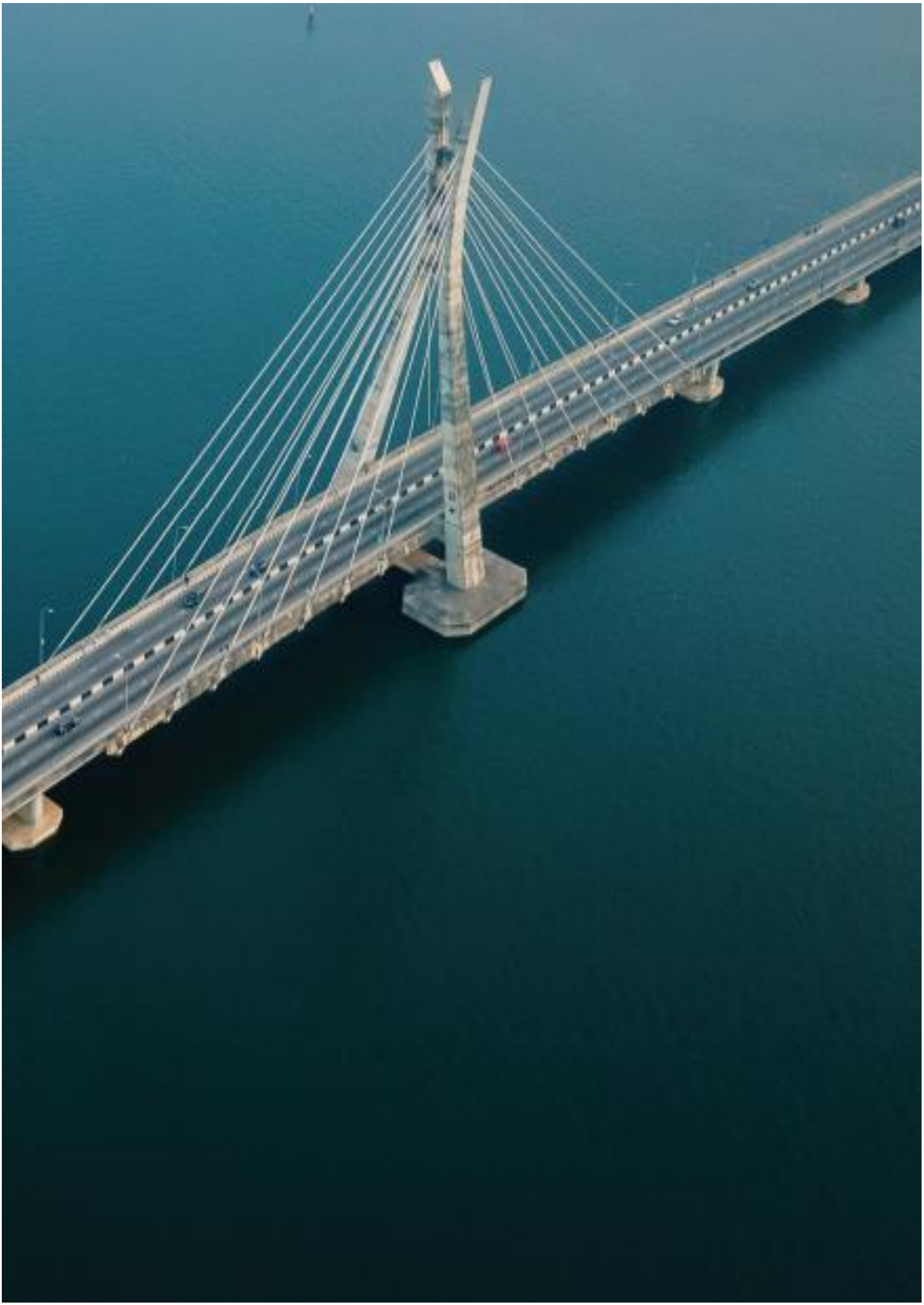


Executive Summary

Without further action, Nigeria's emissions could rise from 129 Mt CO2e in 2022 to about 2000 Mt in 2050. Under Business-As-Usual (BAU), the bulk of emissions growth will come from transport, driven by population growth, GDP per capita growth, and vehicle ownership.

Alternative Net Zero pathways consider five country-level objectives or guiding principles: environmental sustainability, energy system costs, economic impact, social implications, and security of supply.

AN ORDERLY TRANSITION TO NET ZERO

Nigeria could achieve Net Zero CO2 emissions by 2060, through the deployment of low- carbon solutions across all sectors. A 2060 target could achieve an orderly transition, balancing public-policy objectives.

Four main decarbonization technologies will anchor an Orderly Transition. Together, renewables, low-carbon hydrogen, battery electric vehicles and clean cookstoves cover over 90% of 2060 abatement.

SOCIOECONOMIC IMPACTS AND FINANCING NEEDS

The Energy Transition Plan (ETP) is set to lift over 100million people of poverty. In a Net Zero scenario, Nigeria would need around USD 1.9 Trillion in capital investment to 2060 (USD 410 bn more than under BAU), with most of the investment going to the power and transport sectors. Delivering this investment could drive new economic activity in the energy sector and beyond, potentially supporting an additional 840 thousand net new jobs by 2060.

Capital markets could provide the largest funding pool, but tapping these sources will require de-risking interventions.

THE PATH FORWARD

There is a set of clear next steps to drive the implementation of a pathway,

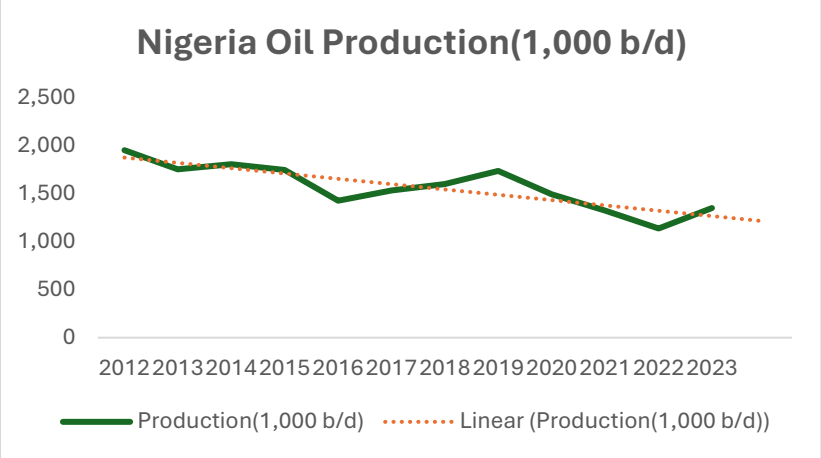
underpinned by strong governance, a clear timeline and cadence of interaction, and supportive policies.

Chapter One

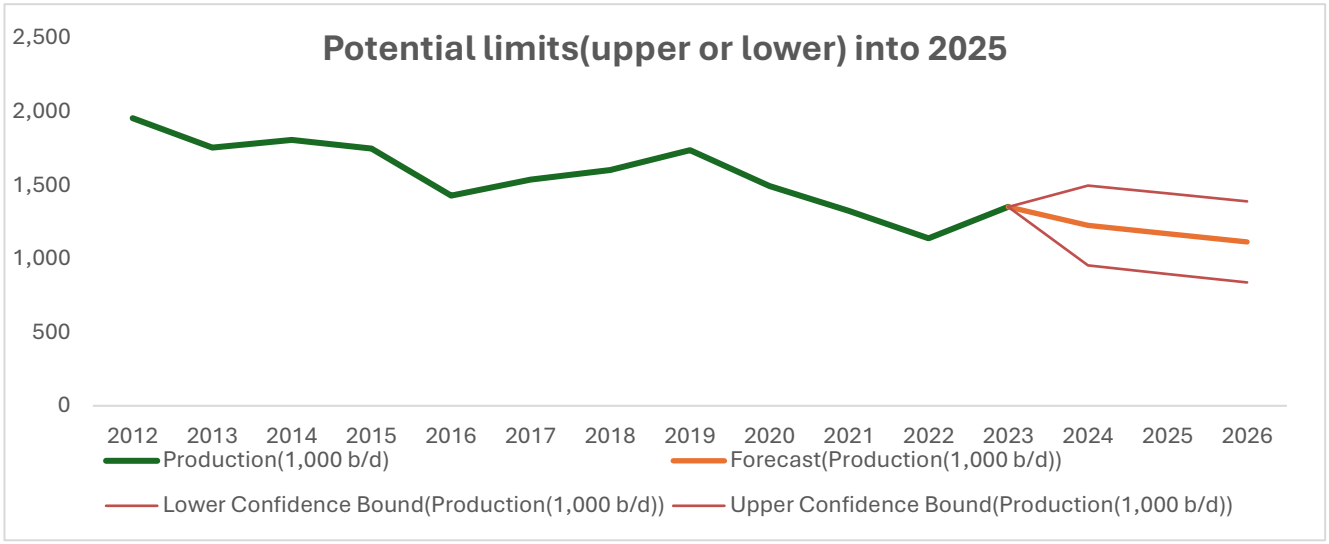
Current Energy Landscape

Nigeria currently ranks as the largest economy and richest oil resource centre of the African continent, as well as the largest gas consumer and producer of West Africa. The country's growing population and array of socioeconomic issues mean it needs sustainable energy sources to meet the increasing needs for all sectors of the economy. Currently, Nigeria's energy sector is heavily dominated by fossil fuels and traditional biomass, making it the 13th-largest producer and the 8th-largest exporter of crude oil in the world.

The Oil and Gas sector: Nigeria's oil production has been on a steady recovery trajectory since 2020 following consistent and repeated efforts by NNPC Ltd to fight crude oil theft. The country's oil and condensate production currently stand at some 1.5-1.6m barrels per day (bpd) and the ambition is to ramp this up pass the 2m bpd threshold in the years to come.



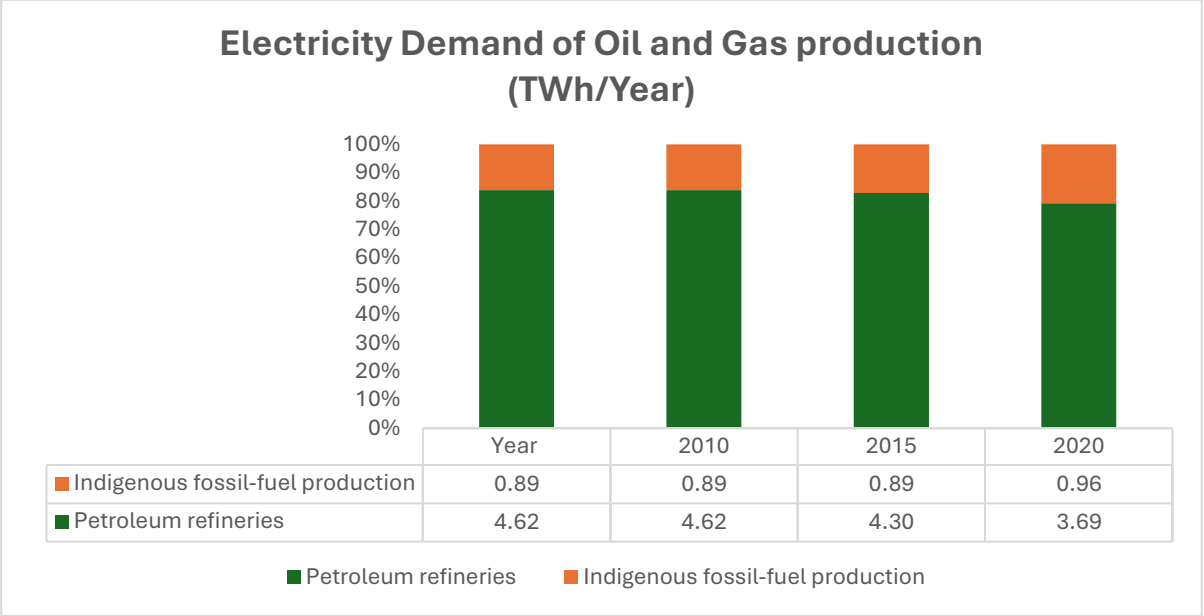
	Oil	Gas
Reserves	37.2 billion barrels	5.2 trillion cubic metres
Production	2417 thousand barrels	43.2 billion cubic metres
Average years of extraction remaining, calculated	42 years	120 years



Source: Nigerian National Petroleum Corporation (2023)

Nigeria is among the leading exporters of crude oil in the world, but it imports about 85% of its refined petroleum products due to low-capacity utilisation of its oil refineries (around 65%). gas only exploration projects, and the gas reserves consist solely of associated petroleum gas. Despite this, Nigeria exported more than 8% of

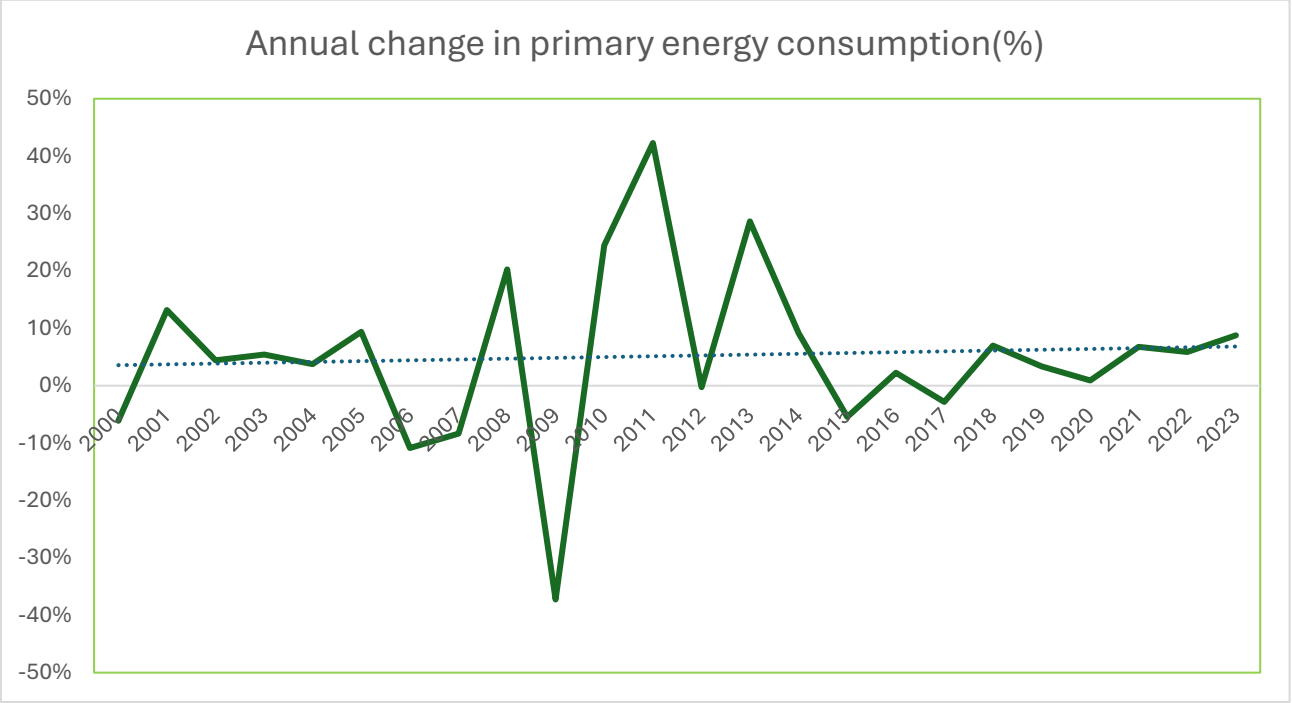
globally traded liquefied natural gas (LNG), making Nigeria the world's fourth largest LNG exporter in 2012.



Source: The World Bank data on Nigeria electricity demand (2022)

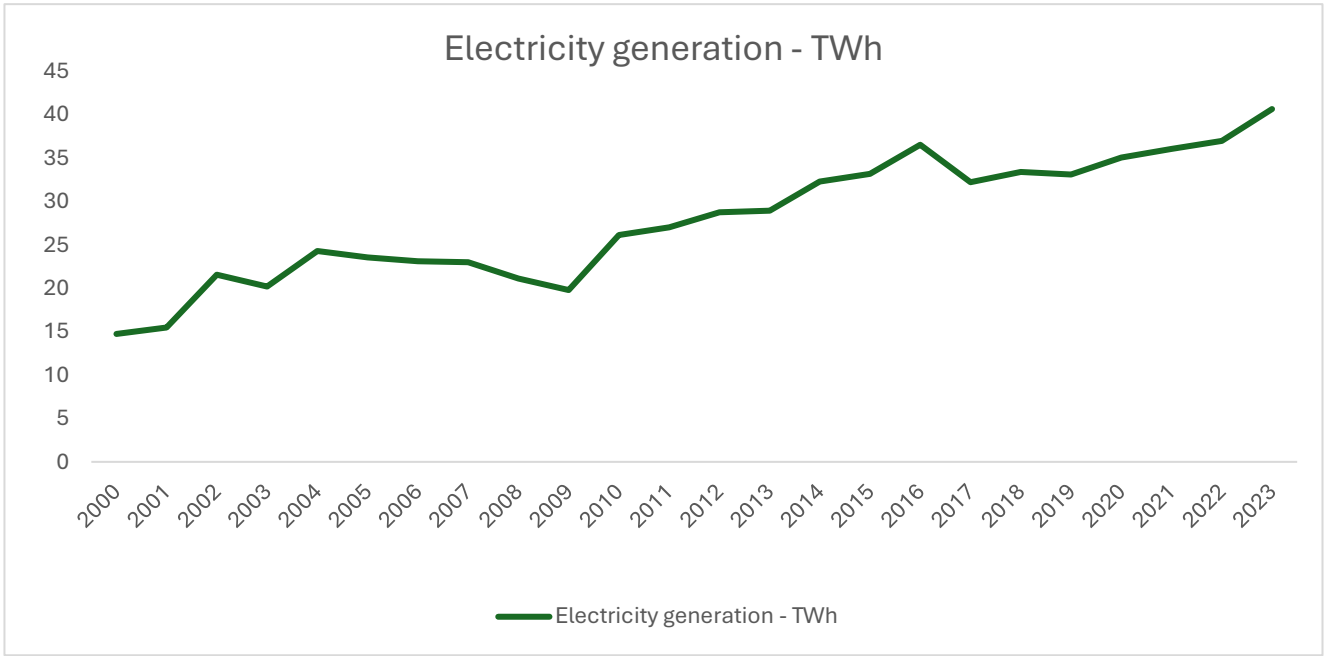
Power Sector: On Sunday, February 4, Nigeria witnessed its first national grid collapse in 2024. The situation led to the shutdown of all 20 power plants, except Ibom Power with 31 megawatts. That collapse makes it more than 200 grid collapses in the past 12 years for Africa's most populous nation, and energy experts have attributed the incessant grid collapse to technical issues and poor management.

Electricity in Nigeria is generated through thermal and hydropower sources. The primary source of electricity generation comes from fossil fuels, especially gas, which accounts for 86% of the capacity, however, this reliance has proven to be unsustainable due to fluctuating global prices, supply disruptions, and environmental concerns. As a result, there has been a growing recognition of the need to diversify the country's energy mix and integrate renewable energy sources. Below is a graph showing the change in primary energy consumption over the years.



Source: The World Bank data (2023)

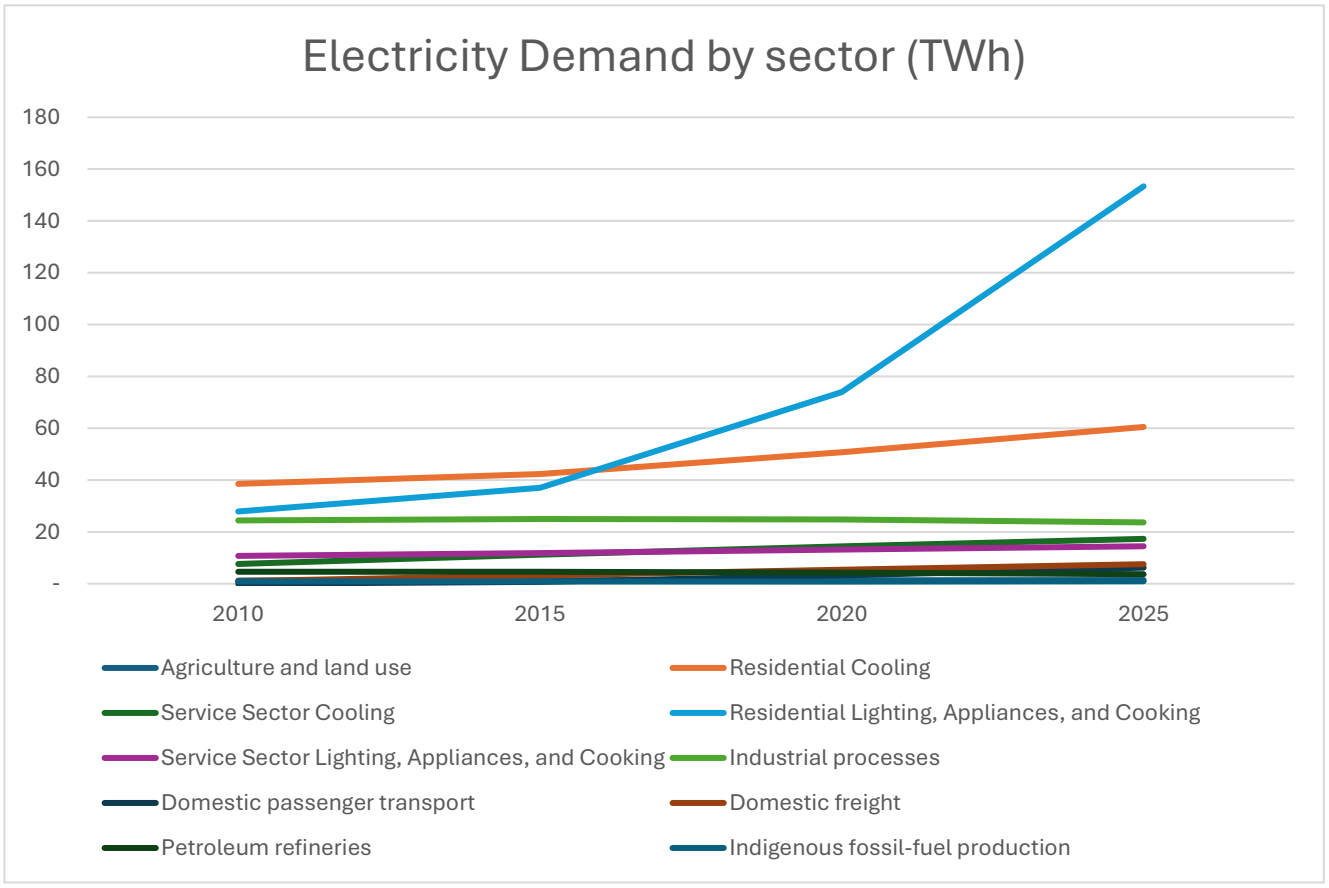
Currently, the power generation capacity of Nigeria is 16.4GW with the operational grid capacity of 6GW, with over 80% of operational energy capacity comes from off-grid diesel/petrol generators.



Source: The World Bank data (2023)

Sector (Electricity demand TWh/Y)	2010	2015	2020	2025
Agriculture and land use	1.24	1.30	1.36	1.44
Residential Cooling	38.55	42.36	50.71	60.50
Service Sector Cooling	7.64	11.16	14.39	17.33
Residential Lighting, Appliances, and Cooking	27.90	37.00	74.01	153.36
Service Sector Lighting, Appliances, and Cooking	10.75	11.88	13.18	14.46
Industrial processes	24.45	24.98	24.83	23.68
Domestic passenger transport	-	0.76	3.19	6.22
Domestic freight	1.04	3.21	5.38	7.54
Petroleum refineries	4.62	4.62	4.30	3.69
Indigenous fossil-fuel production	0.89	0.89	0.89	0.96
Total	117	138	192	289

Source: The African Policy Research institute (2022)



Source: The African Policy Research institute (2022)

KEY OUTCOMES

- Residential energy demand makes up more than 60% of total energy demand. This is due to the rapid population growth.
- Industrial energy demand, mostly for cooling and production make up about 15% today demand.

Chapter Two

Pathway Analysis

Some principles to be considered when planning NetZero for Nigeria.

Investment:
Create conditions for investment into Nigeria's energy system by pursing an energy mix that is aligned with international investor appetite.

New Growth Sector:
Optimize for macroeconomic benefit, supporting economic activity in the energy sector and wider economy.

Environmental sustainability:
Reduce carbon emissions to reach Net Zero and minimize the overall carbon budget for Nigeria to align with international investor expectations.

Affordability:
Minimize energy costs to the Nigerian population and energy-dependent domestic sectors.

Energy security and trade balance:
Ensure system security through self-sufficiency, system stability, and low-risk access to supplies, e.g., free-up a greater share of Nigeria's oil and gas consumption for export under Net Zero vs BAU.

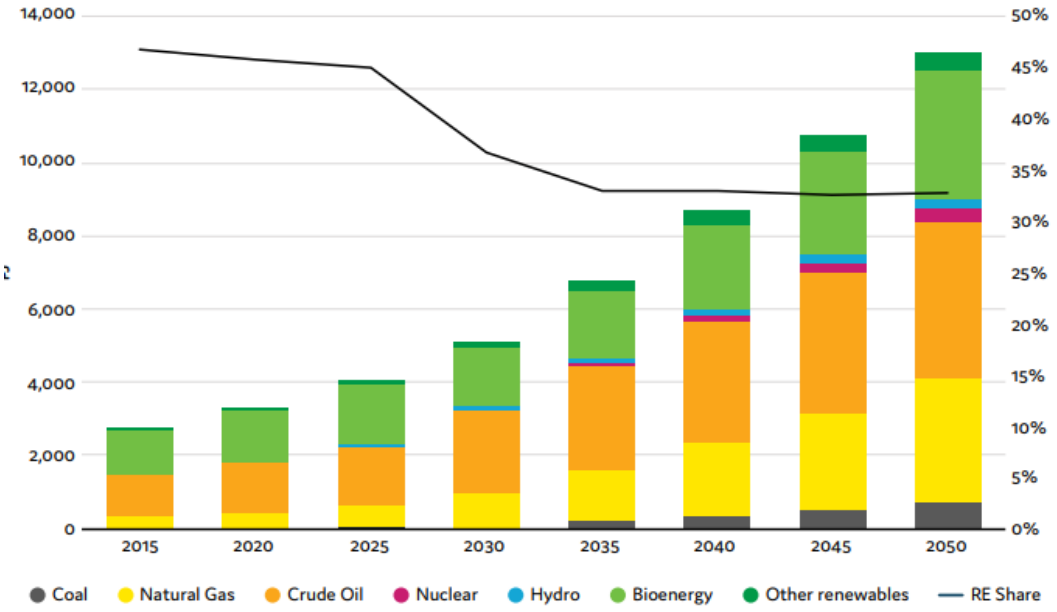
Employment impact:
Solve for job retention and future job creation potential from decarbonizing Nigeria's economy.

Major decarbonization technologies that will anchor an orderly transition pathway till 2050.

TECHNOLOGY					
ELECTRIFICATION & RENEWABLES	CARBON CAPTURE & STORAGE	LOW-CARBON HYDROGEN	BATTERY ELECTRIC TECHNOLOGIES	CLEAN COOKING TECHNOLOGIES[1]	NEGATIVE-EMISSION SOLUTIONS
CONTRIBUTION					
Replace fossil fuels through electrification; power provided by solar, wind, biofuel and potentially nuclear energy in combination with energy storage	**Decarbonize industrial and/or high temperature heating processes by capturing energy and process-related** CO_2 streams (e.g., cement or chemicals)	**Substitute fossil fuels as a heat source and/or feedstock with green and blue hydrogen** and hydrogen derivatives (e.g., ammonia, synfuels) in Industry and Transport	**Replace internal combustion engines with electric batteries**, primarily for passenger cars, 2/3 wheelers and light trucks	**Replace traditional biomass and oil-derivatives** (e.g., LPG and kerosene) **with improved biomass and electric cookstoves** in buildings	**Implement technology-driven solutions such as CCUS**

There are many factors that could influence the transition to NetZero till 2050 and beyond, below is a figure that shows the primary energy supply, which represents a view on energy supply based on current and planned policies under the predicted GDP growth rate.

The total primary energy supply is projected to reach 5138 petajoules (PJ) by 2030 and 13044 PJ by 2050. This indicates a rise by about five times in 35 years, largely attributed to the substantial expansion of the economy and population.



Source: The International Energy Agency (2023)

KEY OUTCOMES

- Bioenergy gained dominance around 2015 but its share will decline from 43% in 2015 to 33% by 2030 and 27% by 2050. while supply rises from 1 129 PJ in 2015 to 1 622 PJ by 2030 and 3 478 PJ by 2050.
- The share of crude oil in the supply mix rises from 45% by 2030 and then declines to 33% by 2050. The 2050 decline in the share of crude oil as primary energy supply mix is on account of the expansion of the utilisation of other energy sources such as natural gas as well as renewables.
- The share of natural gas rose from 18% in 2015 to around 24% by 2030 and 2050.
- The share of "other renewables" in the primary energy mix will grow modestly from less than 1% in 2015 to around 3.5% in 2030 and 4.3% by 2050. Thus, by 2030 and 2050 in the PES, renewables (hydro, bioenergy and "other renewables") will account for around 37% (2030) and 33% (2050) of the primary energy supply mix.

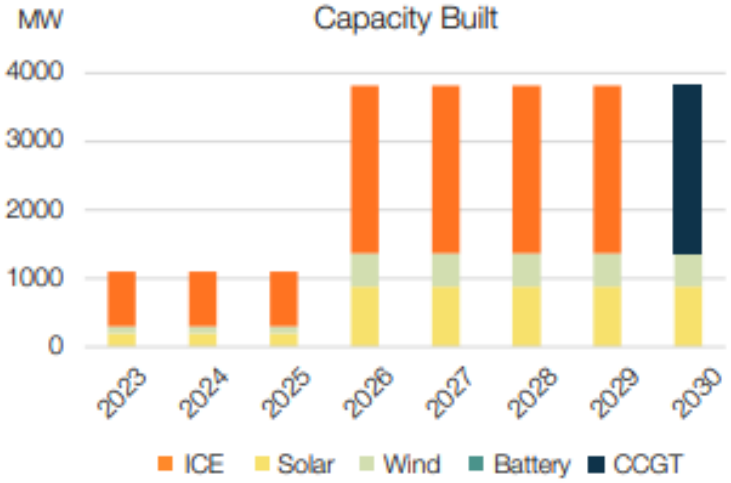
Projection one: 2023 - 2030
Building solid foundations for the decarbonisation of Nigeria's power system

Key actions

- Start investing in new solar and wind power capacity.
- Ramp up investments in flexible ICE power plants.
- Improve the transmission grid and gas distribution network.

By assumption, The Nigerian power system has been simplified into five major demand zones: Lagos, Benin-Delta-Enugu, Oshogbo-Ilorin, Abuja, and Kano.

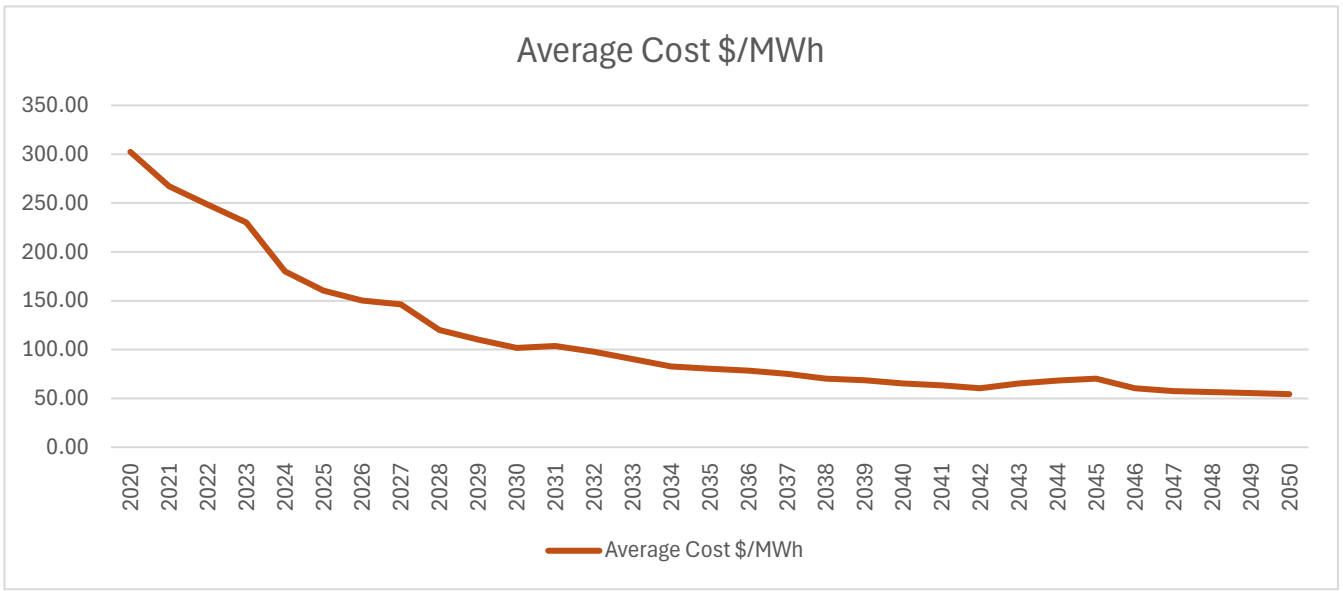
These regions are inter-connected with transmission lines and each region has a specific hourly electrical demand as well as its own hourly solar and wind generation profile. Today, the estimated peak load of the country is 30 GW, and it is expected to quadruple to 130 GW by 2050 – 2060.



Source: The carbon brief profile: Nigeria (2022)

Key Message

- By 2030, Nigeria could reach at least 5GW of solar and 3GW of wind energy added to its energy mix. This will mean renewables will make up about 12% of its generated electricity and 30% of the total installed capacity.
- With increased capacity, the average cost of electricity will fall drastically due to the use of LCTs (Low Carbon Technologies) and more use of natural gas compared to expensive diesel.

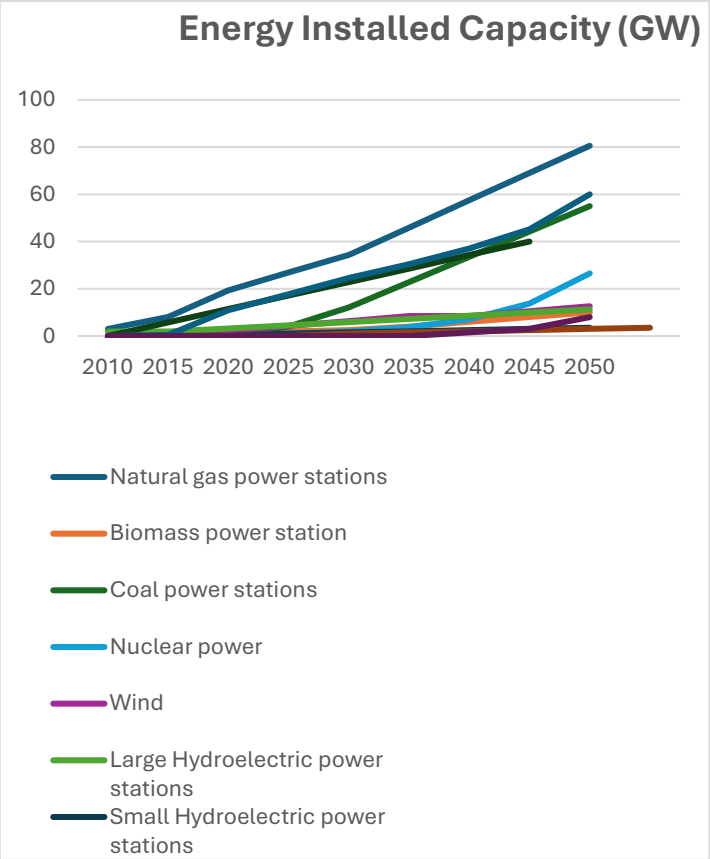


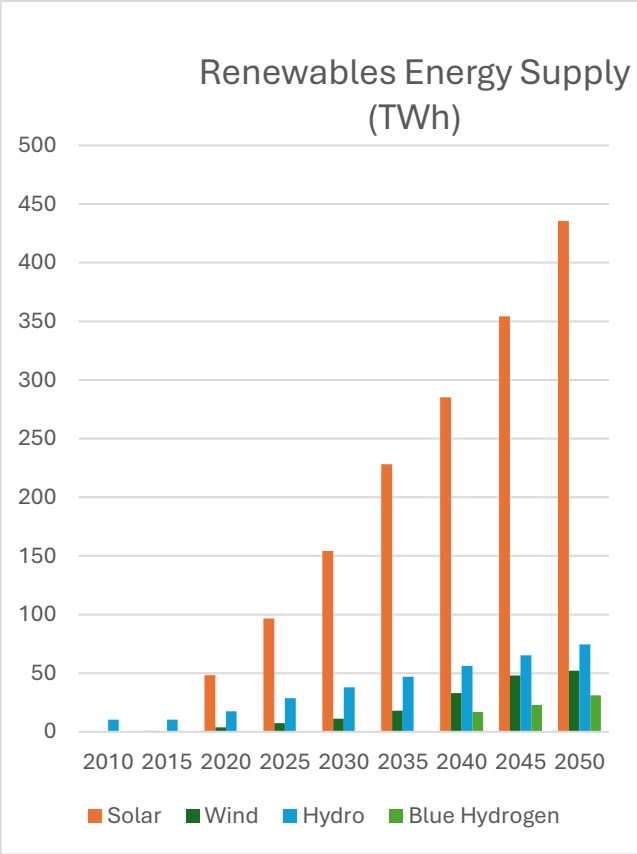
Source: The World Bank data (2020)
The Nigerian Electricity Regulatory commission (2020)

Projection two: 2031 - 2050
Ramping up the Decarbonization roadmap

Key actions

- more investment in flexible gas engine and increase the effort for more renewables to replace traditional diesel generator.
- Start investment in different energy storage technologies.
- Introduce carbon capture technology to reduce carbon footprint for gas-fired power plants.





Source: The Nigerian Energy Transition Plan (2023)
The World Bank data (2022)
The Rocky Mountain Institute (2021)

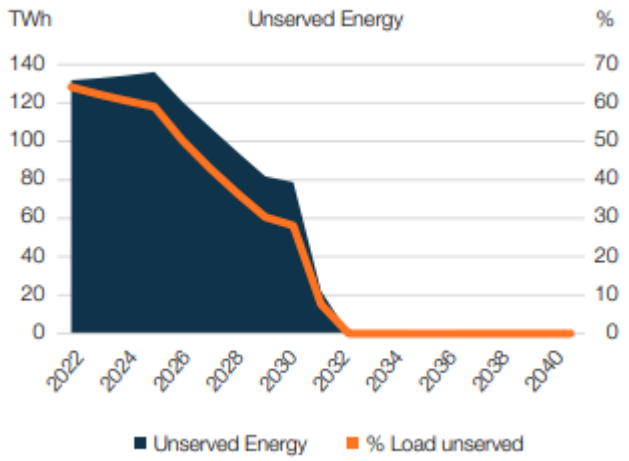
Key Message

- By the end of the decade, Nigeria will reach at least 150GW of renewables, of which at least 60-70% of will be solar energy.
- Geographically and based on best solar irradiation, most of the solar power plants will be installed in the northern part of Nigeria. Thermal power installation will also ramp up in the southern part of the country, reaching at least 15GW of installed capacity.

- Thermal power plants and additions in renewable energy capacity contribute to meeting the country's remaining unserved energy demand, which rapidly drops to zero by 2032.

- The increased capacity in the power system removes any dependence on expensive diesel generators, which become obsolete.

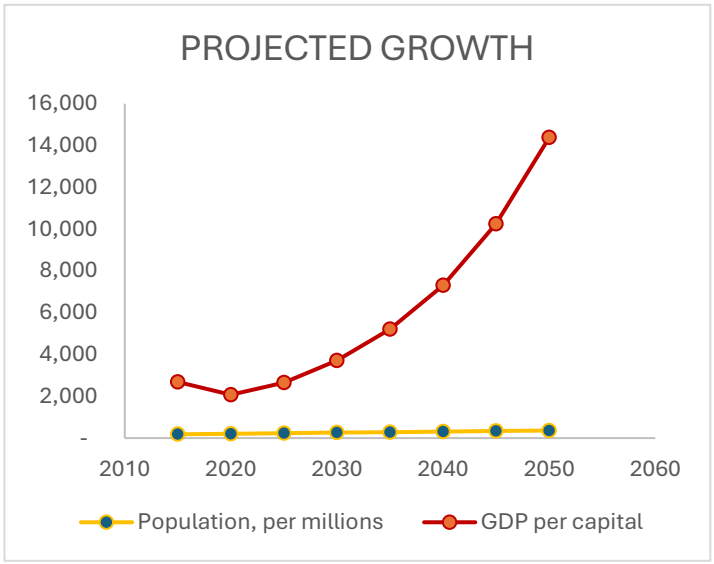
- Energy storage capacity is massively ramped up during the decade, with 24 GW of new additions, matching the rapid growth in intermittent renewable energy capacity. Carbon capture technologies are introduced to allow the country to continue using its natural gas resources whilst keeping carbon emissions at a lower level.

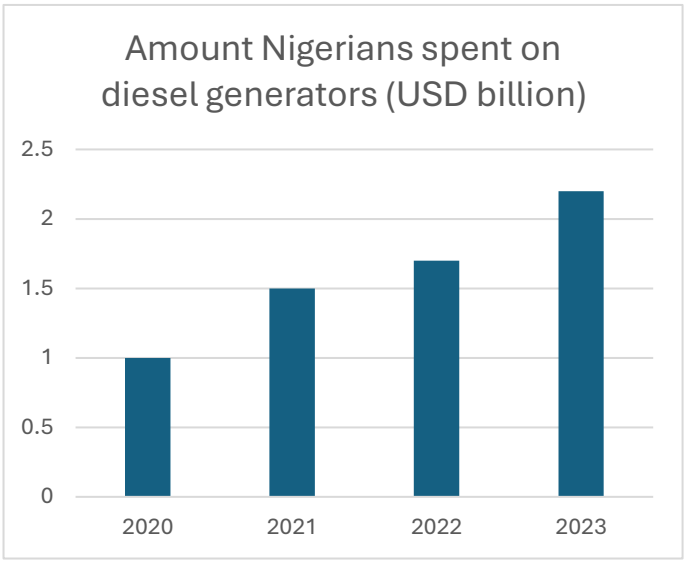


Source: The African Policy Research institute (2022)

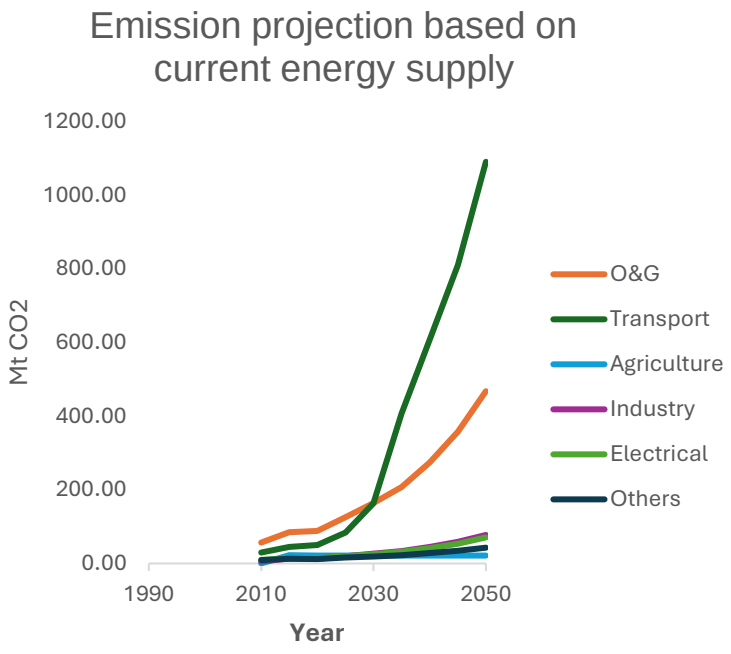
1. Business-As-Usual (BAU) Scenario

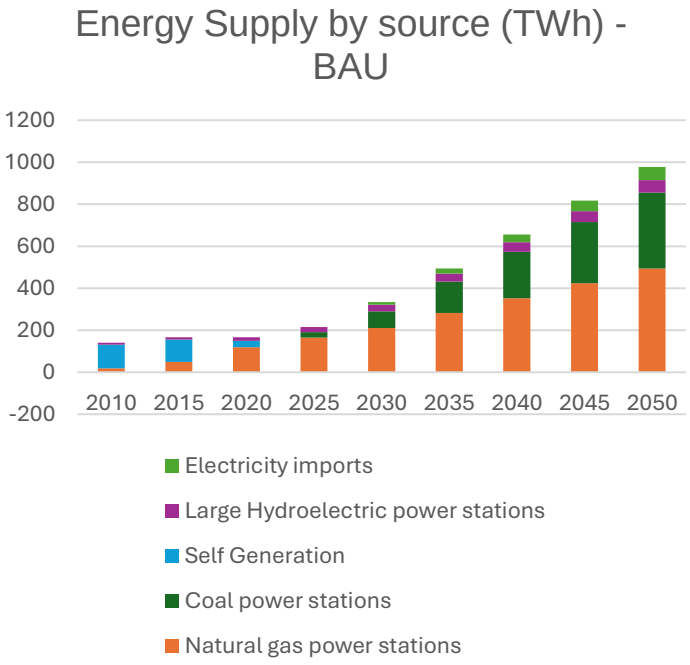
According to Nigerian Bureau of Statistics, and the World Bank, demographic projections show that the Nigerian population might experience a constant increase in the next decades. By 2050, it is forecasted that the population will grow to over 377 million people compared to 2022.






```Source: The National Bureau of Statistics (2023)




Source: The Carbon Brief Profile: Nigeria (2022)
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Technological Factor:

- Nigeria might rely on imports due to growing population.
- Continued reliance on fossil fuels, particularly oil and natural.
- Slow development of renewable energy sources.

Economic Factor:

- Moderate economic growth
- Investment in the energy sector continues at a steady but unremarkable pace.
- Energy infrastructure development is slow and insufficient to meet growing demands.

Environmental Factor:

- With BAU, Nigeria would be emitting up 2000MtCO2e annually.
- Environmental degradation from oil spills and gas flaring.

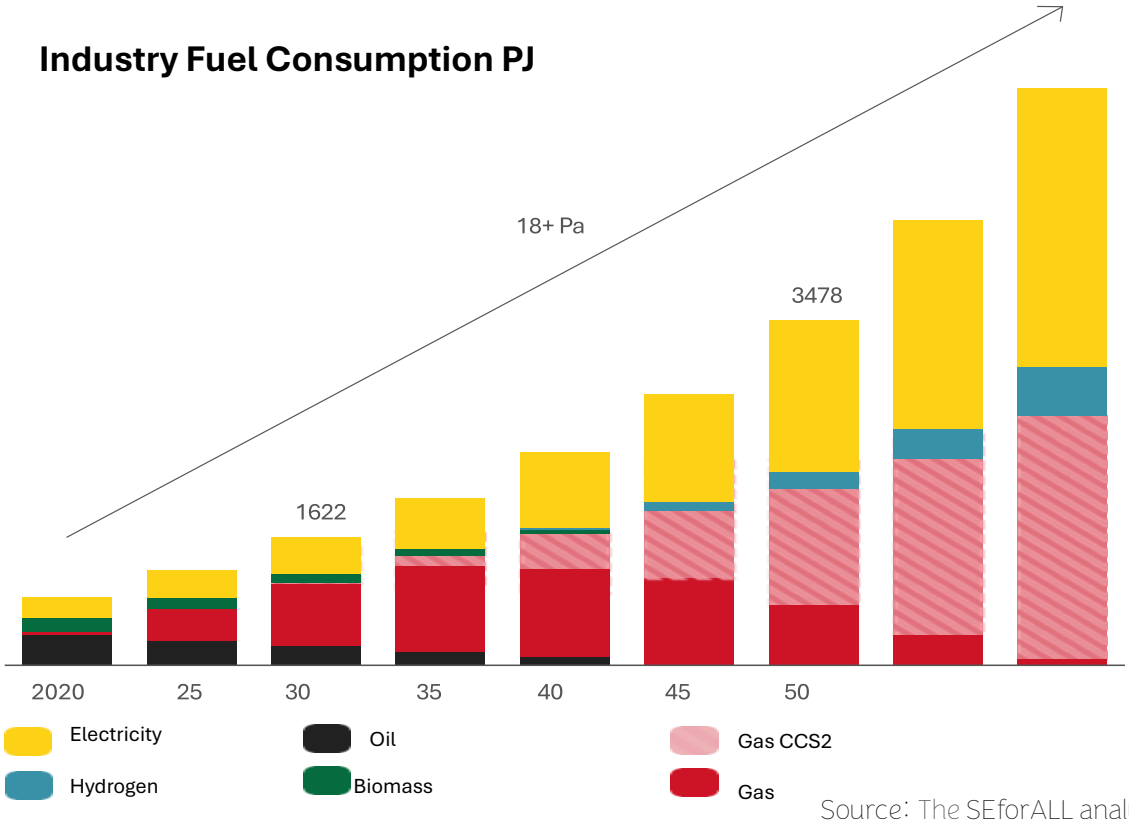
Social Factor:

- Slow improvement in energy access, especially in the rural areas
- Employment will loop, due to energy poverty.
- Health issues due to pollution

2. Green Growth Scenario

- According to the Nigeria Energy Transition Plan, gas will play a critical role as a transition fuel in Nigeria's net-zero pathway particularly in the Power and Cooking sectors. This can be seen in the figures below. Energy consumption will reach 1 129 PJ in 2015 to 1 622 PJ by 2030 and 3 478 PJ by 2050.

Industry Fuel Consumption PJ



Source: The SEforALL analysis (2022)

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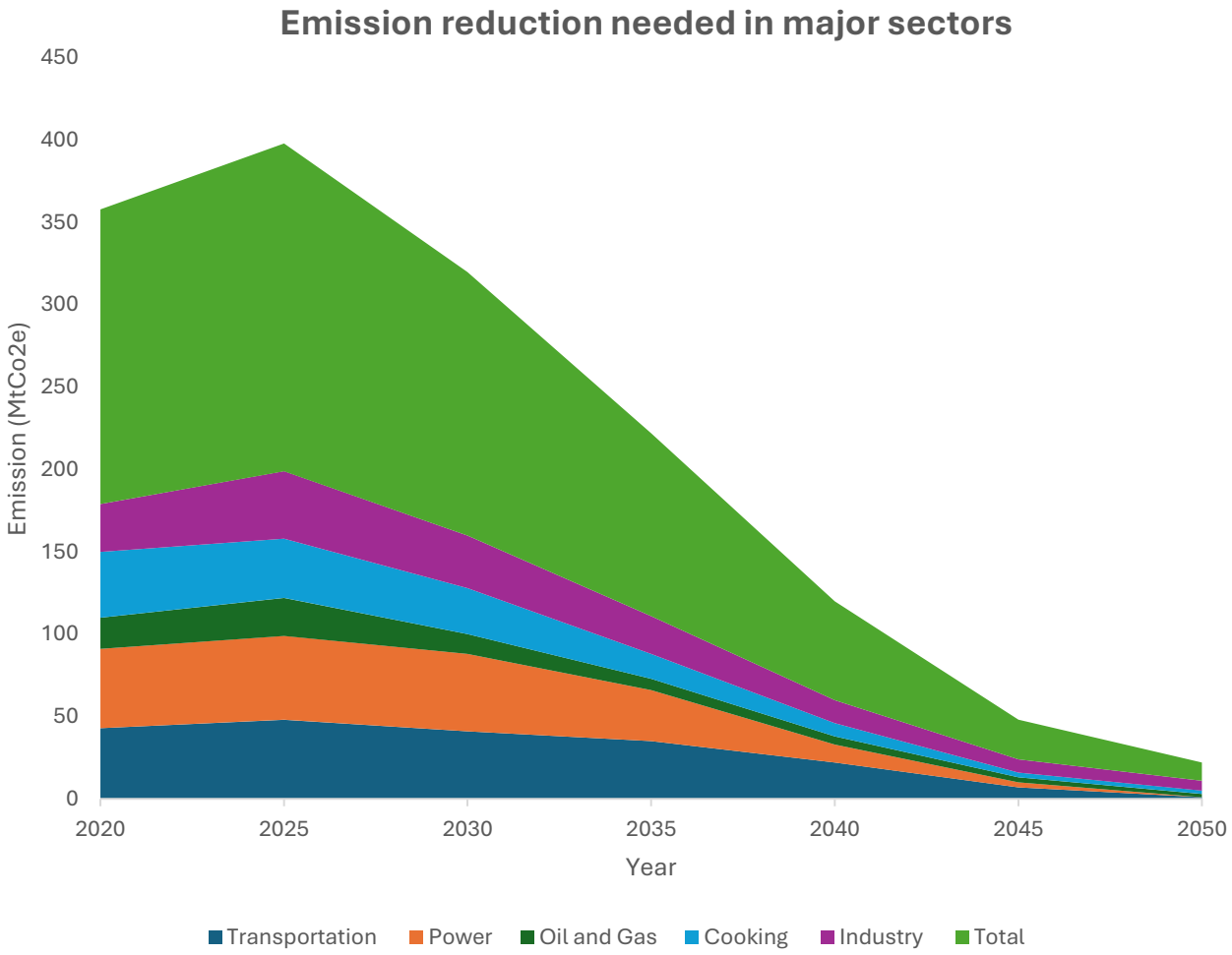


Source: Federal Ministry of Transportation (2020)
Nigerian Civil Aviation Authority (2022)
The Nigerian Carbon Brief Profile (2022)

Key Message

- In transportation, emission will reduce by 97% due to uptake of EVs.
- Gas will completely replace the traditional firewood and kerosene. Post 2030, electric cookstove and biogas will take the full picture.
- There will be a drastic reduction in oil and gas emission due to reduction in flaring and primary response to climate change.
- Industry emission will reduce by at least 97%, despite industrial growth.

Technological Factor:

- Significant investment in renewable energy technologies (solar wind, hydro, CCUS etc)

- Development of smart grid and decentralised energy systems.

Social Factor:

- Nigeria's net zero pathway will result in significant job creation, up to 340K jobs by 2030 and 720K in 2050.

Economic Factor:

- Strong economic growth driven by green energy investments.

- Creation of green jobs and industries.

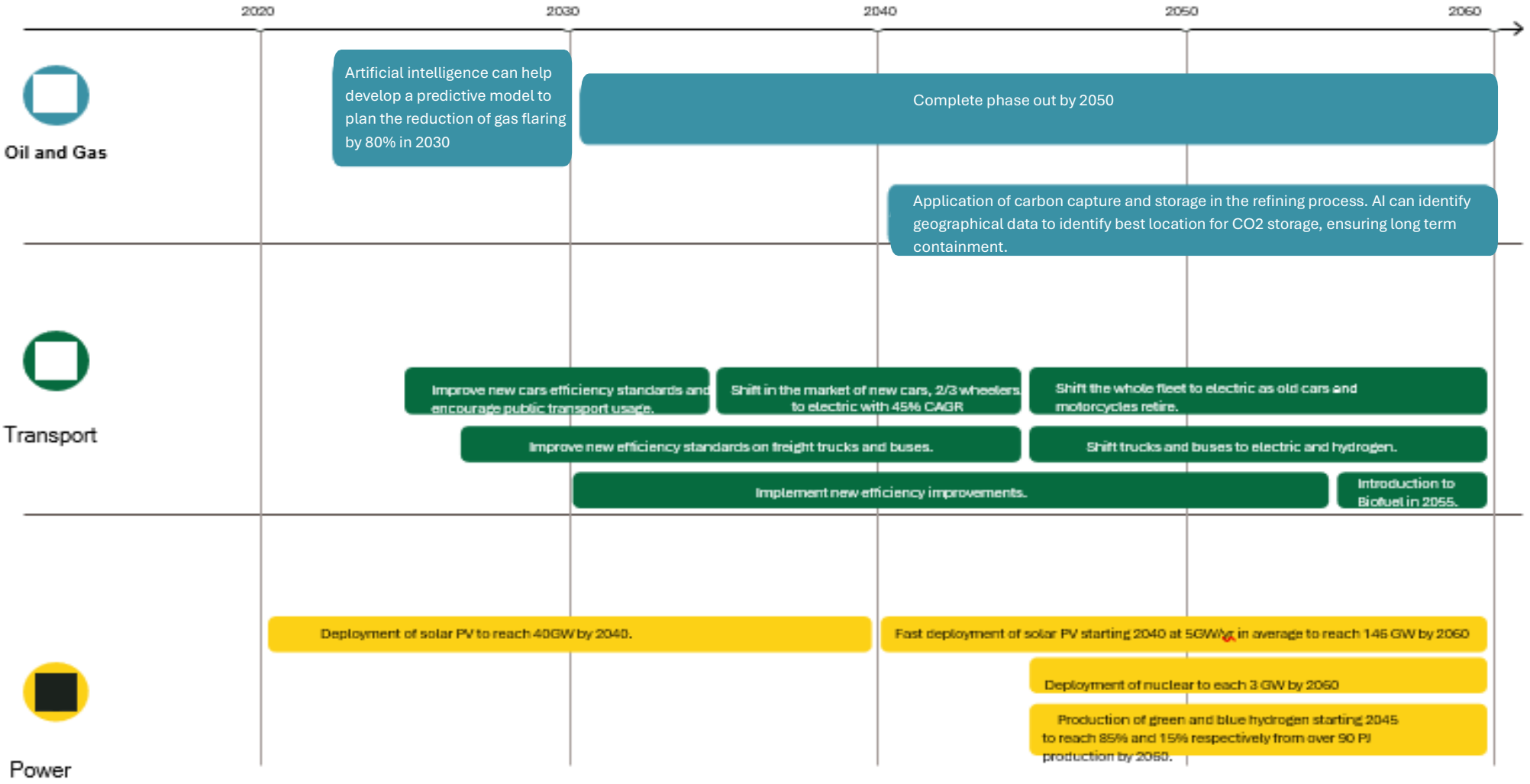
Environmental Factor

- Strong economic growth driven by green energy investments.

- Creation of green jobs and industries.

High-Tech Scenario Source: SEforALL (2022)

Nigeria can leverage more advanced cutting-edge technologies that use AI to it manage energy, leading to the NetZero pathway and targets

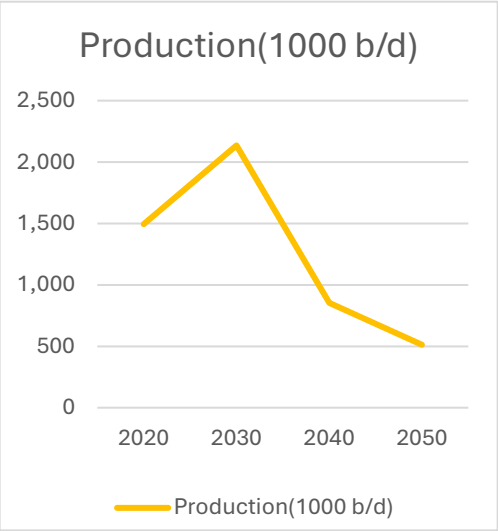


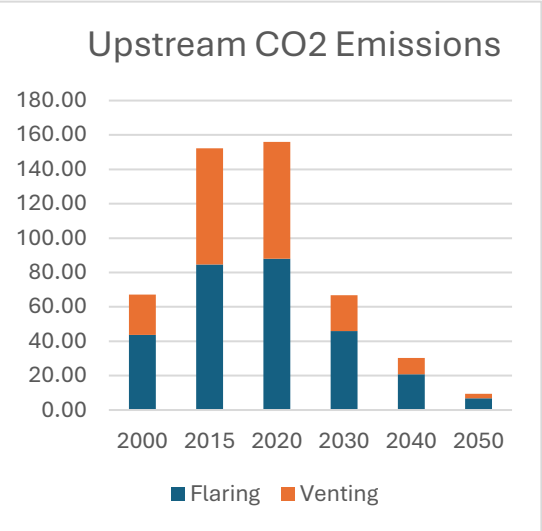
Chapter Three

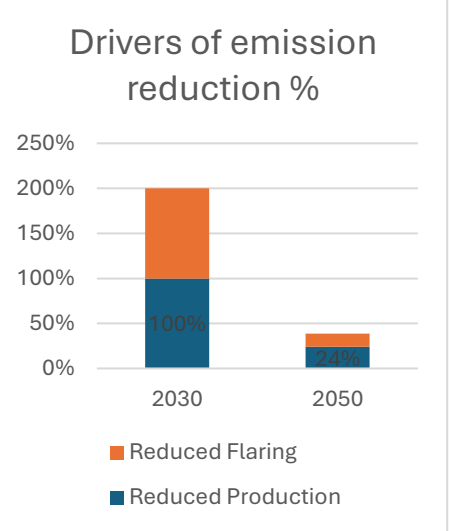
Sector Specific Analysis

Oil and Gas

Reducing oil and gas flaring offers the greatest emissions reduction potential.







Source: World Bank data (2023), Federal Ministry of Petroleum Resources (2020)

KEY MESSAGES

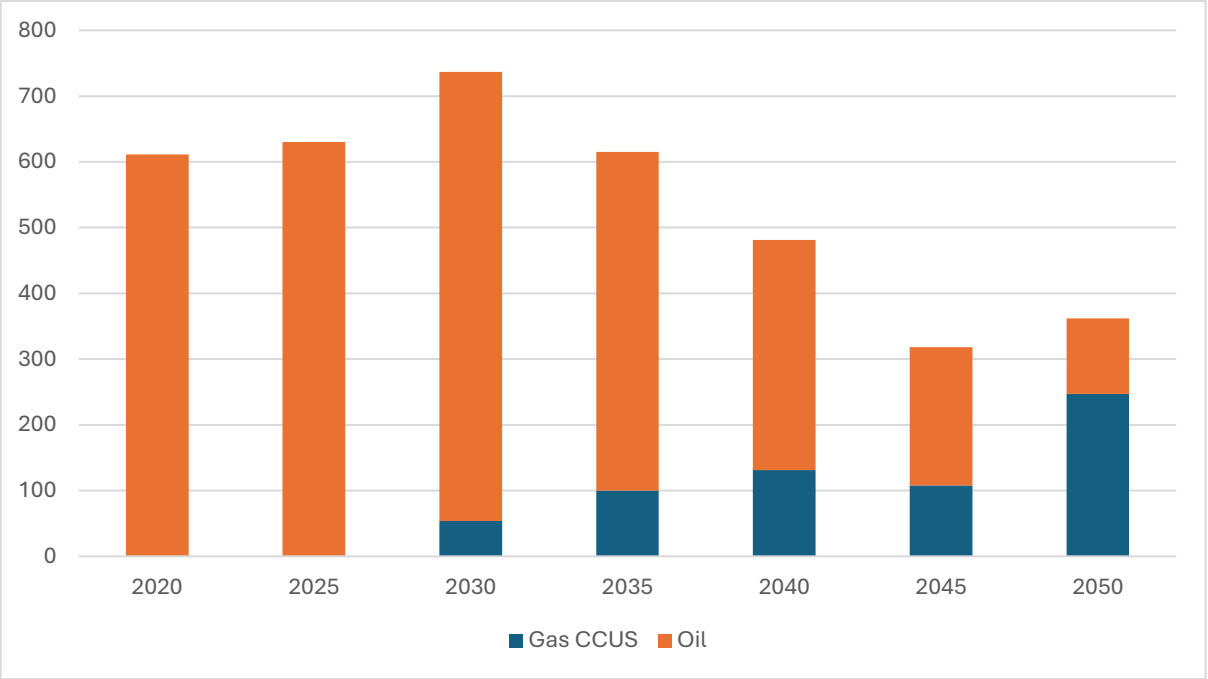
- Oil production is expected to have a major peak in 2030 and then decline over the period to 2050 as the energy transition dampens global oil demand.

- Flaring accounts for 85% of oil and gas emissions, and around 25% of total CO2 emissions:
- Flaring and venting are reduced by around 80% by 2050 and possibly 0 by 2060.

Reducing flaring is the primary lever to reducing oil and gas emissions:

- Flaring and venting: Cost positive abatement options include improving flaring efficiency and exporting gas through pipeline; repurposing gas can also deliver additional abatement.

CCUS is the main solution to decarbonise refining operations in Nigeria. According to the IEA, CCUS could help Nigeria meet those targets and national drivers for CCUS include the Petroleum Industry Act, the Nigeria Economic Sustainability plan, and the 2021 updates to Nigeria's NDC. There are significant potential emissions sources from the oil & gas industry and power generation, which the technology of CCUS can rapidly tackle if deployed.



Source: Nigerian National Petroleum corporation (2022)
Federal Ministry of Petroleum Resources (2022)

KEY MESSAGES

- Refining activity falls by around half over the period to 2050 as domestic oil demand decreases.
- Oil remains the key fuel for oil refining processes for the next two decades.
- From the mid-2030s new oil refinery plant fuelled by gas with carbon capture are delivered to reduce emissions from oil refining processes
- By the next decade after 2050, all refinery processes would possibly use CCS to minimise CO2 emissions.

UNDERLYING DRIVERS OF THE PATHWAY

- Due to the cost premium of carbon capture and storage, this technology might be best introduced in the mid- 2030s to achieve the Net Zero target for 2050 and beyond.

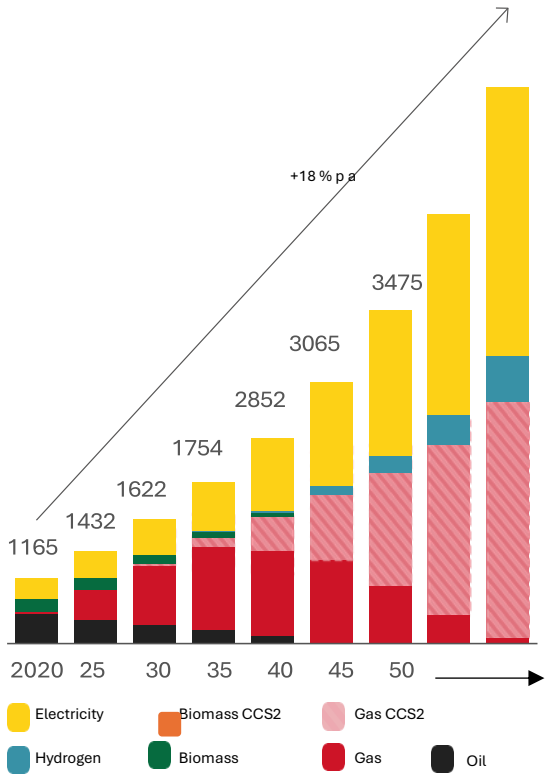
ALTERNATIVE SOLUTIONS

- Depending on the rate of innovation, hydrogen could also provide a cost-effective solution for decarbonising refining operations.
- While biomass could also play a role in decarbonizing low- and high-temperature for heating, it is likely that sustainable biomass will be in limited supply and will be prioritized by sectors such as aviation and shipping with fewer viable alternatives.

Industry

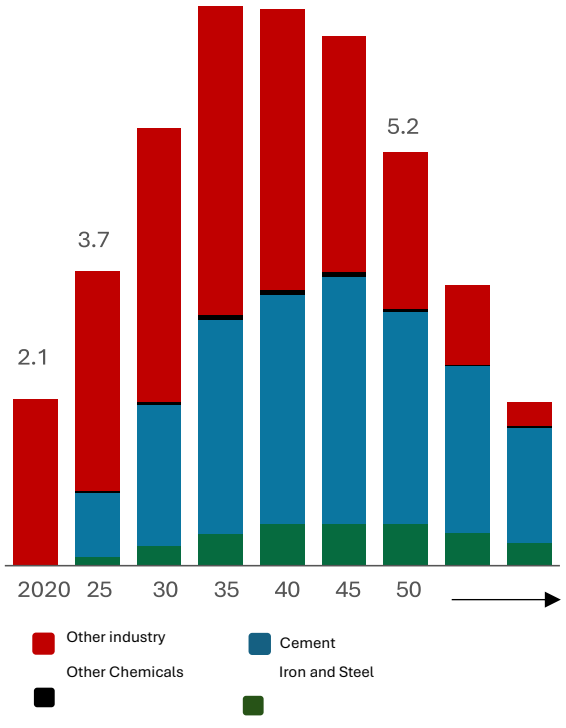
Low-emissions technologies and clean fuel sources will allow Nigeria to decarbonise a rising industry production. (Source: The World Bank data (2021)

INDUSTRY FUEL CONSUMPTION PJ



INDUSTRY CO2 EMISSIONS MtCO2

Totals represent net CO2 emissions.



KEY MESSAGES

- Decarbonization of industry drives a shift in the fuel mix, with strong roles for electricity, hydrogen, gas with CCS, and a smaller role for biomass.
- A small amount of biomass CCS is used to offset residual emissions (chiefly from fossil CCS)

ALTERNATIVE SOLUTIONS

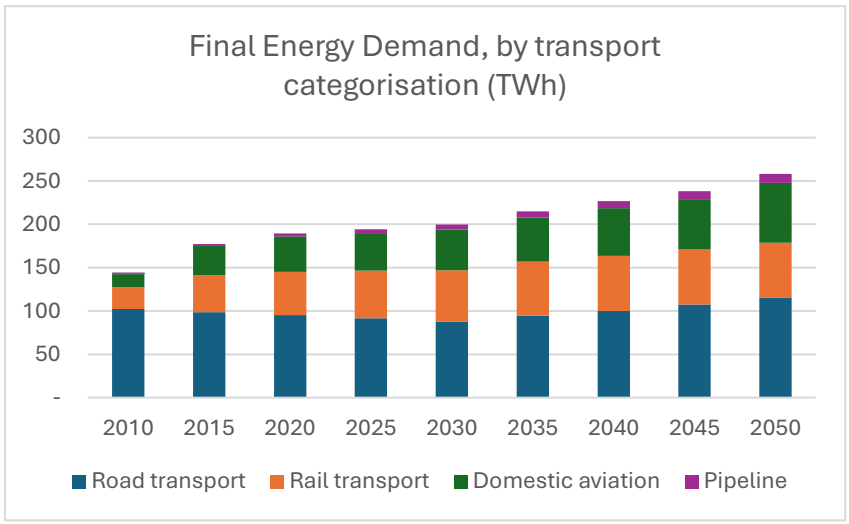
- There is high confidence that electrification will be a key decarbonisation solution for low temperature heat processes.
- Hydrogen or innovative electric technologies such as electric cement kilns are alternative solutions to decarbonise high temperature heat.
- CCS emerges as the least-cost solution to decarbonise the cement sector as well as other high temperature heating in chemicals and other industries.

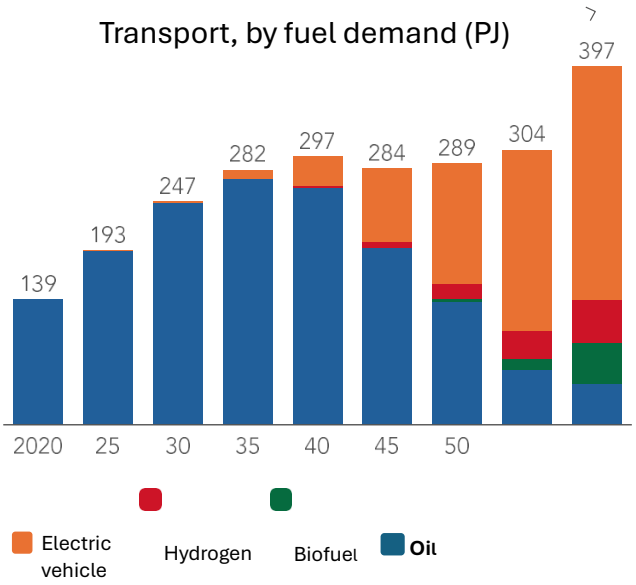
UNDERLYING DRIVERS OF THE PATHWAY

- Industrial heat pumps replace fossil heating at low temperatures, driving up the use of electricity though with high efficiency. Heat pumps account for around half of electricity demand, while the other half is to power appliances in industrial facilities.
- Hydrogen demand is driven by its use in the steel sector, which uses H2-based direct reduced iron.

EVs, hydrogen fuel cell vehicles and biofuels, replace oil-based transport to decarbonise the sector.

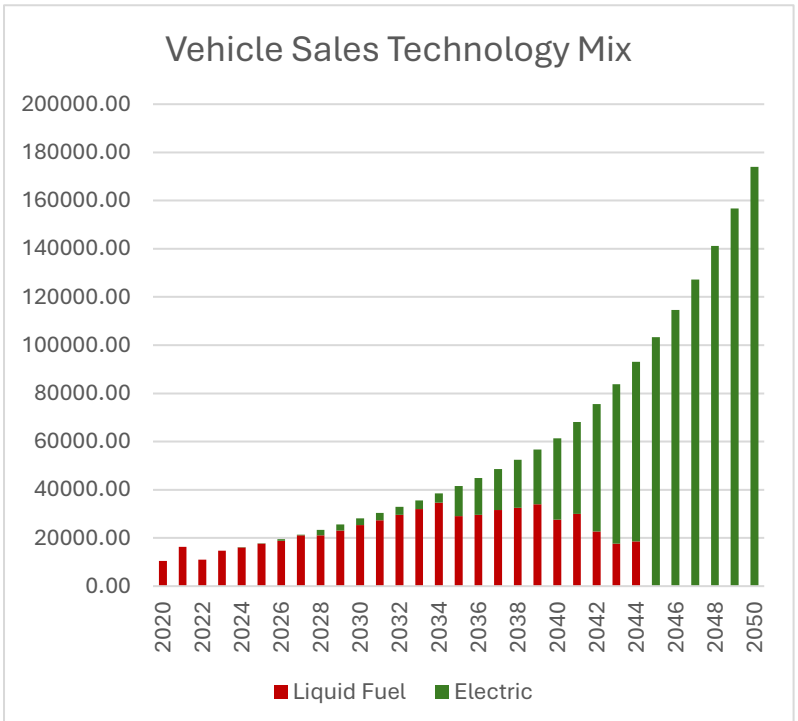
Source: Federal Ministry of Transportation (2021)





KEY MESSAGES

- With an average annual growth of 7 % pa, Economic growth drives 3-4x increase in transport sector energy demand, with growth in all modes.
- Roll out of hydrogen-powered heavy trucks in heavy trucks drives a shift to hydrogen as a fuel.
- Biofuels replace oil-derived fuels in aviation and shipping.
- Overall fuel demand levels out from around 2040 as the increased efficiency of electric and hydrogen vehicles offsets the effect of rising demand for travel.



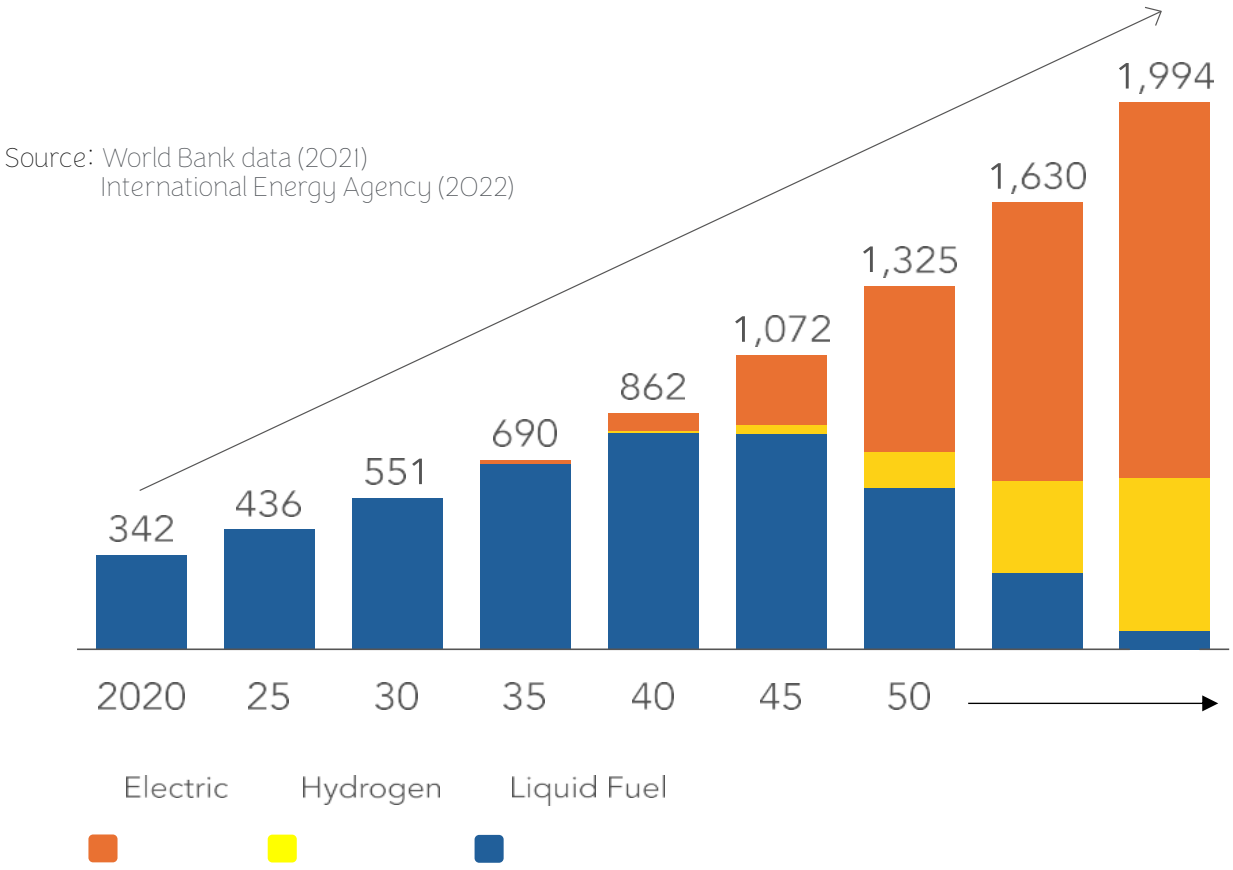
KEY MESSAGES

- Initially the vast majority of cars are ICE due to the current EV cost premium and low volumes of EVs in the used vehicle market.
- By the mid-2030s, used EVs are cost-competitive and are available in the market.
- By the mid-2030s, annual EV sales increase sharply, doubling between 2045 and 2050.
- By 2050 electric vehicles dominate the fleet and fully replace fossil vehicles.

UNDERLYING DRIVERS OF THE PATHWAY

- Battery cost reductions drive a shift to electric vehicles in the international auto market.
- In Nigeria, second hand electric vehicles are cost-competitive with internal combustion vehicles by 2030, though market availability
- A shift away from used vehicles in the auto market would be needed to accelerate the EV transition.

A mix of battery electric and hydrogen fuel cell trucks can also decarbonise the road freight sector.



KEY MESSAGES

- Fleets will potentially grow around 4x to 2050 as rising incomes and population drive a greater volume of freight.
- Conventional liquid fuel trucks dominate for the next two decades as the global market.

for low-carbon trucks remains small and the vehicles carry a significant cost premium

- Deployment of electric and hydrogen trucks begins in the 2040s, and will most like constitute about 60% of fleets by 2050.

UNDERLYING DRIVERS OF THE PATHWAY

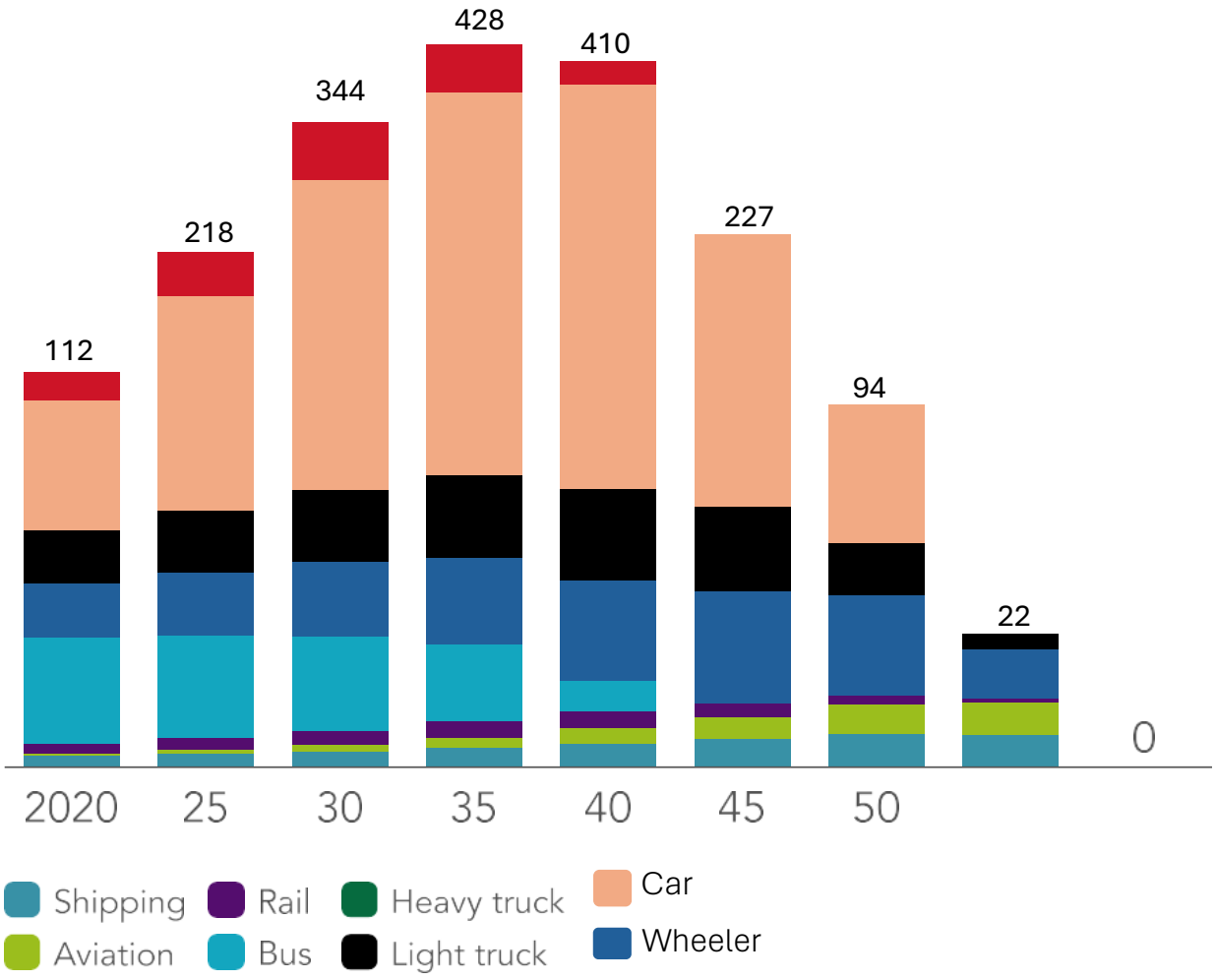
- Low-carbon trucks continue to carry a significant cost premium and strong policy support will be needed to deliver them at the scale needed.
- Hydrogen is the preferred solution for long-distance trucking due to greater range, while battery trucks are preferred for shorter distances due to their greater efficiency.

ALTERNATIVE SOLUTIONS

There is high confidence in wide transition to EV and H2-fuel cells for long-distance fleets.

- The specific mix of battery vs hydrogen vehicles will depend on improvements in battery cost and vehicle range.

Cars will significantly drive emissions up to peak in mid 2030s before falling back, with alternative vehicles driving the largest growth and largest reduction in carbon emissions.



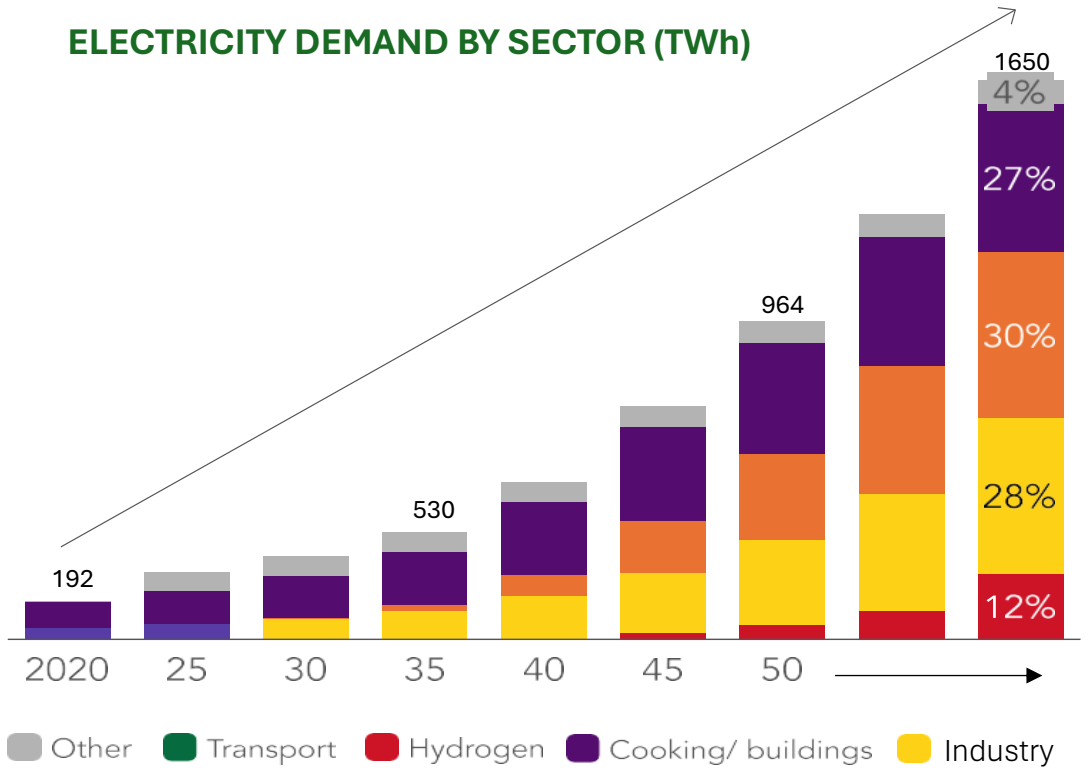
KEY OUTCOMES

- Transport CO2 emissions peak around 2035 before falling back as all modes decarbonise.
- Emissions from passenger cars account for most CO2 emissions in all years.
- Trucks also an important contributor to CO2 emissions, though smaller due to their lower distance travelled and fuel consumption.

UNDERLYING DRIVERS OF THE PATHWAY

- Electrification of cars, and 2/3 wheelers, buses and light trucks drives the largest share of CO2 reduction.
- Hydrogen in heavy trucks and sustainable fuels in aviation and shipping drive the remainder, achieving Net Zero transport by 2060.

Power demand is going to grow around 15-20x to 2050 and 2060, driven by population growth the GDP/Capital.



Source: Nigerian Electricity Regulatory Commission (202)
SEforALL Analysis (2021)

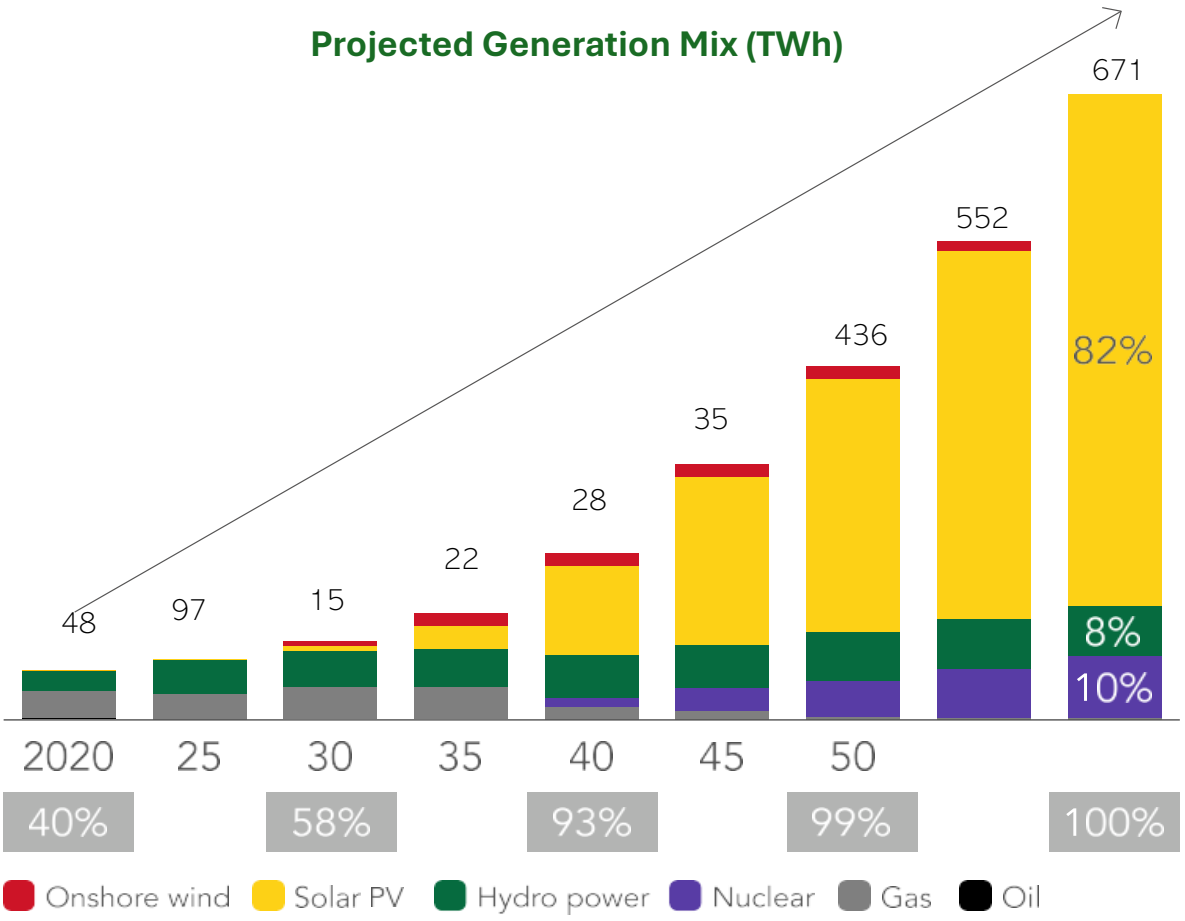
KEY MESSGAES

- Demand for power in Nigeria will grow at 7% p.a. to 2050 according to the Energy Transition Plan.
- The buildings and industry sectors, which today account for almost all electricity demand, grow strongly to 2050.
- Transport emerges as a significant source of demand from around 2040, and by 2060 accounts for almost 30% of total demand.
- Hydrogen production also emerges, accounting for 12% of demand by 2060.

UNDERLYING DRIVERS OF THE PATHWAY

- Income growth drives substantial power demand growth, primarily in the buildings and industry sectors.
- Growth in transport and hydrogen sectors is driven by the Net Zero target, and the associated electrification of transport and the shift to hydrogen in the transport and industry sectors.

Solar PV will meet most of the growth in power demand and drive decarbonization of the sector.



Source: Rocky Mountain Institute (2022)
International Energy Agency (2023)

KEY MESSAGES

- Power demand grows 15x to 2060 due to robust underlying growth, and electrification of end-use demands.
- New solar PV meets most of this increase.
- Rest of growth is met with nuclear and hydro, as far as available resource allows.
- By 2060, unabated fossil is phased out, with storage playing the key balancing role.

UNDERLYING DRIVERS OF THE PATHWAY

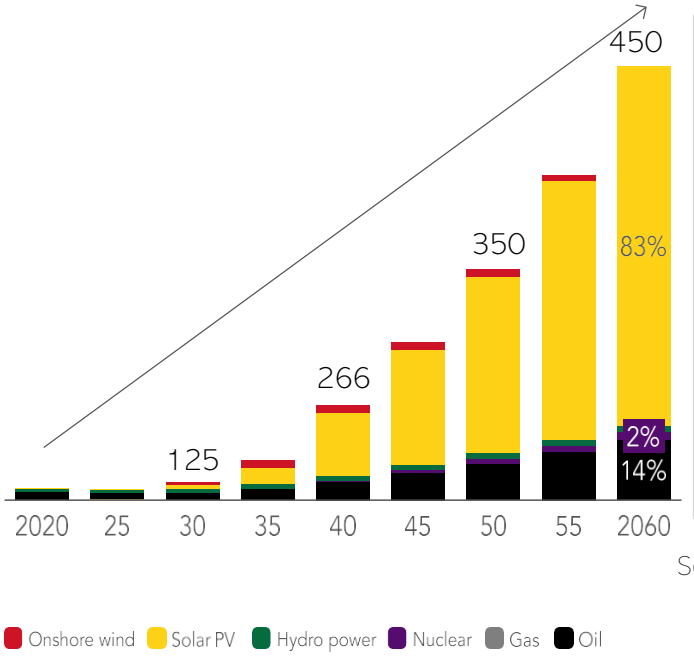
- By the mid-2020s solar PV emerges as the most cost-competitive power generation technology. However, deep decarbonisation through solar PV will require storage, increasing costs and requiring public support.
- Nuclear can provide cost-effective baseload low carbon power but will require significant lead times due to consenting, planning and construction timelines.
- Hydro can also provide cost-effective flexible power, but its maximum resource is estimated at 2.5 GW.

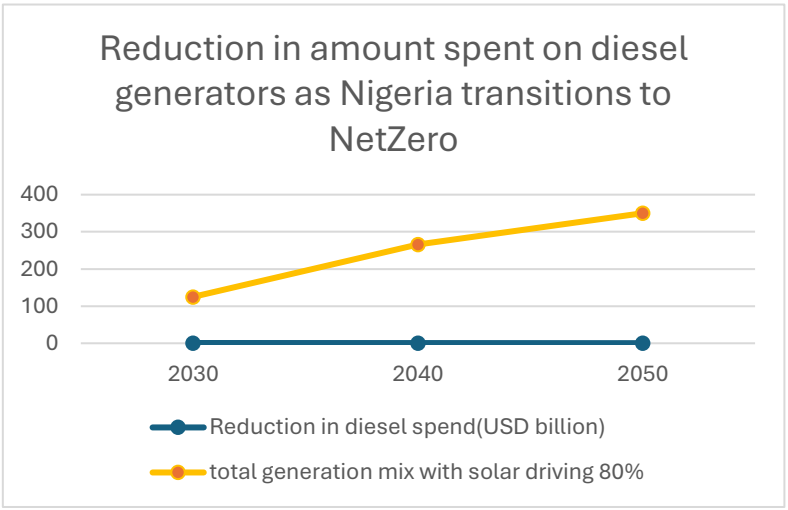
ALTERNATIVE SOLUTIONS

- Solar PV is highly likely to play a key role in the generation mix, while wind may play a complementary role. The precise mix of wind and solar will depend on their cost reduction pathway.
- Significant storage is needed to firm the output from wind and solar. Alternative sources of firm power could include a greater role for nuclear, gas CCS, or hydrogen generators.

Wind will highly supplement solar to drive decarbonization of the sector.

Projected Generation Mix (GW)





Source: Nigerian Bureau of Statistics (2023)
International Energy Agency (2022)

ALTERNATIVE SOLUTIONS

- Total capacity grows in line with demand.
- Solar PV accounts for most of the capacity with over 150 GW in 2060
- Gas capacity also rises to around 25 GW by 2060. By 2060 gas is primarily used for security of supply
- Other technologies (gas CCS, nuclear, hydro-power, and hydrogen) contribute only a small share of total capacity.
- This pathway requires new capacity additions of 1 GW in the 2020s, rising to around 3 GW per year in the 2035s and 6-12 GW per year in the 2040s and 50s.
- The fast build out of solar capacities would require significant technical, financial and policy support, to simplify and accelerate projects development.
- The continuous addition of solar PV to generation mix will drastically reduce the amount Nigerians spend on diesel generator

UNDERLYING DRIVERS OF THE PATHWAY

Unabated gas is the cheapest form of reserve capacity and operates at only 2% capacity factor by 2060.

Chapter Four

General finance, policy and strategy recommendation

Around USD 1.9 Trillion bn cumulative capital investment is needed, with power sector accounting for up to 70% of the total capex.

To achieve net-zero goals, about 220GW of solar, biomass and hydro generation capacity, 90 GW of storage and 34GW of hydrogen systems need to be built.

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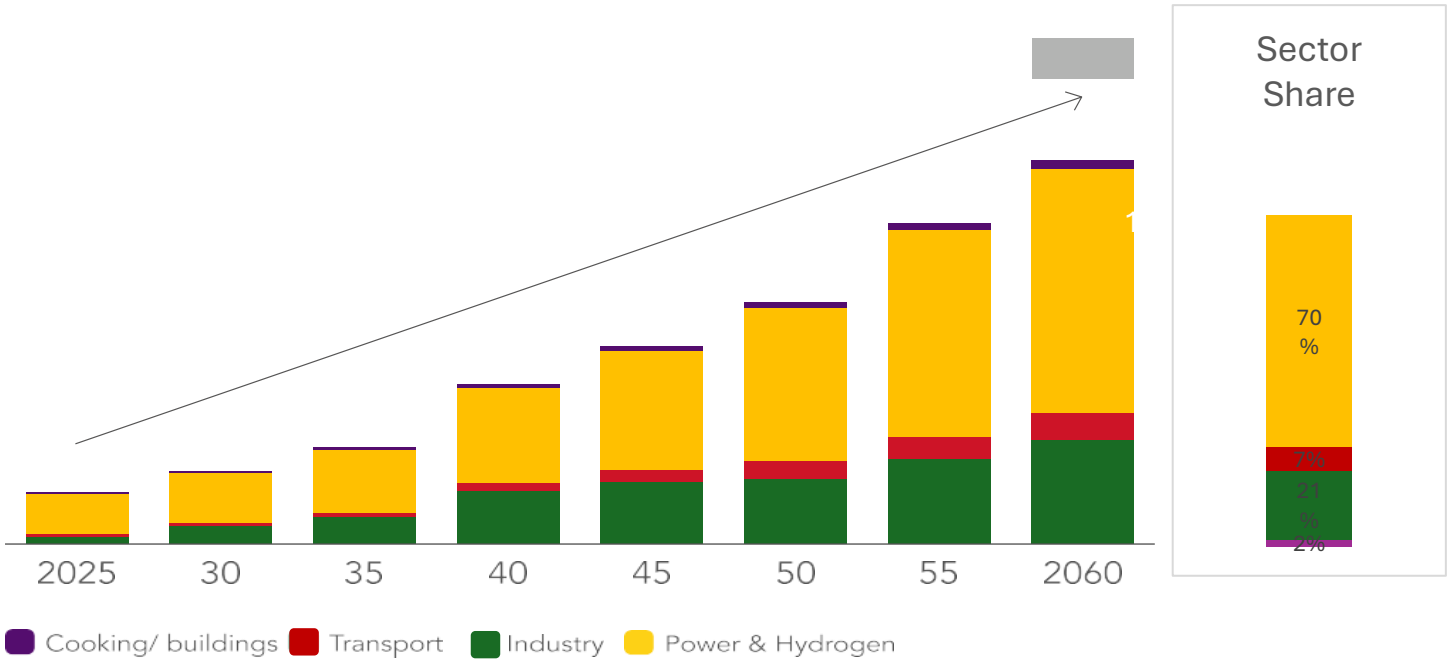
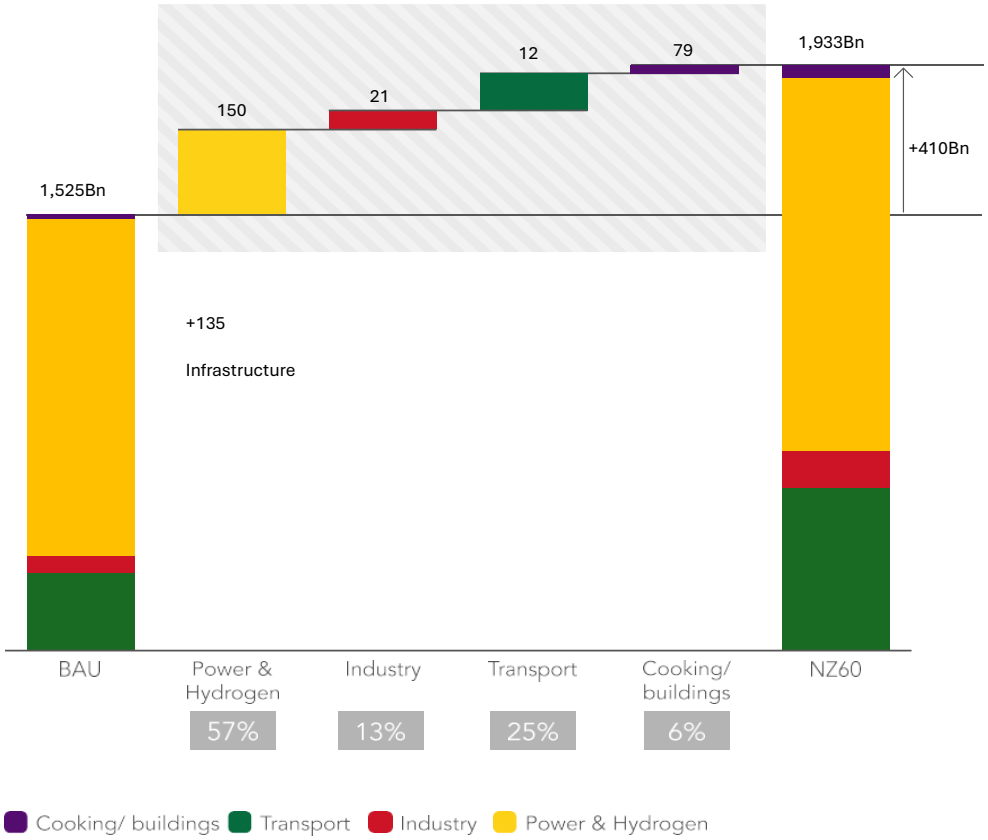


Source: World Bank data (2022)
Nigerian Energy Transition Plan (2023)

KEY MESSAGES

- Most of the effort will be needed in the power sector: an extra CAPEX of at least $200Bn will be needed to finance the power sector generation capacity.
- Significant savings in terms of fuel costs for power, considering the switch to 90% renewables.

Around USD 410bn capital investment is additional to investment needs in a BAU scenario



KEY OUTCOMES

- Most of the effort will be needed in the power sector: an extra CAPEX of at least $200Bn will be needed to finance the power sector generation capacity.
- Significant savings in terms of fuel costs for power, considering the switch to 90% renewables.

Source: Energy Transition Plan (2023)
Rocky Mountain Institute (2021)

Current policies

Year	Law, Strategy, Policy	Institution Responsible for Implementation	Short Description
2023	Constitutional amendment permitting states to supply grid-based electricity	National Assembly	Allows states to generate and distribute electricity within their own borders, which could help to improve access to electricity in rural areas.
2023	Electricity Act	Nigerian Electricity Regulatory Commission/Ministry of Power	Modernizes the Nigerian electricity sector, with a focus on increasing access to electricity and reducing energy costs, devolving regulatory power to states, & creating independent system operator.
2021	Petroleum Industry Act	Department of Petroleum Resources	Reforms the Nigerian oil and gas industry, with a focus on increasing transparency and accountability, and reducing gas flaring.
2021	Climate Change Act	Federal Ministry of Environment	Establishes a National Council on Climate Change and sets out a framework for mainstreaming climate change actions into national development planning, and creates Climate Fund, carbon tax etc.
2023	Renewable Energy Roadmap	Energy Commission of Nigeria	Sets out a roadmap for the development of renewable energy in Nigeria, with a focus on solar and wind power.

Source: The Nigeria Energy Transition Plan (2023)

Key Alignment

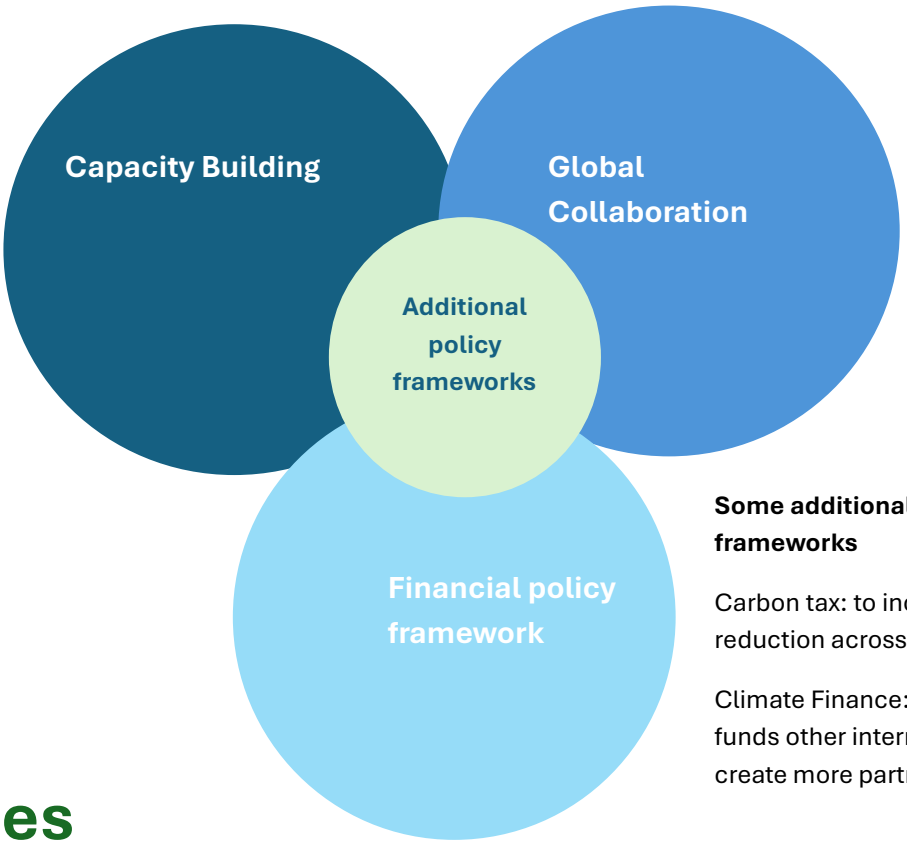
- Office of the VP established a working group to support the Energy Transition Office, staffed by SEforALL and funded by GEAPP.

Key Misalignment

- Lacked adequate buy-in from the President, NNPC and Ministry of Environment.
- Reduced investors' confidence due to the development of multiple energy transition policies.
- Competing Legislative Priorities. Climate Change Act and Petroleum Industry Act enacted within 60 days of each other.

Capacity Building

Implement more government funded training programs to enhance the technical and institutional capacities required for effective climate action.



Institutional framework

Policies that would attract more technological collaborations.

Develop international emission standard to ensure strict adherence to decarbonization goal.

Some additional financial frameworks

Carbon tax: to incentivize emission reduction across sectors.

Climate Finance: Green Climate funds other international fundings, to create more partnerships.

Strategies

A combination of private sector capital and de-risking instruments could help finance Nigeria's energy transition. Blended investment of both public and private sectors is needed.

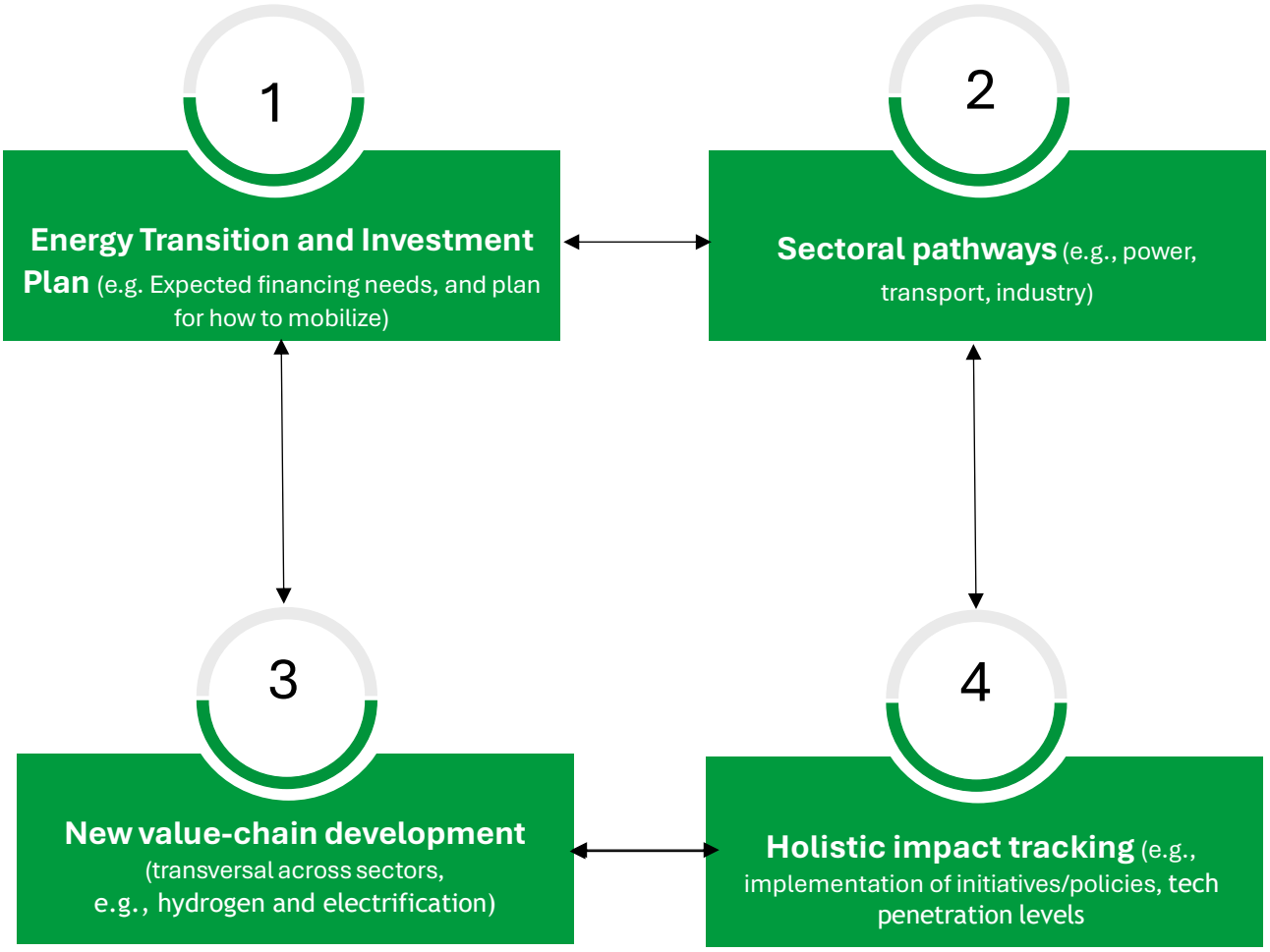
	CORE FINANCE PROVIDERS				PROVIDERS OF DE-RISKING INSTRUMENTS e.g., guarantees/insurance, first-loss-capital, etc.				
	Private sector			Domestic public sector	International institutions				
Actors	**Commercial financial institutions**	**Corporations**	**Households and individuals**	**Public institutions**	**Multilateral DFIs[1]**	**Bilateral DFIs[1]**	**National DFIs[1]**	**Green finance funds**	**Private foundations**
Examples	Nigeria Commercial Bank FirstRand Bank BNP Paribas Blackrock Major pension funds	BHP Billiton Royal Dutch Shell	N/A	Nigeria Ministry of Finance	World Bank African Development Bank	French Agency for Development UK FCDO USAID GIZ	Development Bank of Nigeria	Green Climate Fund Global Environment Facility Adaptation Fund Clean Technology Fund	Rockefeller Foundation Climate Works Foundations Bloomberg IKEA Foundation Bezos Earth Fund

KEY DERISKING INSTRUMENTS

		RISK								
		MACRO		CREDIT			TECHNICAL		MARKET	
		POLITICAL/ COUNTRY RISK	CURRENCY RISK	CREDIT RISK	LIQUIDITY RISK	DEMAND RISK	CONSTRUCT-ION RISK	OPERATIONAL RISK	LACK OF PIPELINE	OFF-TAKE TISK
INSTRUMENT	1. Guarantees	■		■	■		■	■		■
	2. Insurance	■			■		■	■		
	3. Hedging		■			■				
	4. Securitization			■	■					
	5. Results-based incentives							■		
	6. Grants				■				■	

Implementation plan

To successfully implement the net-zero ambition, a best-practice governance structure, process, and action plan is needed.



Level 1: Target setting. A national Net Zero ambition provides an overall target and vision for the country. The more concrete the end goals are, and the clearer the country is on the required pre-requisites to achieve them, the better private and public actors can act in accordance with them.

Level 2: Coordination and enabling. An integrated Energy Transition and Investment Plan (ETIP) ensures transparency and coordination across the ministries, and sectoral policies are consistent with national objectives.

Level 3: Implementation. Private and public actors responsible for the implementation at the sector level (mandates, price incentives, controls, enablers). This includes sectoral pathways with clear mechanisms to ensure policies are owned by the relevant ministries (but roll up to the overall target). It also includes the development of new technology and fuel platforms for themes that transcend sectors – such as Carbon Capture and Storage.

Level 4: Impact Tracking. Holistic impact tracking, from tracking emission impact and clean technology uptake, to optimizing socio-economic ("just transition") and fiscal impact.

Some potential barriers that could hinder an orderly energy transition.

Sector	Potential Barriers	Actions Required
O&G	High cost of reducing oil and gas sector emissions, particularly in refining	Regulation and standards: Institute penalties per mcf of gas flared to ratchet up pressure for operators to decarbonize. Set mandatory gas flare reduction required for operating licenses renewal. Price incentives or regulations:

		Create tax holidays for operators to invest in gas monetization infrastructure and emissions reduction technology (e.g. LDAR, VRUs), or investment in CCS (e.g. pioneer status) Co-invest or help finance required natural gas infrastructure (e.g. gas trunkline, treatment/processing infra) which in turn helps make it attractive for companies to monetize the gas vs. flaring or re-injecting. Enabling programs: Play orchestration role to launch collaborative decarbonization projects (e.g. CCS hub pilot project) which would reduce the cost of decarbonization to individual O&G operators.
Transport	High cost of sustainable aviation fuels and low-carbon shipping fuels Deployment of electric vehicles will depend on consumer preferences. High capital costs of electric and hydrogen vehicles Limited charging and fuelling infrastructure may slow growth of passenger and freight low emission vehicle markets.	Price incentives or regulations: Implement incentive mechanisms to drive uptake of low-carbon fuels in aviation and shipping. Ensure infrastructure is in place to enable low- carbon fuels usage near ports and airports. Building on ambition of National Electric Mobility Roadmap, implement incentive mechanisms to ensure consumers shift to electric and fuel-cell vehicles when cost-competitive (e.g. purchasing tax credits, low-emission zones, vehicle trade-in programs, free parking, lower vehicle registration costs) Enabling programs:

		Develop and implement delivery plan for electric vehicle charging infrastructure (incl. grid assessment, regulatory framework, home charging incentives, and partnerships with the private sector) Where possible promote further efficiency and drive behavioural shift (e.g., to buses and trains
Power and Hydrogen	At high volumes solar PV and wind require battery storage, which carries a cost premium; and depress electricity prices, potentially deterring investors. Gas CCS carries capital cost premium.	Price incentives or regulations: Building on ambition of Renewable Energy Master Plan, create interventions to speed up deployment of especially solar PV and wind (e.g., net metering framework, renewable energy projects incentives, etc.) Enabling programs: Implement incentive mechanism for flexibility (for CCS in industry/ power, or batteries in micro-grids)