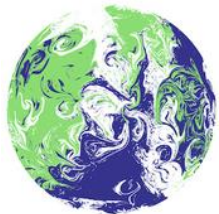


Nigeria Energy Transition Plan

Baseline and Scenarios

June 2021



**UN CLIMATE
CHANGE
CONFERENCE
UK 2021**

IN PARTNERSHIP WITH ITALY



This document presents preliminary results

NOT FOR DIFFUSION

Please note that the revision of Nigeria's Nationally Determined Contribution (NDC) is under going and might affect the results presented in this document

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Content

01.

Nigeria carbon emissions
baseline and overall energy
needs

02.

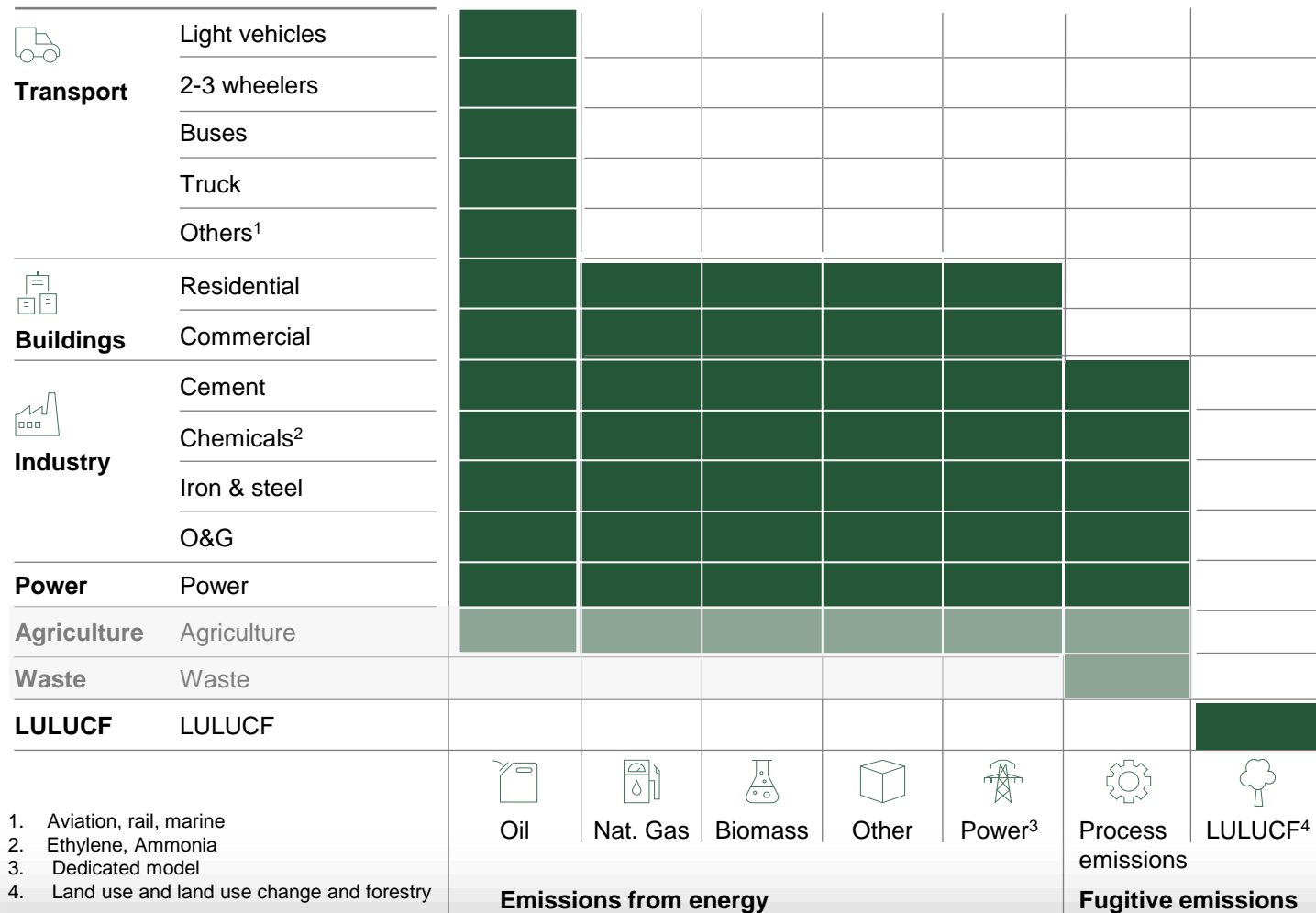
Decarbonisation scenarios –
approach

03.

Decarbonisation scenarios –
snapshots

Emissions can be of two main types: from energy consumption or fugitives – our project focuses on ~65% of the total emissions

Sectors and sub-sectors



Out of scope

65%

Of total emissions covered

As part of this overall effort, we have focused on the energy emissions of the economic sectors of Nigeria, hence agriculture and waste have been considered out of scope (except for the energy consumed by the agricultural sector)

For the rest of the sectors, processes emissions have also been considered, especially considering the pressing issue of O&G flaring in the country

LULUCF represents the highest share of emissions and has been partially considered in our scope considering the high amount of biomass (firewood) used to provide energy, especially for cooking

1. Aviation, rail, marine
 2. Ethylene, Ammonia
 3. Dedicated model
 4. Land use and land use change and forestry

Emissions from energy

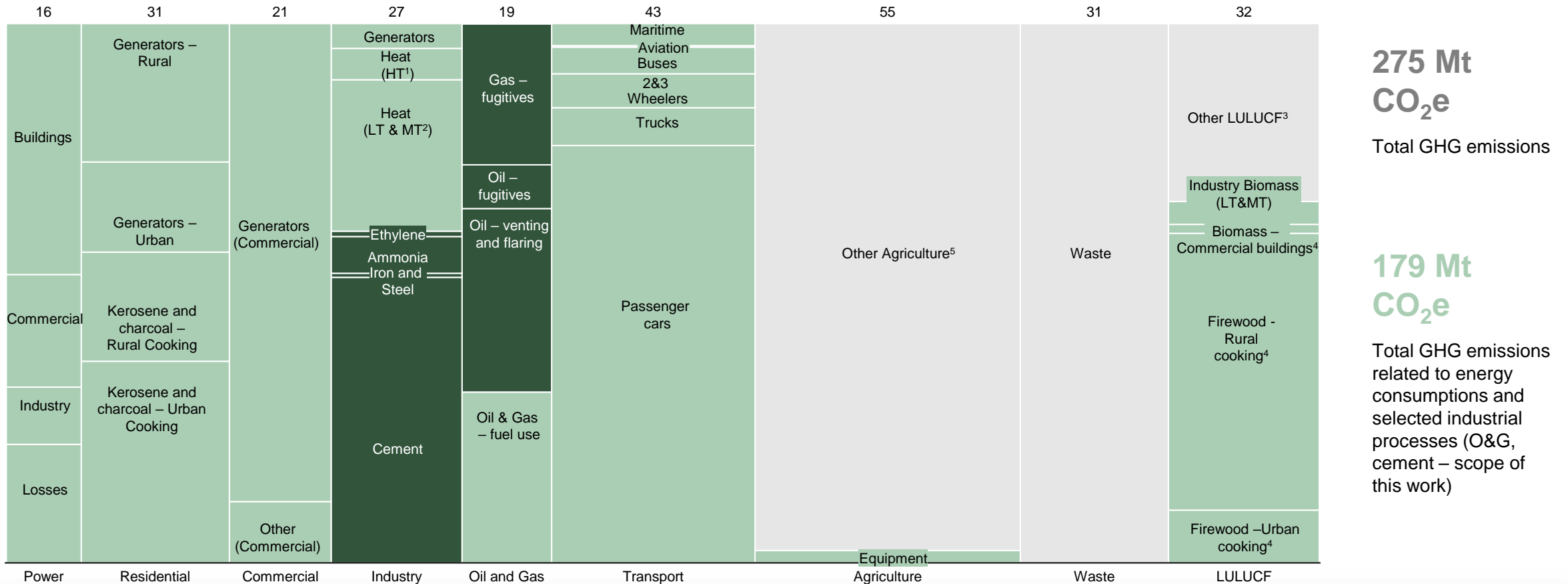
Fugitive emissions

Total GHG emissions of Nigeria in 2020 are estimated at ~275 Mt CO₂e, with 65% related to energy consumption and industrial processes

GHG emissions in Nigeria (2020), MtCO₂e

Differs from the latest NDC intermediary publication – see back up page⁶

■ Mostly emissions related to energy consumption
 ■ Mostly process emissions
 ■ Out of scope/not modeled



275 Mt CO₂e

Total GHG emissions

179 Mt CO₂e

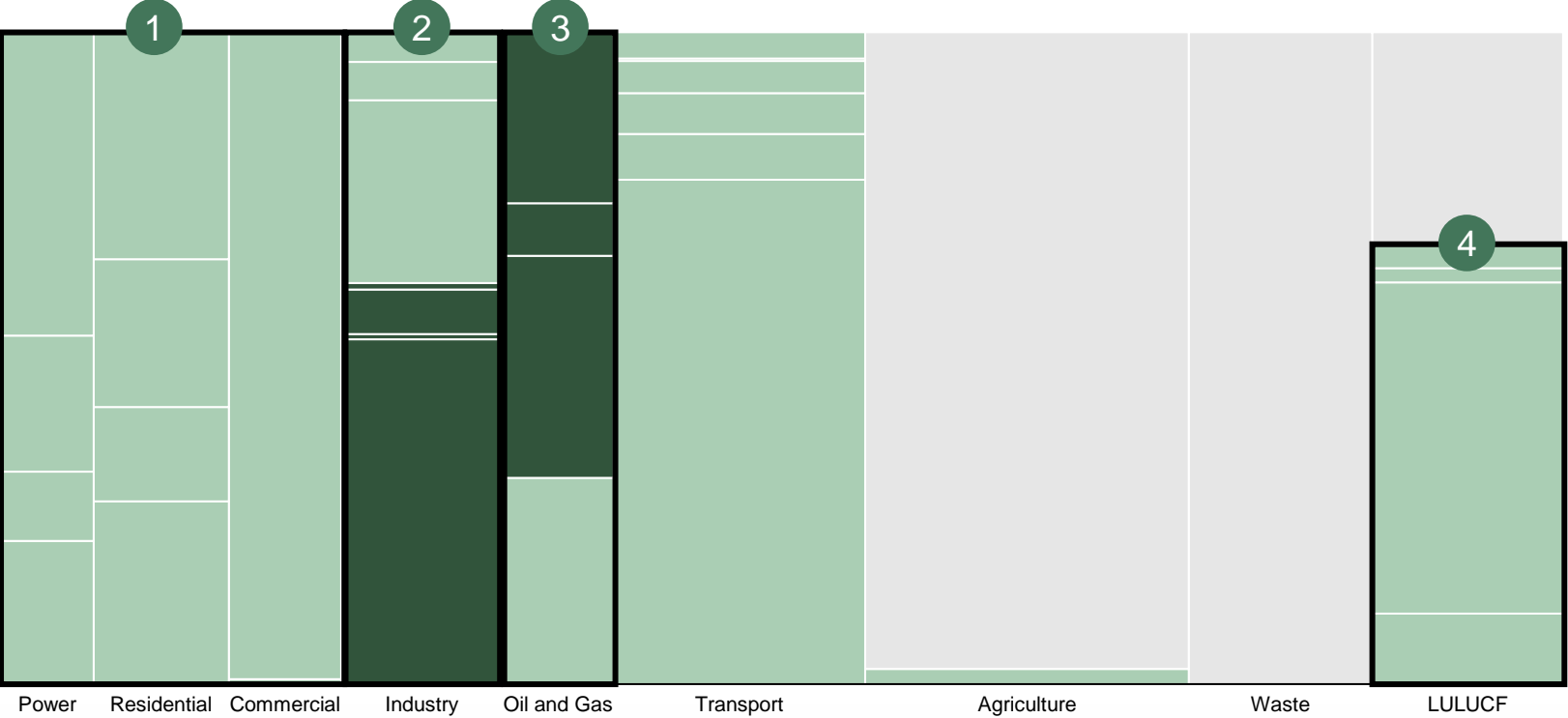
Total GHG emissions related to energy consumptions and selected industrial processes (O&G, cement – scope of this work)

1. High Temperature Heat; 2. Low-Medium Temperature Heat; 3. Land use, land use change and forestry; 4. Will be modelled as part of their end-use sector; 5. Emissions from livestock and soils 6. Slight discrepancy with NDC Intermediary 2020 due to lower emissions considered for O&G

We have identified 4 critical components of the energy and process-related emissions

■ Mostly emissions related to energy consumption ■ Mostly process emissions ■ Out of scope/not modeled

GHG emissions in Nigeria (2020), MtCO₂e



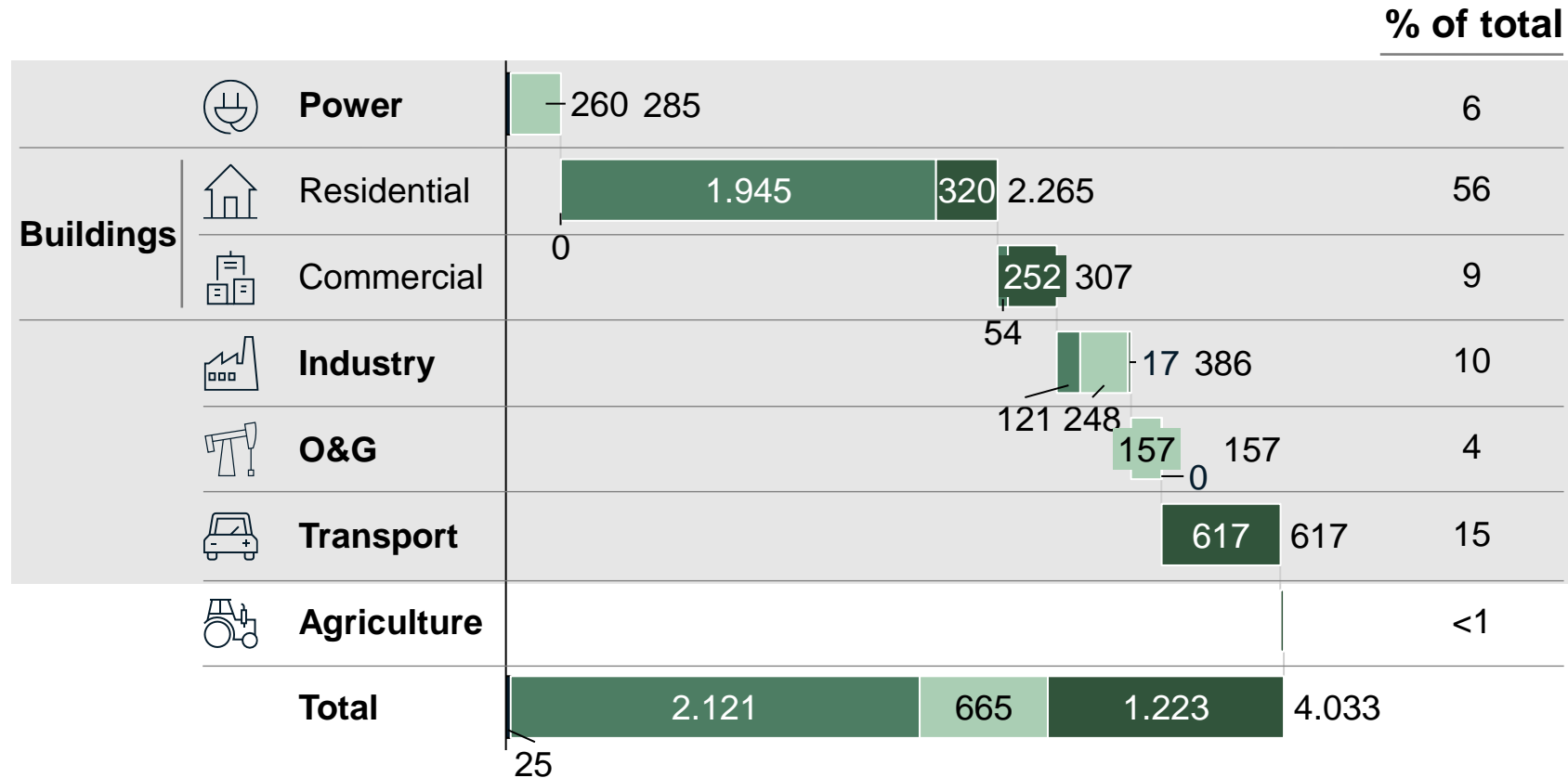
4 critical components

- 1 Power incl. residential and commercial generation
- 2 Industry
- 3 Oil and Gas
- 4 Cooking

1. Focusing on energy, out of ~3200 PJ of primary energy consumed annually, 80% come from biomass and oil

Primary energy consumption by sector in Nigeria in 2020, PJ

Other¹ Biomass Natural gas Oil Scope of our project



Key takeaways

53% of energy consumed in Nigeria comes from **biomass** and **31% from oil**

Buildings (i.e. residential and commercial and public buildings) represent **65% of total energy consumed** and drive **> 90% of biomass consumption**

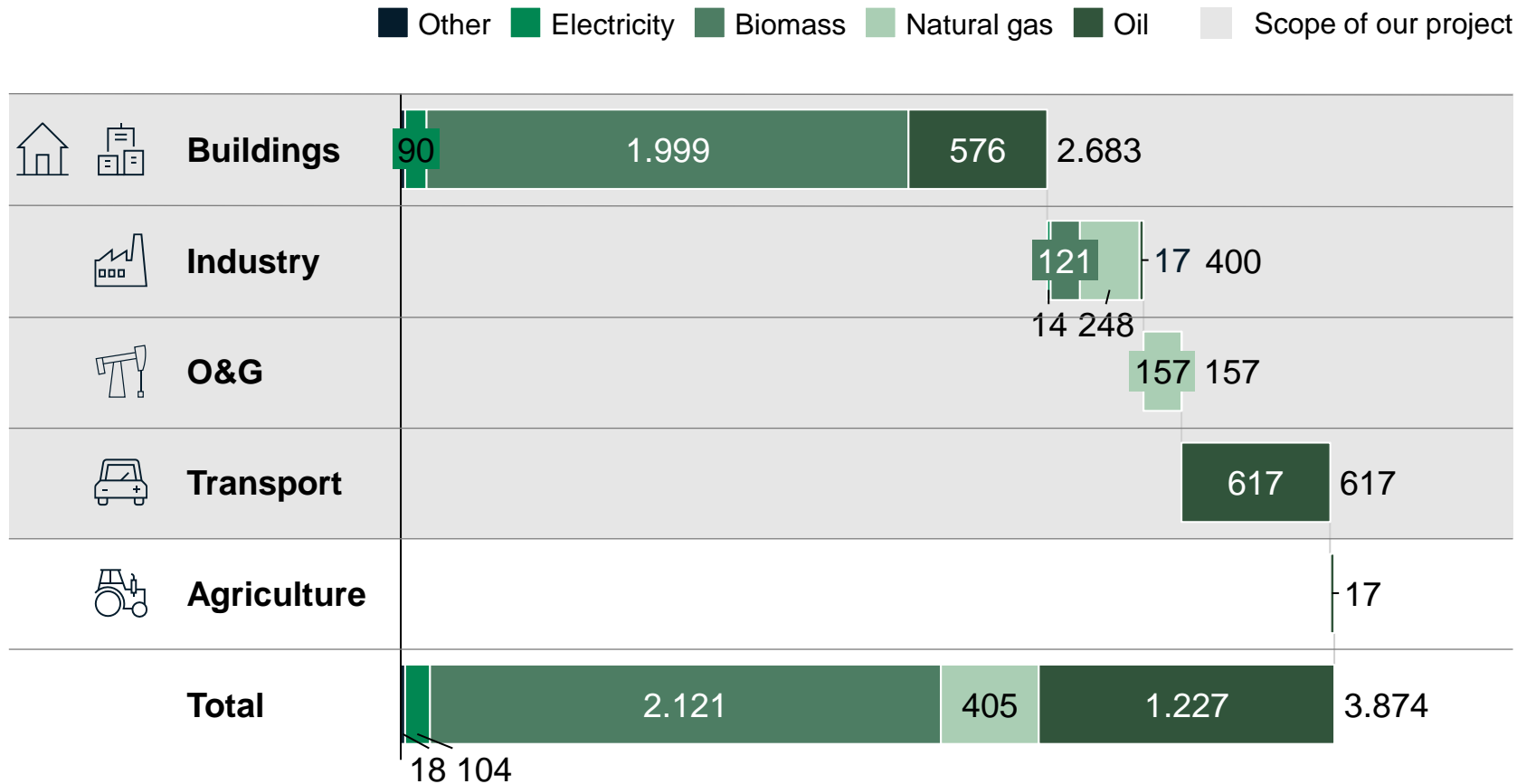
Oil consumption driven by **transport sector and back-up generators in buildings**

Power sector (6%) consumes primarily **natural gas**

1. Incl. hydro (power sector), residual fuel oil, liquefied petroleum gas, bagasse, coal, aviation turbine kerosene, petroleum coke, refinery gas

1. Electricity from the central grid is only a fraction of the fuel consumption by sector

Fuel consumption by sector in Nigeria in 2020, PJ



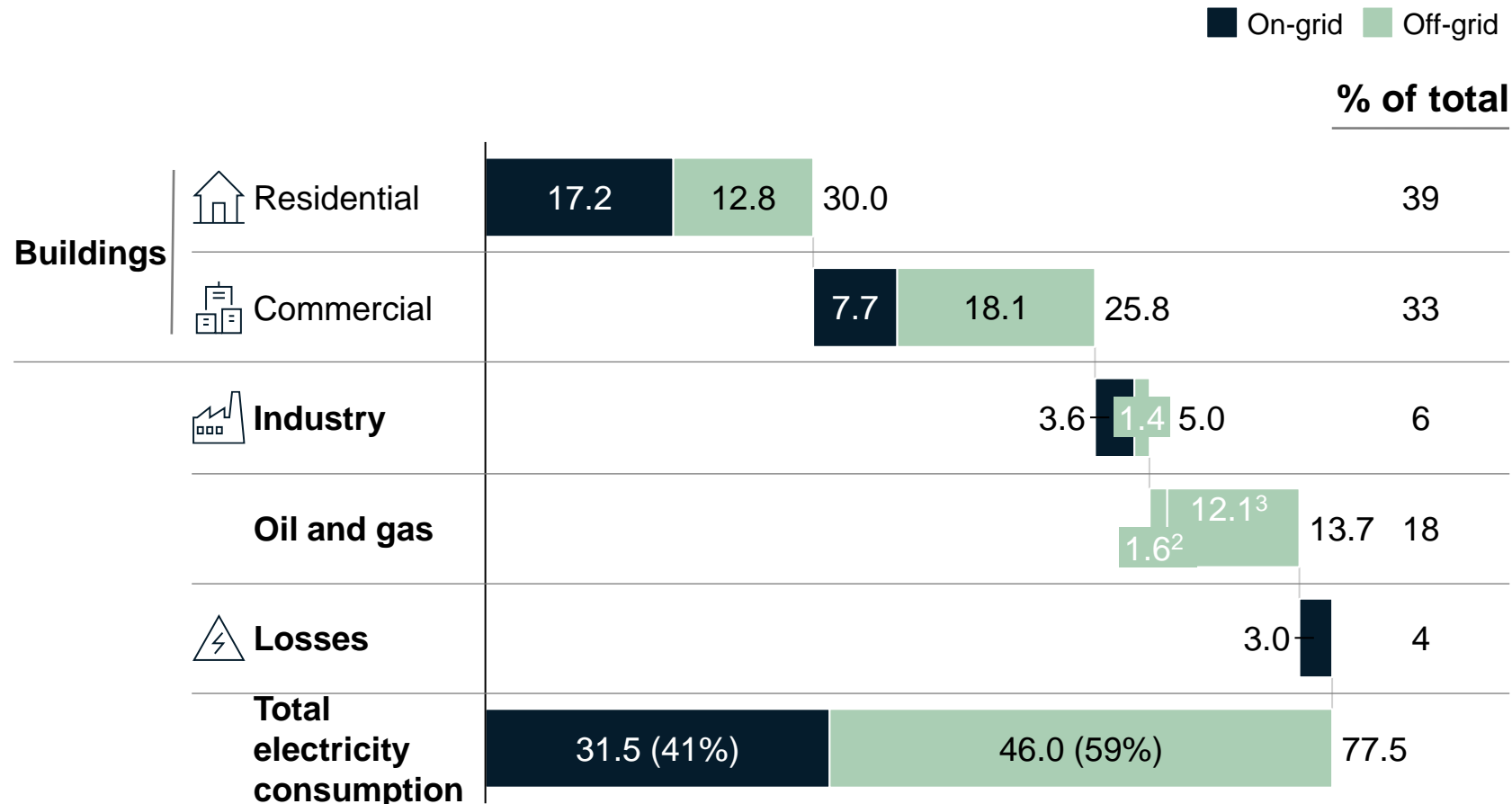
Key takeaways

- The **263 PJ** of primary energy consumed by **power sector** transformed into **104 PJ of grid electricity**, meaning **average efficiency of 35%**
- Out of 104 PJ of grid electricity, **90 PJ (86%)** consumed by the **buildings sector**

1. Incl. hydro (power sector), charcoal, household kerosene, residual fuel oil, liquefied petroleum gas, bagasse, coal, aviation turbine kerosene, petroleum coke, refinery gas

1. >60% of Nigeria's electricity consumption is generated off-grid

Electricity consumption in Nigeria by sector in 2020, TWh



Key takeaways

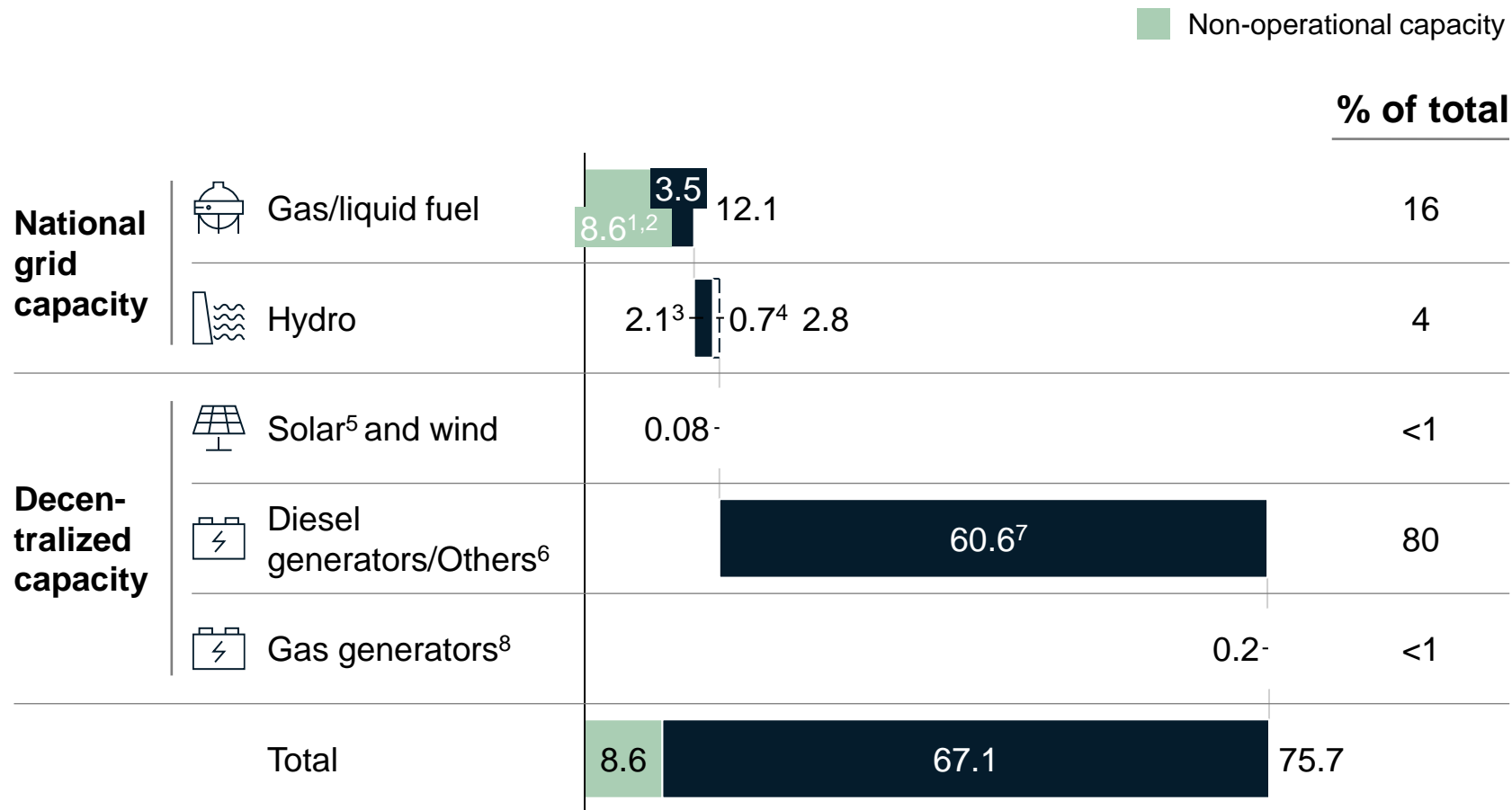
Out of 77.5 TWh of electricity consumed in Nigeria, **59%** (46.0 TWh) produced **off-grid**, by diesel or gasoil generators, and gas generators or gas turbines in O&G sector

Buildings sector responsible for **72% of Nigeria's electricity consumption**, with residential accounting for 39% of total consumption and commercial buildings for 33%

1. On-grid electricity consumption between sectors split using 2018 split provided by IEA
 2. Back-up generators
 3. Mainly turbines fueled with natural gas

1. Diesel generators amount for 80% of total electricity generation capacity

Electricity generation capacity by technology in Nigeria in 2020, GW



[Details available in back up](#)

Key takeaways

Diesel generators amount for **80%** of electricity generation capacity

Centralized power capacity represents **only 20% of total capacity** in Nigeria and is almost exclusively provided through **two technologies: natural gas (16% of total capacity) and hydro (4%)**

Out of the 14,9 GW of national grid capacity, **8,6 GW (58%) are not operational**, due to **maintenance and repair issues and gas, water management and other constraints**

1. According to Nesistats

2. Due to maintenance and repair issues and gas, water management and other constraints

3. Assumed to be fully available capacity

5. AFSIA reports 77 MWp installed capacity in 2020 (FYI: IRENA 28 MW for 2019)

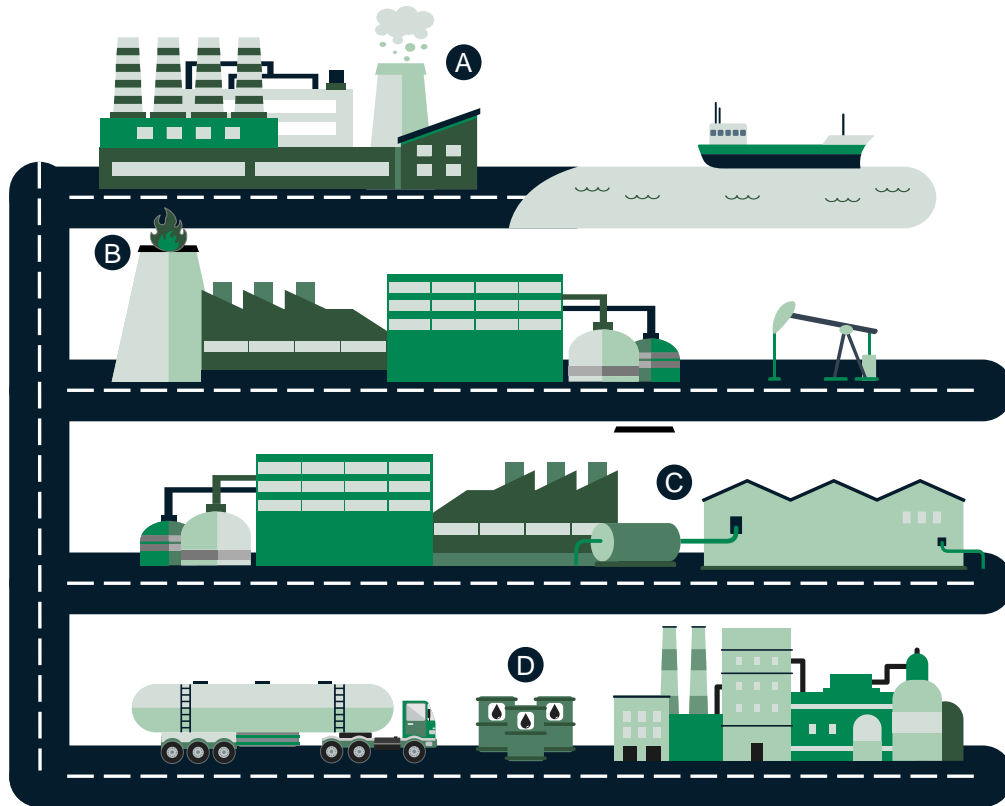
7. Generators for MSMEs might be partially double-counted in residential sector

4. Zungeru project expected to become operational in 2022

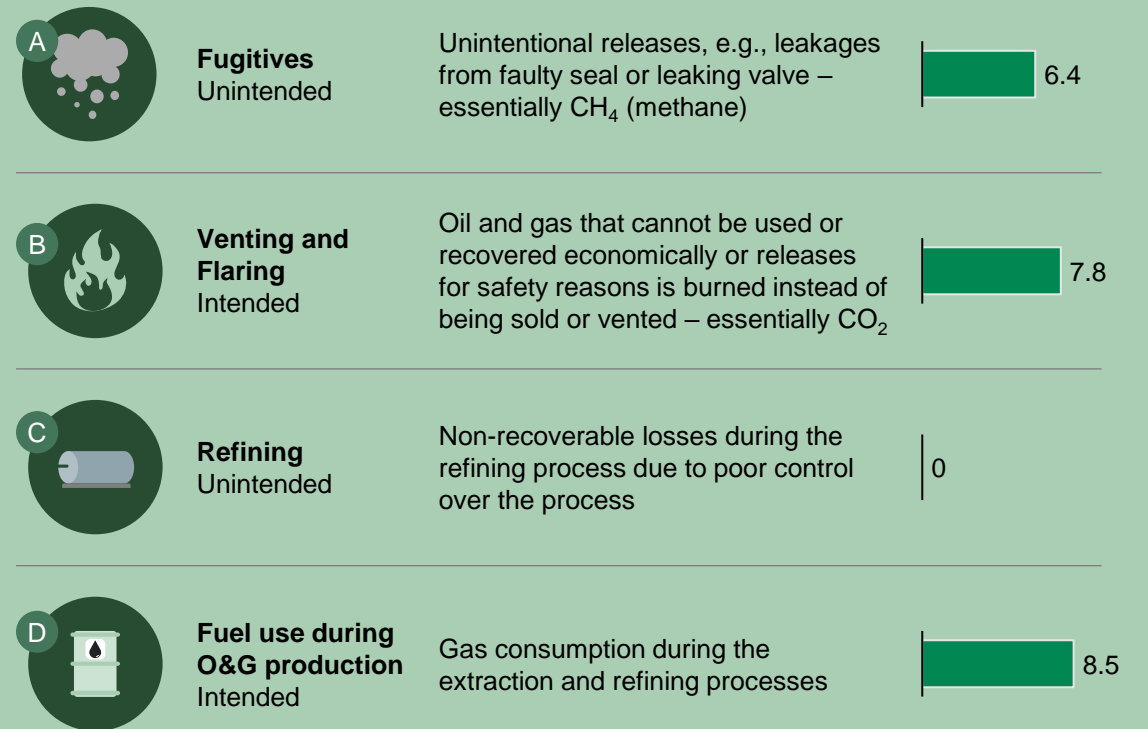
6. Assumed to be decentralized, fully available power capacity

8. Used in oil fields

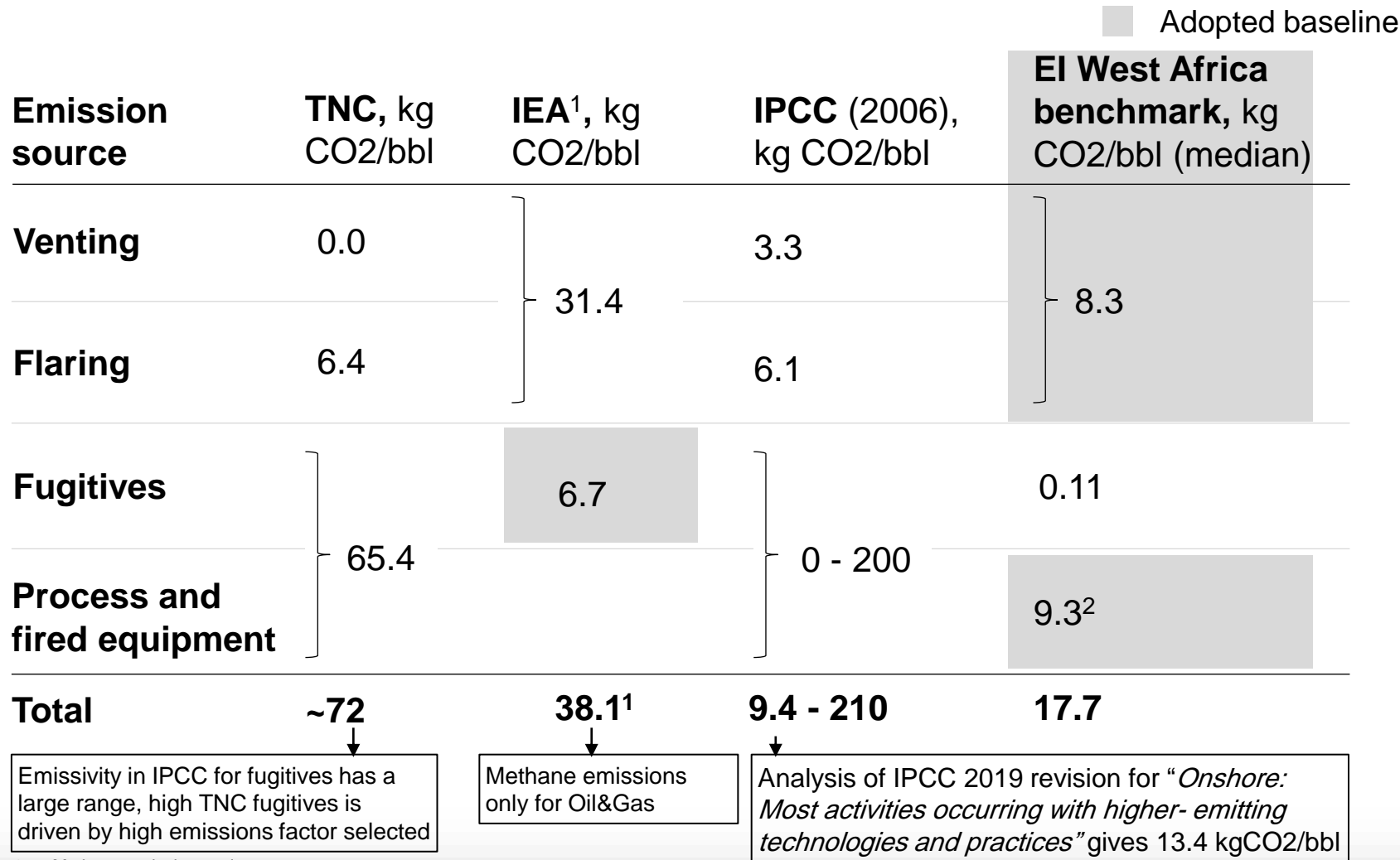
2. Emissions in the Oil and Gas sector come from fugitives, flaring and fuel use during production



■ Emissions, Mt CO₂ e



2. Fugitive emissions vary significantly depending on the source, IEA figures were adopted due detailed assessment of methane emissions undertaken



Commentary

EI West Africa values for venting and flaring and P&FE adopted as baseline due to alignment with IPCC baseline and IRENA energy demand

IEA value for fugitives adopted due to detailed assessment of methane emissions undertaken (fugitives are primarily methane)

The main divergence from TNC numbers is on fugitives, if fugitive emissions are closer to TNC value in reality then fugitive focused levers (e.g., VRU³ on storage tanks, LDAR³) should be primary focus and these levers will abate more CO2 e than this analysis shows

1. Methane emissions only

2. Median benchmark number is 9.9 kg CO₂ e/bbl however triangulating with IRENA figures on energy demand gives 9.3 kg CO₂ e/bbl

3. VRU = vapour recovery units; LDAR = Leak Detection and repair

3. Cement is the highest emitting industrial sector, mainly due to the clay calcination process

Methodology and data used to derive emissions of industrial segments in 2020

Segment	Segment activity level in 2020, Mt	×	Segment emission factor, tCO ₂ e/t	=	Segment emissions in 2020 MtCO ₂ e
Cement	23.5		0.6		14.3
Ammonia	0.9		2.0		1.9
Ethylene	0.2		1.4		0.3
Iron	0.1		2.3		0.2

Key insights

Cement:

- Highest emitting manufacturing sector in Nigeria with a baseline of **~14.3 Mt CO₂e** in 2020
- **~2/3 of cement emissions** due to process emissions with the rest from fuel combustion

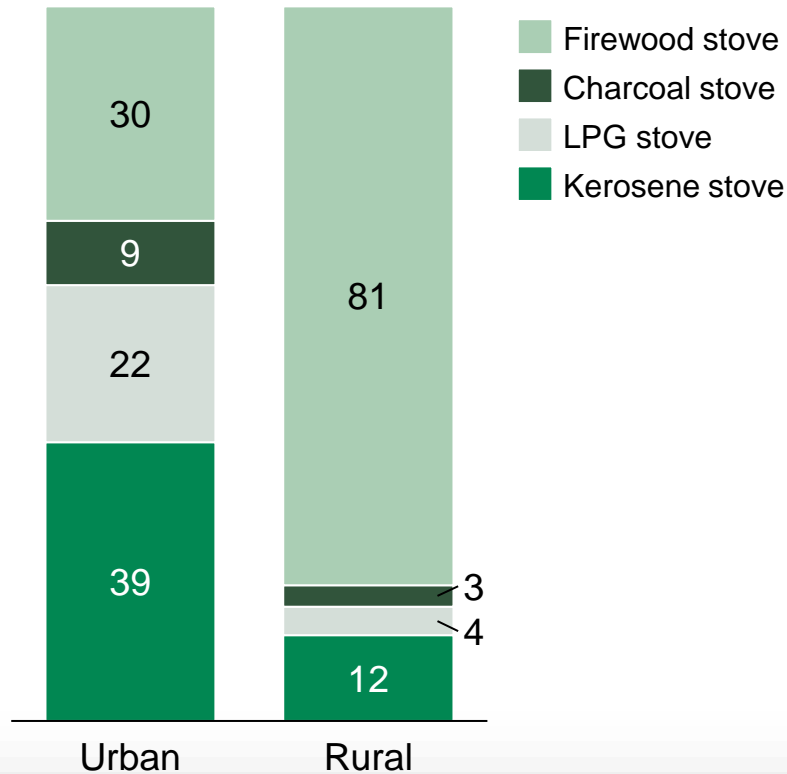
Ammonia: existing capacity will increase by **~750kt in 2025** when OCP ramps up production in its **new Nigerian ammonia fertiliser plant**

Ethylene: high energy-intensive industrial process, all the **emissions come from fuel use**

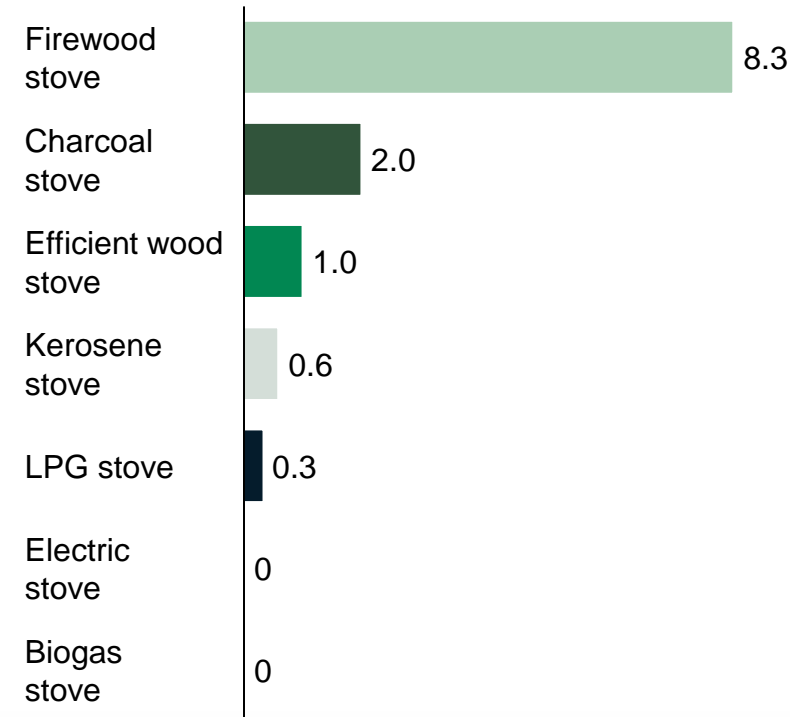
Iron: **small scale, decentralised** production expected to remain constant in the coming years

4. Firewood is the main fuel used for cooking, especially in rural areas despite being the highest GHG emitting and least efficient one

Share of households in Nigeria per primary cook stove, % 2020



Greenhouse gas emissions per household relative to cook stove used, teqCO₂/HH/year



Key takeaways

Rural households tend to use proportionally:

- **More wood stoves** than urban households (81% VS 30%)
- **Less LPG and kerosene stoves**

This can be explained by **volatile, often high LPG and kerosene prices**, whereas **unsustainable fuel wood can be harvested for free**

Traditional firewood and charcoal stoves have higher carbon intensities than LPG, kerosene, efficient wood and electric cook stoves, and cause **indoor air pollution** that **threatens the users health**

Content

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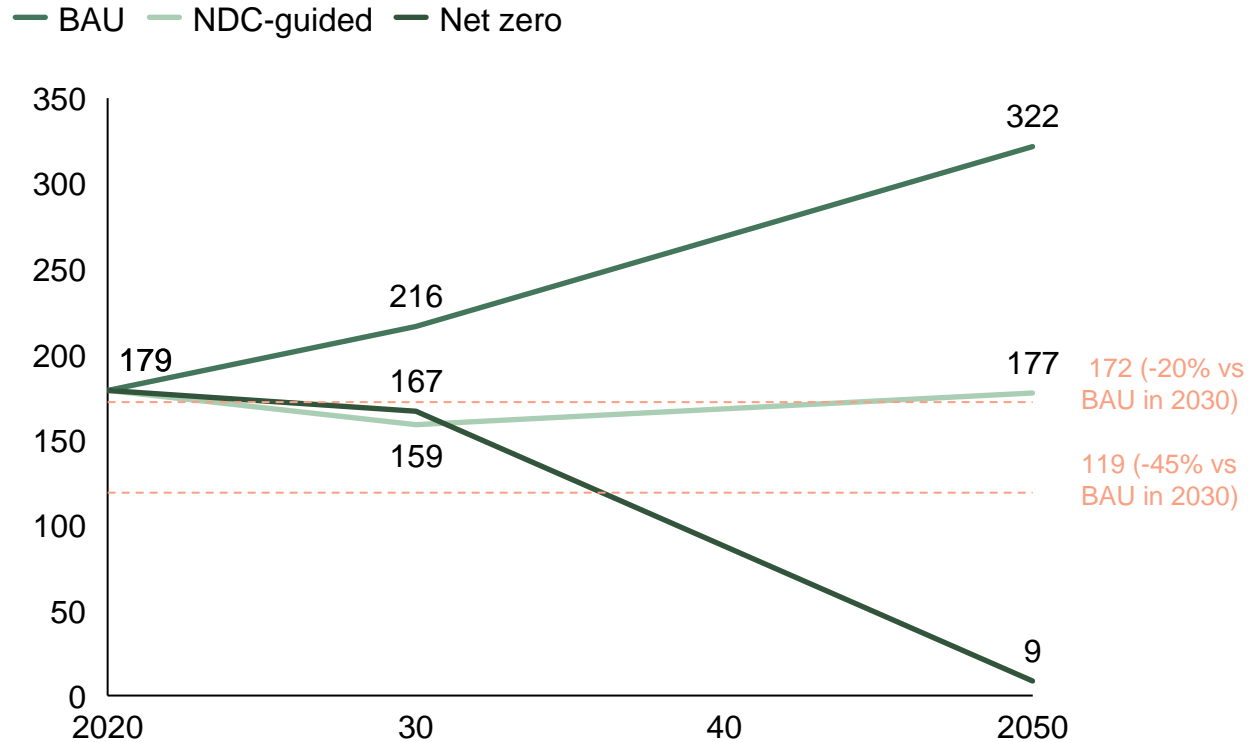
03.

Decarbonisation scenarios –
snapshots

Two potential scenarios are explored to guide what an Energy Transition Plan could look like for Nigeria

ONLY ENERGY AND INDUSTRIAL PROCESSES INCLUDED

GHG emissions trajectory, MtCO₂e



1. Out-of-scope emissions reduction have not been modelled (e.g., agriculture, waste and other LULUCF) and account for 137Mt CO₂e of residual in 2050, based on a standard GDP growth applied to the 2020 amounts

2. Nationally Determined Contribution

Scenario description



BAU (Business As Usual)

Projects emissions based on current pathway for macroeconomic development and without decarbonisation effort



NDC²-guided

Incorporates current national programs with decarbonisation effects:

- Strong gas up take – 80% of vehicles to be CNG by 2050
- >50% of population using LPG for cooking








Net Zero 2050

Explores what it would take to get to Net Zero by 2050 to be aligned on 1.5°C pathway; main focus is a transition to full electrification of economy by 2050:

- ~250 GW of installed capacity; >90% renewable
- Electric vehicles making up 80% of fleet
- Clean cooking for >80% of the population








Multiple programs relevant for decarbonization have been developed across ministries and sectors...

Program with high public endorsement  Program part of Nigeria Economic Sustainability Plan

Owner Sector	Office of the Vice President	Federal Ministry of Petroleum Resources	Federal Ministry of Power	Federal Ministry of the Environment	Rural Electrification Agency	Energy Commission of Nigeria	Nigerian Atomic Energy Commission	Multiple/Unknown
Power 			Presidential Power Initiative Mambilla Hydropower Project	Creation of a renewable energy market ¹		Nigeria 2050 Calculator	Nigerian nuclear Power program	SEforAll Country Action Agenda
Industry 	National Gas Expansion Program (NGEP) - track 2 (LPG)	National Gas Expansion Program (NGEP) - track 1 Nigeria Gas flare Commercialization program (NGFCP)						
Buildings 	National Gas Expansion Program (NGEP) - track 2 (LPG)			Pre-Urban/Rural Cooking Energy Scheme (PRCES) ¹ Infrastructure clean energy scheme (ICES) ¹ Urban Residential Housing Scheme (URHS) ¹	Solar Power Naija Nigeria Electrification Project (NEP) Energizing Education Program (EEP)			SEforAll Country Action Agenda Universal Green Energy Access Program (UGEAP)
Transport 	National Gas Expansion Program (NGEP) - track 2	National Gas Expansion Program (NGEP) - track 1		Clean Energy Transport Scheme (CETS) ¹				
LULUCF				New National Forest Policy				
Modelling/other				National GHG inventory and submissions to the UNFCCC, NDC Nigeria Deep Decarbonization Pathways Project (DDP) "Vision 2050"	Nigeria Energy Database			Climate Finance Accelerator program 2050 Pathways Platform

1. Included in the National Decarbonization Program (NDP)

... and key targets were integrated to our scenarios

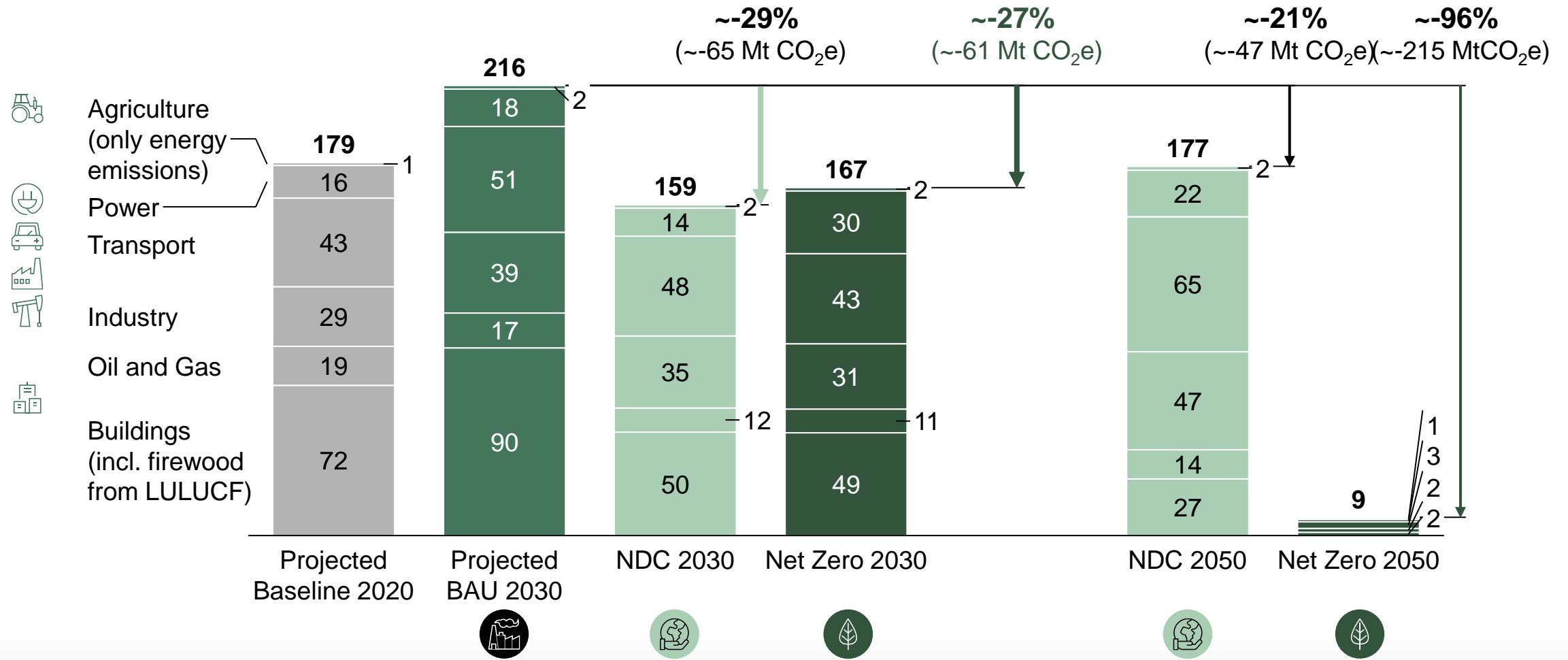
Sectors impacted	Program	Targets mentioned	Current status	Included in...			Potential target adjustment
				BAU	/NDC-guided ³	Net 0 ³	
 Power	Presidential Power Initiative	7GW operational capacity in 2021, 11 GW in 2023, 25 GW in 2025	Pre-engineering phase		✓	✓	Same
	Mambilla Hydropower Project	3.05 GW in 2030, 4.7 TWh/year	Contracted, funded		✓	✓	Same
	SEforAll Country Action Agenda	30GW of power capacity with at least 30% of RE (excl. large hydro power) by 2030 – 16% ² energy consumed from RE	Official target confirmed by Ministry		✓	✓	Same
 Buildings	National Gas Expansion Program – track 2	Production of 5 Mn t of LPG (0.8 Bcf/d) in 2027 for the domestic market: - conversion of 30 Mn homes from kerosene/charcoal/diesel to LPG (>2 Mn t) - use of LPG in agriculture, transport, power, industry	Launched in 2017 1.1 Mn t of LPG today		✓	?	Adjusted 2030
	Solar Home Systems Project	SHS to 5 Mn households not connected to the grid by 2023	Launched in 2020		✓	✓	Adjusted 2030
	Nigeria Electrification Project (NEP)	2,5Mn people with new or improved electricity service through off-grid solutions (incl. 500 000 households, 70 000 MSMEs) by 2023	70 000 households with new electricity access		✓	✓	Adjusted 2030
 Industry	Nigeria Gas Flare Commercialization Program	Flare-out by 2030, by offering flared gas for sale through a transparent and competitive bidding process	Approved in 2016 Bidding launched in 2020		✓	✓	Same
	National Gas Expansion Program – track 2	Production of 5 Mn t of LPG (0.8 Bcf/d) in 2027 for the domestic market: - conversion of 30 Mn homes from kerosene/charcoal/diesel to LPG (>2 Mn t) - use of LPG in agriculture, transport, power, industry	Launched in 2017 1.1 Mn t of LPG today		✓	?	Adjusted 2030
 Transport	National Gas Expansion Program – track 1	1 Mn CNG cars by the end of 2021 (Presidential discourse)	Launched in Dec 2020		✓	?	1 Mn + low growth by 2030
 LULUCF	New National Forest Policy	25% forest cover - still considered as a priority decarbonization lever (?)	Approved in Aug 2020		Will be tested separately		N/A
Additional input							
 Power	Geospatial work	3.6 Mn grid connections, 1.4 Mn mini-grid connections, 7.5 Mn SHS connections, 2030 ¹	N/A		✗	✓	Same
 Industry	Oil production target	3 Mn barrels of crude produced per day	1.65 Mn barrels per day in July 2020		Will be tested as a sensitivity		N/A

1. Scenario with universal electricity access in 2030 and possible grid within 10 km of existing grid
3. Further levers beyond stated policies will be explored as part of these scenarios

2. Small Hydropower (7.07%); Solar (5.90%); Biomass (2.78%); and Wind (0.25%)

Both NDC-guided and Net Zero scenarios achieve similar abatements by 2030, however the choices made in Net Zero drive continued improvement to 2050

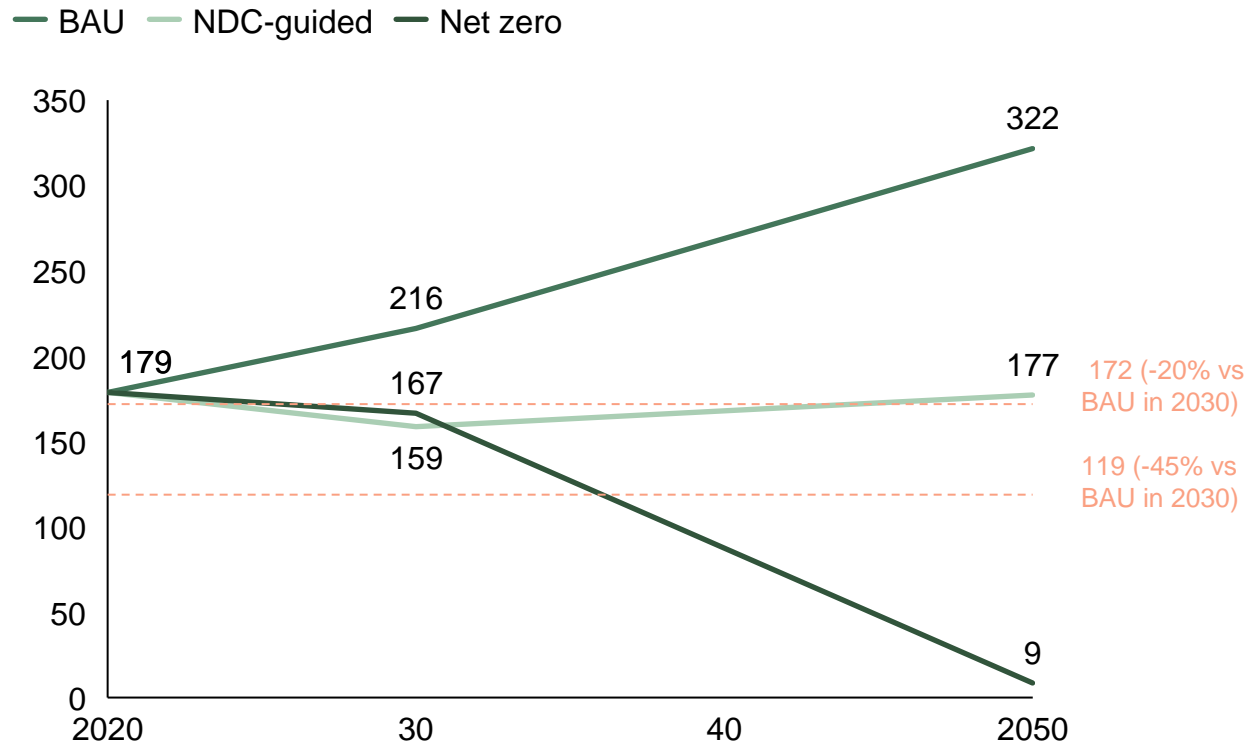
Total greenhouse gas emissions MtCO₂e



BAU maintains current trends and enables the comparison with the 2 decarbonisation scenarios considered

ONLY ENERGY AND INDUSTRIAL PROCESSES INCLUDED

GHG emissions trajectory, MtCO₂e



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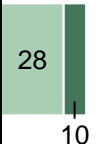





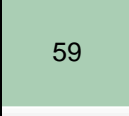
Net Zero 2050

Explores what it would take to get to Net Zero by 2050 to be aligned on 1.5°C pathway; main focus is a transition to full electrification of economy by 2050:

- ~250 GW of installed capacity; >90% renewable
- Electric vehicles making up 80% of fleet
- Clean cooking for >80% of the population


The menu of options includes measures across all sectors (1/2)

■ NDC-guided ■ Net Zero

	Menu option	KPI 2050	2050 Impact, MtCO ₂ e
 Power	Expand grid capacity while maximising RE share in centralised energy mix	NDC-guided : 44GW of solar to be built Net Zero : ~200GW of solar + 90GW of storage to be built	
	Deploy decentralised RE	> 25 TWh of decentralized RE generation, fully replacing diesel generators and ensuring universal energy access	Accounted for in Buildings/Industry
 Transport	Alter fleet mix to lower carbon alternatives e.g. natural gas/EV	NDC-guided: 80% shift to CNG by 2030 with ~27% of gasoline stations having natural gas re-fueling facilities Net Zero: ~60% passenger cars transitioned to EV with remainder modal shifted to buses/2 and 3 wheelers	
	Mode shift passengers from passenger cars to 2-3 wheelers or public transport	Net Zero: ~20% reduction in passenger cars from BAU through mode shift to 2-3 wheelers and public transport	
 Buildings	Switch to clean cooking technologies	NDC-guided : 75% LPG/ 25% electric in urban centers, 40% biogas/ 35% efficient firewood in rural areas Net Zero: 100% electric in urban centers, 50% biogas/ 50%efficient firewood in rural areas	
	Replace diesel generators	100% of diesel generators replaced by centralized or decentralized electricity by 2030	

The menu of options includes measures across all sectors (2/2)

■ NDC-guided ■ Net Zero

	Menu option	KPI 2050	2050 Impact, MtCO ₂ e
 Industry	Increase feedstock substitute in cement	NDC-guided and Net Zero 2050: ~50% clinker substituted for calcined clay	7.96 -0
	Implement low carbon heating alternatives in industry	NDC-guided: 80% low/mid temp heating from gas, 20% from solar; 100% high temp heat from gas Net Zero: ~100% of heating from zero emission alternatives	-4.91 25.01
	Utilise hydrogen in ammonia production	NDC-guided: 35% green hydrogen, 65% grey hydrogen Net Zero: 35% green hydrogen, 65% blue hydrogen	2.82 4.72
	Deploy BECCS in cement	NDC-guided: Apply biomass to 40% cement production Net Zero: Apply BECCS to 50% cement production	13.73 -3.38
Oil and Gas	Reduce fugitive emissions in Oil	95% fugitive reduction by 2050	-0.14
	Reduce flaring in Oil	100% flaring reduction by 2030, maintained to 2050	-0.8
	Reduce fugitive emissions in gas	81% fugitive reduction by 2050	-1.4
	Increase fuel use efficiency	100% switch to zero emissions fuel by 2050	-0.6
	Apply CCS to refining in Oil	CCS applied to 100% refining by 2050	12.2

Content

01.

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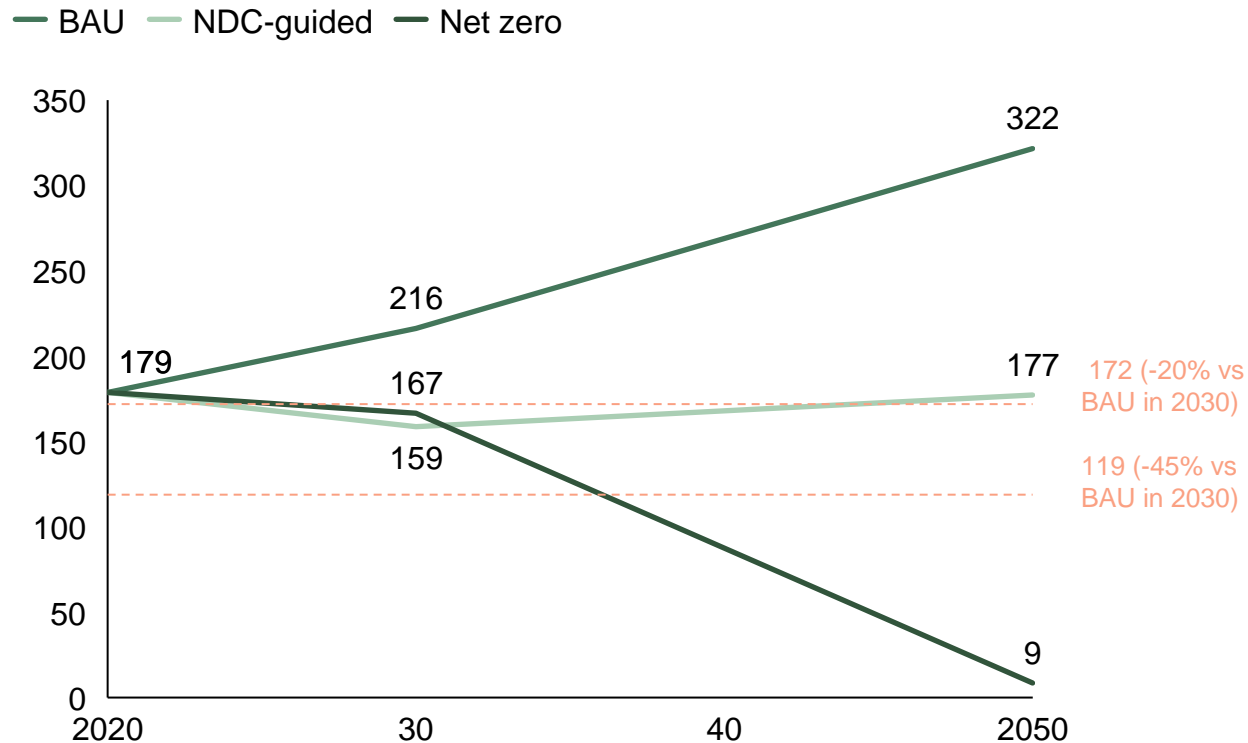
Decarbonisation scenarios – snapshots:

- BAU
- NDC-guided
- Net Zero

BAU maintains current trends and enables the comparison with the 2 decarbonisation scenarios considered

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GHG emissions trajectory, MtCO₂e



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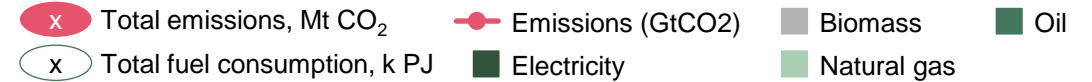
- ~250 GW of installed capacity; >90% renewable
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Scenario snapshot: BAU



Preliminary

Details available in backup



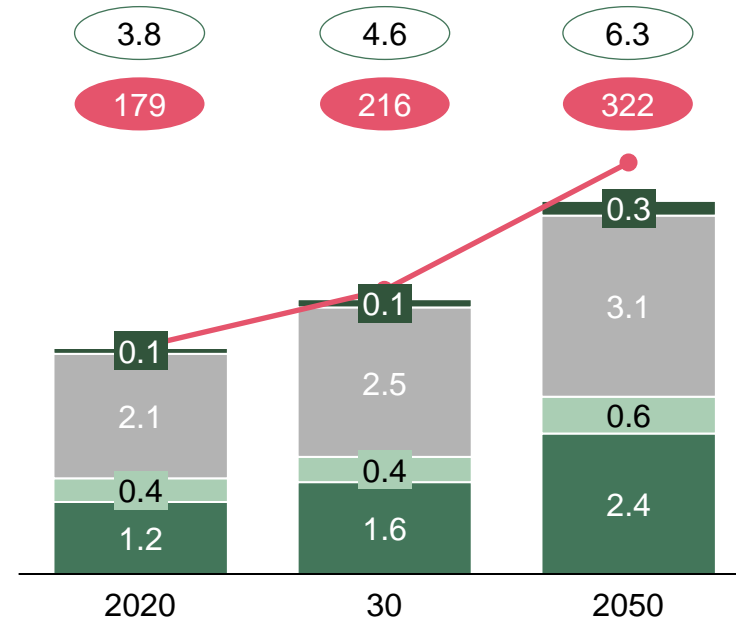
Scenario description

Projects emissions based on current pathway for macroeconomic development and without decarbonisation effort

Key features

- Population growth 2.5% in 2020-30 and 2.1% in 2030-50
- Limited power capacity increase (from ~7GW to ~17GW in 2020-50)
- Traditional firewood kept as main cooking fuel
- No efforts made to reduce Oil and Gas fugitives and venting
- Car fleet remains 100% ICE vehicles
- Industrial growth of 2.3% p.a. until 2050

Fuel consumption and emissions, k PJ, Gt CO₂



Implications

+80%

Emission increase by 2050 and neither NDC or 1.5°C pathway commitments met

~100 GW

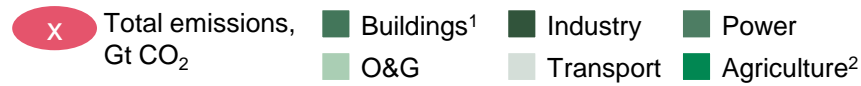
Power capacity from diesel generators in 2050, compared to ~54 GW in 2020

Source: World Bank, McKinsey Decarbonisation Scenario Explorer



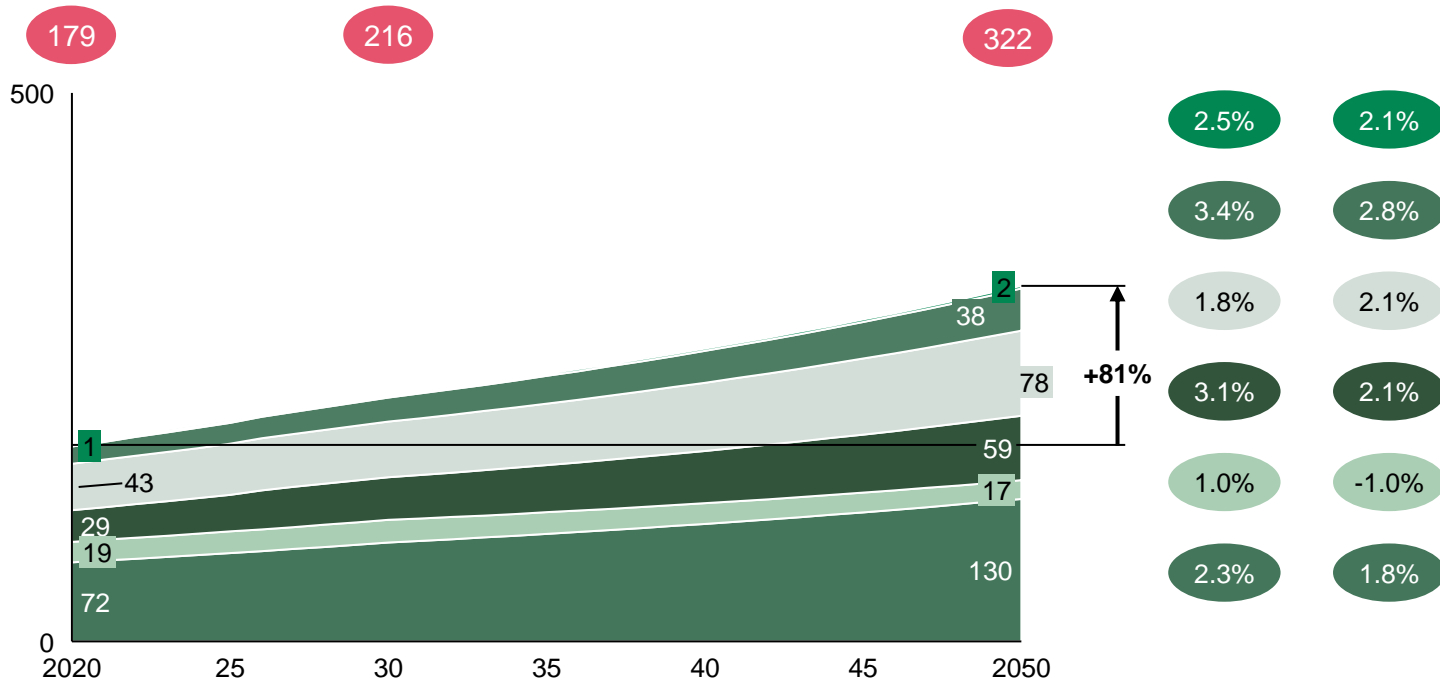
In BAU, in-scope emissions reach ~322 Mt CO₂e in 2050, ~80% above today's level

Preliminary



Emissions by sector³, MtCO₂

CAGR 2020-30 CAGR 2030-50



Key drivers of emissions

Across sectors, split of **technologies** remains as it is today

- **Buildings:** highest emission sector with ~130 Mt CO₂e in 2050. Sector grows with population, however, emissions grow at slower rate due to urbanisation and subsequent shift from firewood
- **Oil & Gas:** emissions remain relatively stable as reduction from demand decline is counteracted by increase in refining activity
- **Industry:** growth primarily driven by increased activity in cement, refining and ammonia production
- **Transport:** passenger cars almost double in line with population, while emissions increase ~80% due to improved vehicle efficiency⁴

1. Includes LULUCF emissions from firewood removal
 2. Energy emissions in Agriculture only
 3. Non-energy agriculture, waste and other LULUCF emissions are not included in this assessment
 4. Improved vehicle efficiency is -0.5% p.a.

Source: McKinsey Decarbonisation Scenario Explorer

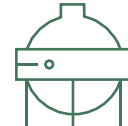
Cement is a major emitter in 2020, but ramp-up of refining and ammonia production will increase industrial emissions faster than GDP



Preliminary



Cement



Refinery



Ammonia

Starting point

Cement is the highest emitting manufacturing sector in Nigeria contributing to 33% of overall 2020 industrial emissions

Currently all Nigerian refinery capacity is shut down for overhaul

Nigeria accounts for ~20% of all ammonia produced in Africa, with 1.75 Mt output p.a.

Development

Growth of cement production in line with growth of the economy

New refinery to open in 2022

Additional production to open in 2025



**~2.2% p.a.
2020-50**



**~ 650k bbl/day
refined post-2022**



**+750 kt production
from 2025**

Source: Press, web search

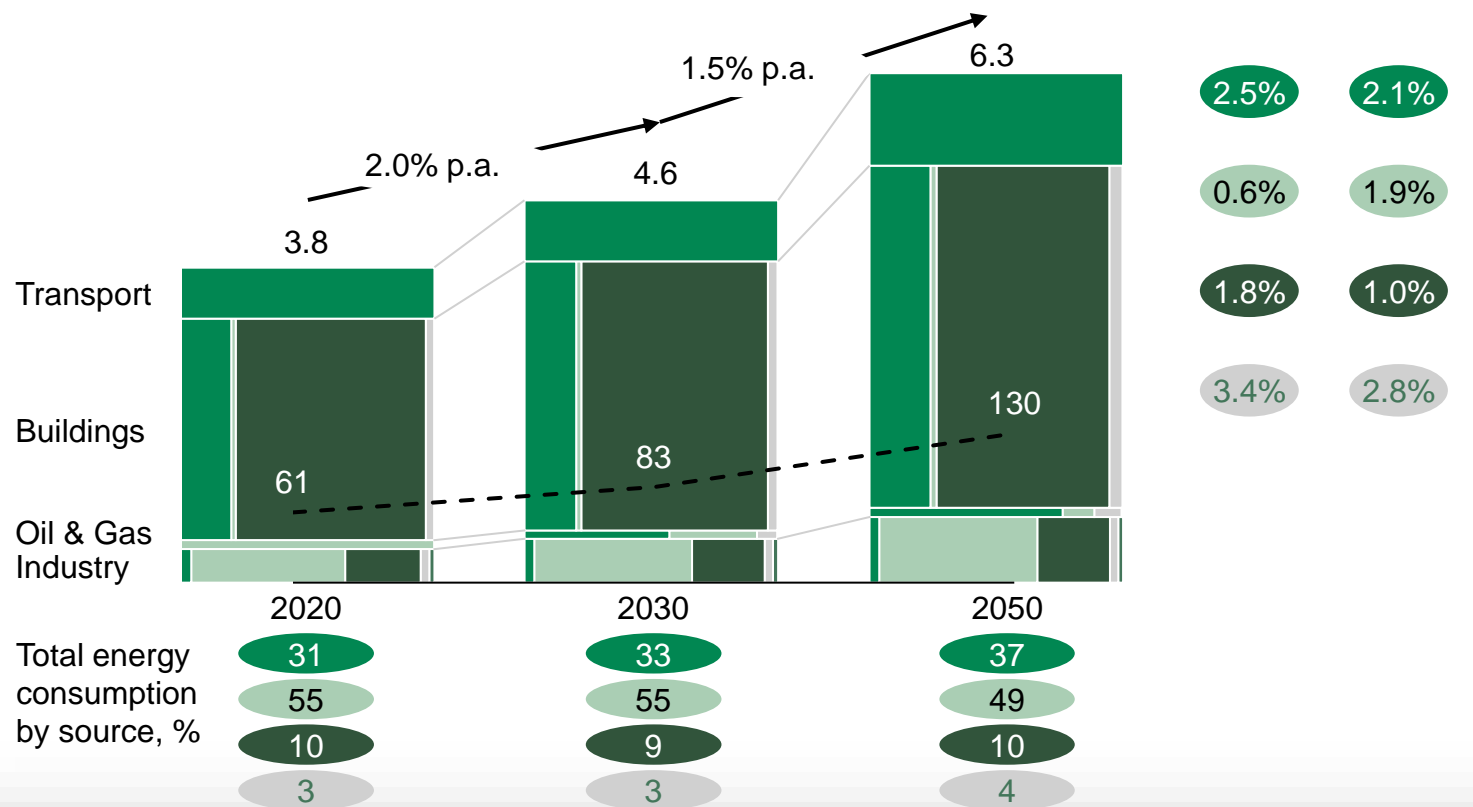


In BAU, energy consumption pattern remain reliant on biomass with limited uptake of power consumption

Preliminary

■ Oil ■ Biomass ■ Coal - - Power consumption (TWh) – centralised and decentralised
■ Natural gas ■ Electricity

Final energy consumption by fuel, PJ



Key drivers of consumption

~94% increase in oil consumption by 2050 driven by population growth and urbanisation

~45% increase in biomass consumption by 2050 driven up by population growth but reduced by trend to urbanisation

Electricity representing only 3-4% of the total energy consumption in 2050

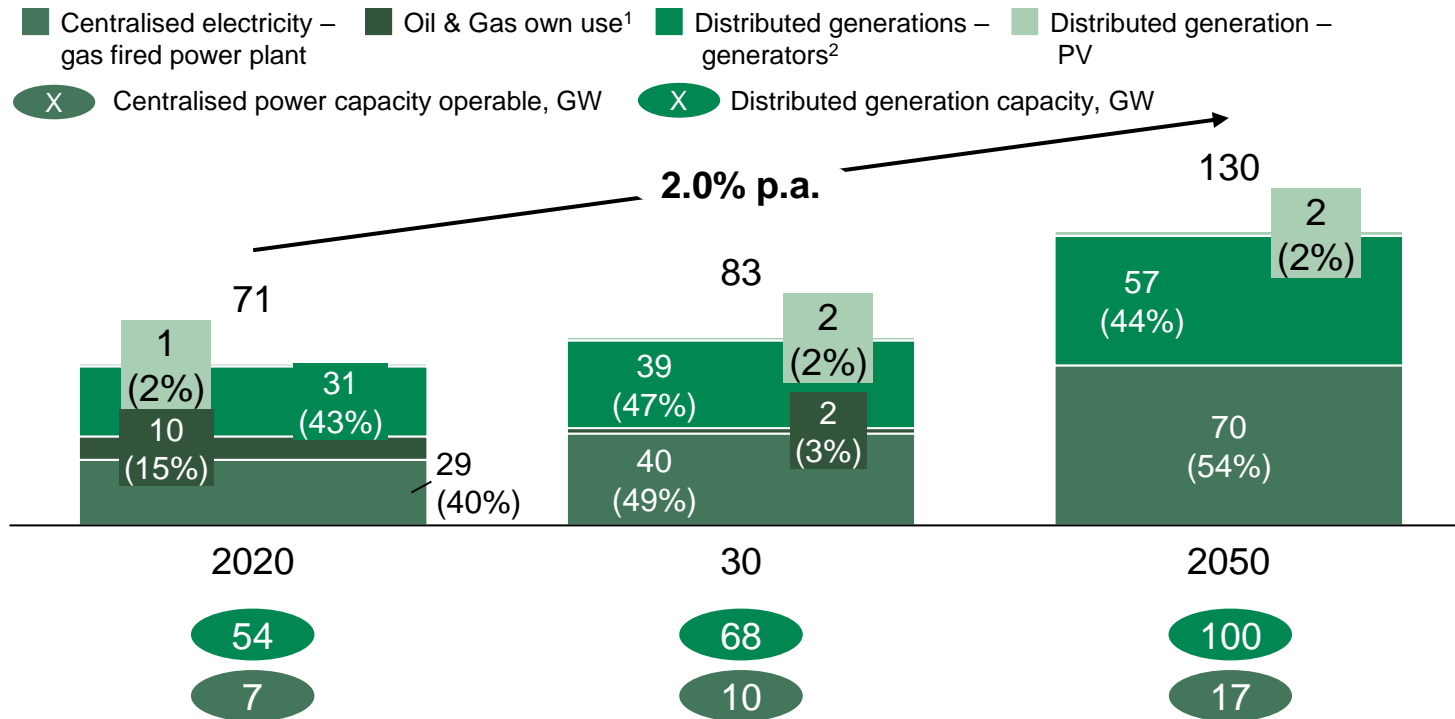
Without an increase in grid network or PV, diesel generators will continue to meet ~40% of electricity demand in 2050



Preliminary

2019-50 Nigeria power generation distribution under BAU scenario

TWh



Key takeaways

Operational centralised generation grows ~145% in 2020-50, aligned with an operational capacity of 17 GW³

Diesel generators continue to provide ~44% power generation in 2050 driven by growing need from communities with limited or unreliable grid access

Without grid network build out, and/or an increase in PV, electricity generation remains heavily reliant on diesel generators in 2050





1. Assumed that all gas used in the O&G sector is for on-site power generation, at an efficiency of 35%
 2. In BAU, only generators are considered, running at 40% load for 4 hour per day at an efficiency of 25%.
 3. 17 GW is aligned with today's installed capacity being fully utilised

BAU scenario: Activity level assumptions – macro-activity and sector-specifics



Nigeria activity of key sectors

Backup

		2020 Baseline	CAGR 2020-30	CAGR 2031-50	Comment
Macrodrivers	Population, Bn	206	2.5	2.1	UN, medium population growth scenario
	GDP, Bn	448.1 ¹	2.3	2.1	IMF 2021-26 projections taken for 2020-30, population growth used 2030-50
Transport 	Passenger cars, Bn vkm	205.3	2.1	2.1	Growth in line with MCFM model for Nigeria
	Trucks, Bn vkm	8.6	2.3	2.1	Growth in line with GDP growth rates
	Buses, Bn vkm	2.3	2.5	2.1	Growth in line with population growth
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	Oil refining, k bbl crude/day	0	N/A (650k in 2022)	2.2	CAGR 2030-50 reflects domestic oil demand growth
Buildings 	Residential Urban dwellings, Mn	14.4	3.4	3.4	UN urbanisation projections for Nigeria to 2050
	Residential Rural dwellings, Mn	27.8	1.4	-0.1	Estimated based on population growth and urbanisation rates
Power 	Grid capacity, GW	14	0.0	0.0	Non-operational capacity assumed to become operational and available

1. 2019 GDP figure used due to Covid-19 impact on 2020 figure

Content

01.

Nigeria carbon emissions baseline and overall energy needs

02.

Decarbonisation scenarios – approach

03.

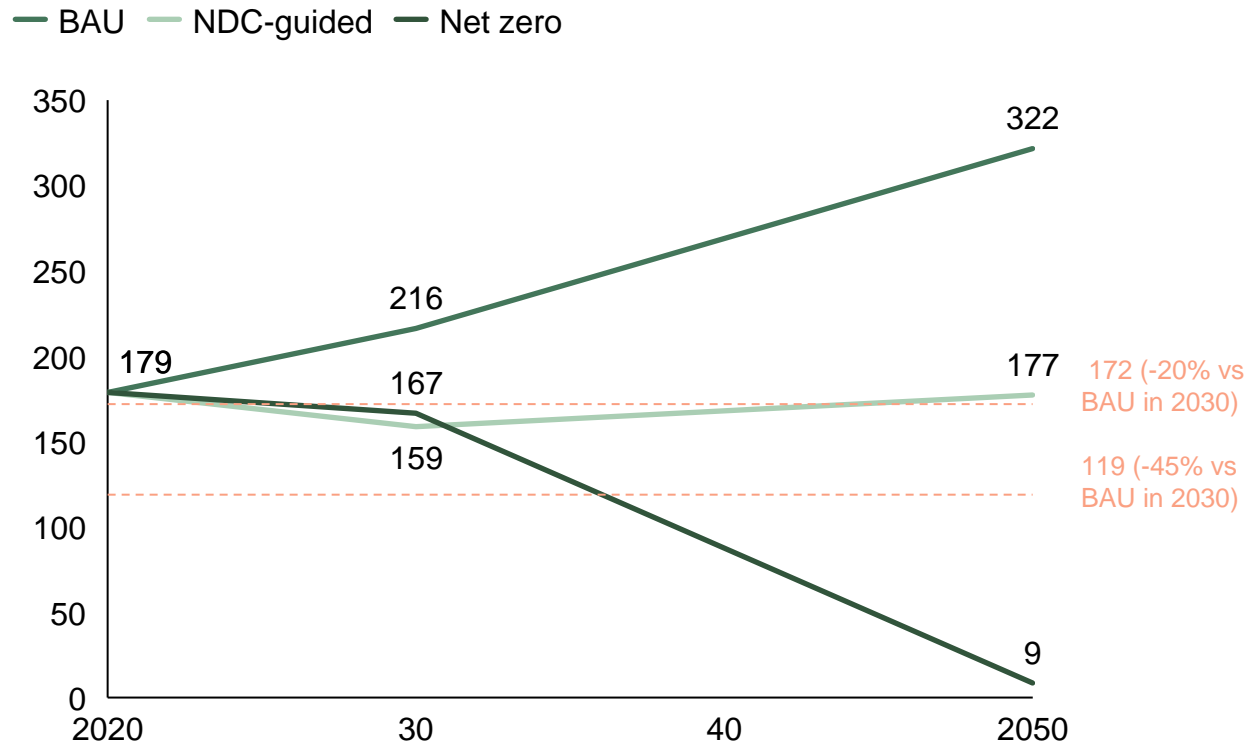
Decarbonisation scenarios – snapshots:

- BAU
- **NDC-guided**
- Net Zero

The NDC-guided scenario explores where Nigeria would land following current policies and program, mainly oriented towards gas

ONLY ENERGY AND INDUSTRIAL PROCESSES INCLUDED

GHG emissions trajectory, MtCO₂e



1. Out-of-scope emissions reduction have not been modelled (e.g., agriculture, waste and other LULUCF) and account for 137Mt CO₂e of residual in 2050, based on a standard GDP growth applied to the 2020 amounts

2. Nationally Determined Contribution

Scenario description



BAU (Business As Usual)

Projects emissions based on current pathway for macroeconomic development and without decarbonisation effort



NDC²-guided

Incorporates current national programs with decarbonisation effects:

- Strong gas up take – 80% of vehicles to be CNG by 2050
- >50% of population using LPG for cooking



Net Zero 2050

Explores what it would take to get to Net Zero by 2050 to be aligned on 1.5°C pathway; main focus is a transition to full electrification of economy by 2050:

- ~250 GW of installed capacity; >90% renewable
- Electric vehicles making up 80% of fleet
- Clean cooking for >80% of the population



Scenario snapshot: NDC-guided

Preliminary

Details available in backup



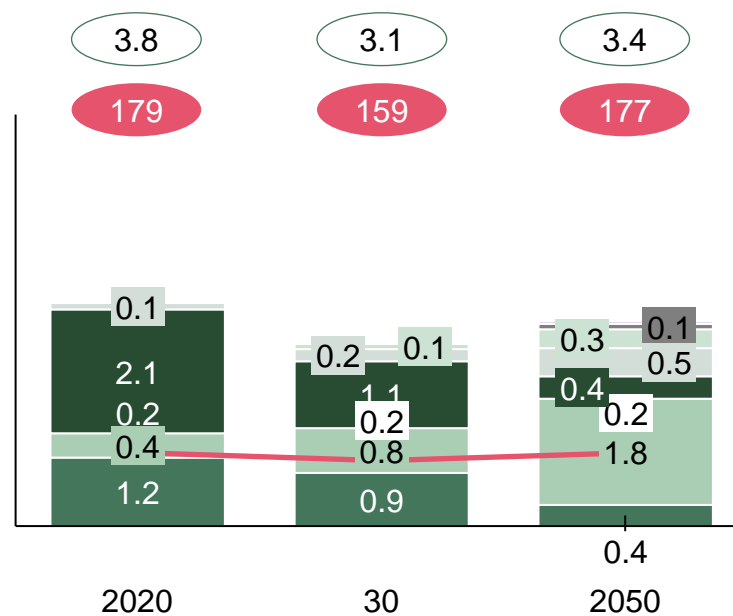
Scenario description

Incorporates current national programs with decarbonisation effects, with the objective to assess where Nigeria lands in 2030 compared to the NDC 2015 (-20% unconditional and -45% of emissions conditional compared to 2030 BAU). Post-2030, activity levels are assumed to continue to improve

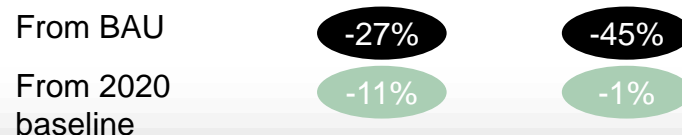
Key features

- Population growth 2.5% in 2020-30 and 2.1% in 2030-50
- Centralised power capacity increases from ~7 GW to ~34 GW in 2020-50
- Switch to LPG for cooking
- Switch of 80% of passenger cars to natural gas by 2050
- All industrial heating from gas sources by 2050

Fuel consumption and emissions, k PJ, Gt CO₂



Emission reduction, %



Implications

-27%

Emission decrease from BAU in 2030 allowing to meet unconditional NDC targets by 2030

-1%

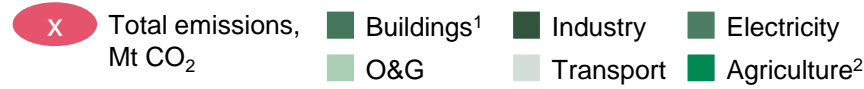
Emission decrease from 2020 baseline in 2050, due to emissions coming back up after 2030 due to increased activity levels and gas-based energy system

1. Primary biogas

Switching to gas enables partial decarbonization by 2030 however emissions come back up with increasing activity levels by 2050

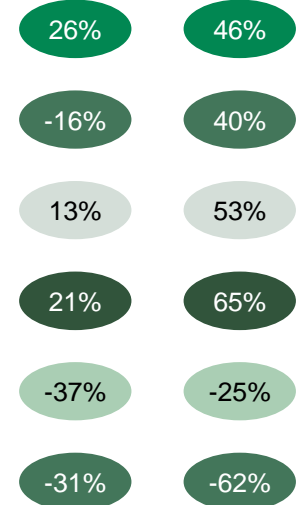
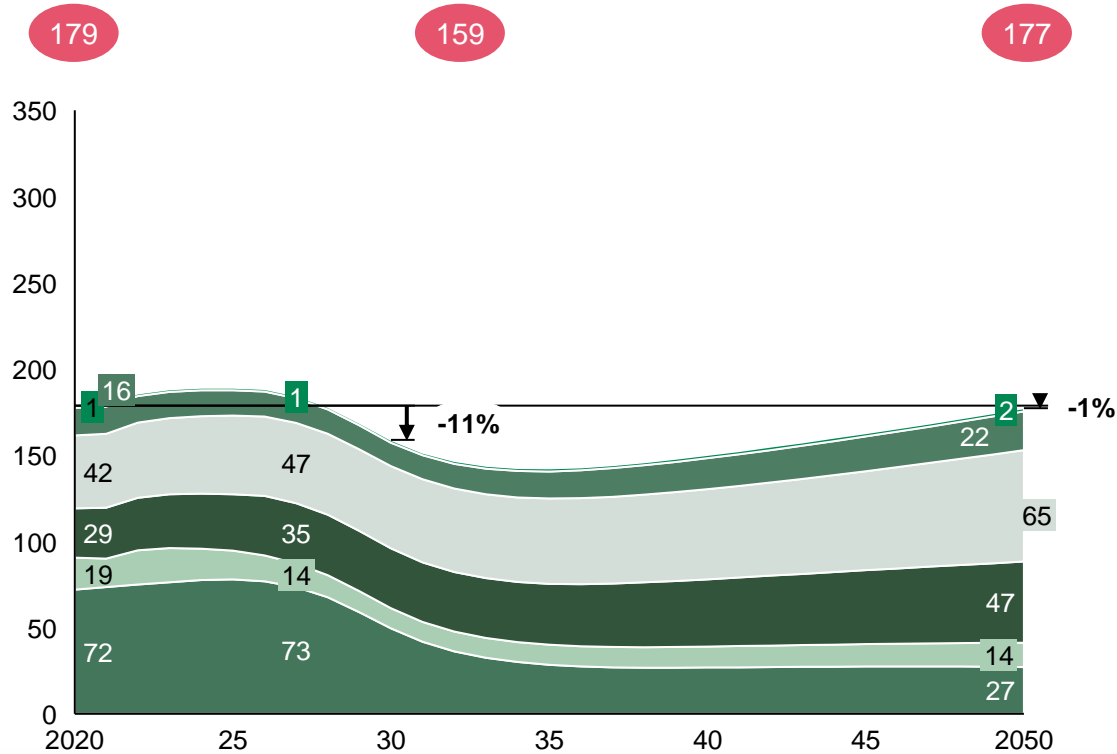


Preliminary



Emissions by sector³, MtCO₂

Emissions shift
2020-30 2030-50



Key drivers of emissions

Decarbonisation impact of natural gas is counteracted by growth of the sectors

- **Buildings: emissions decrease of ~62%** by 2050, is primarily driven by rapid decrease in firewood for cooking, most of which is achieved by 2030
- **Oil & Gas: emissions decrease of ~25%** by 2050 as refining activity increase counteracts oil demand decrease⁴
- **Industry: emissions increase of ~65%** despite ~100% growth in industrial sector due to decarbonisation efforts in cement and ammonia production and 100% shift to gas for heating
- **Transport: emissions increase ~53%** despite the shift to natural gas, driven by the increase in passenger cars and 2 and 3 wheelers
- **Power: emissions increase of ~40%** by 2030 as gas use increases due to higher electricity demand. Post-2040 solar increases and starts to replace gas leading to emission reduction

1. Includes LULUCF emissions from firewood removal
 2. Energy emissions only
 3. Non-energy agriculture, waste and other LULUCF emissions are outside scope and not shown here
 4. Model for NDC-guided scenario uses Nigerian oil production trajectory under a global 1.5oC pathway

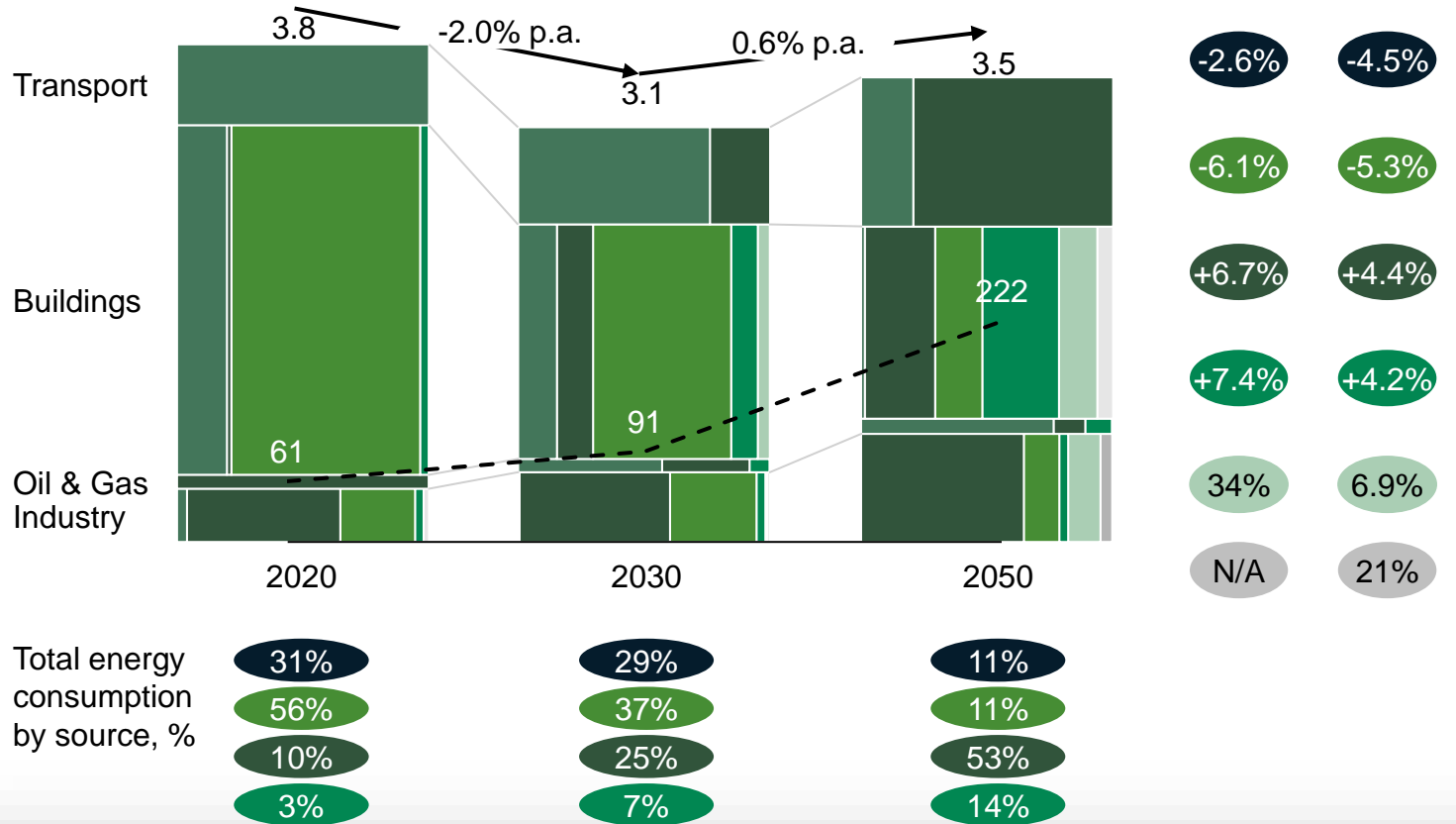


Shifting to more efficient fuels decouples growth in power consumption from growth in emissions

Preliminary

■ Oil ■ Biomass ■ Renewable power ■ Other¹ - - Power consumption (TWh) – centralised and decentralised
■ Natural gas ■ Electricity ■ Hydrogen

Final energy consumption by fuel, PJ



Key drivers of consumption

By shifting to more efficient fuels, increased power generation can be decoupled from emission increases. Power consumption increases to 222 TWh in 2050, primarily driven by increased grid access

Shift away from oil is enabled by:

- **~3.5 times increase in gas consumption 2020-50** driven by shift to natural gas vehicles in Transport and as a fuel for heating in Industry
- **~3.6 times increase in electricity demand 2020-50**

Increased oil consumption in Oil and Gas sector is due to increased refining compared to 2020

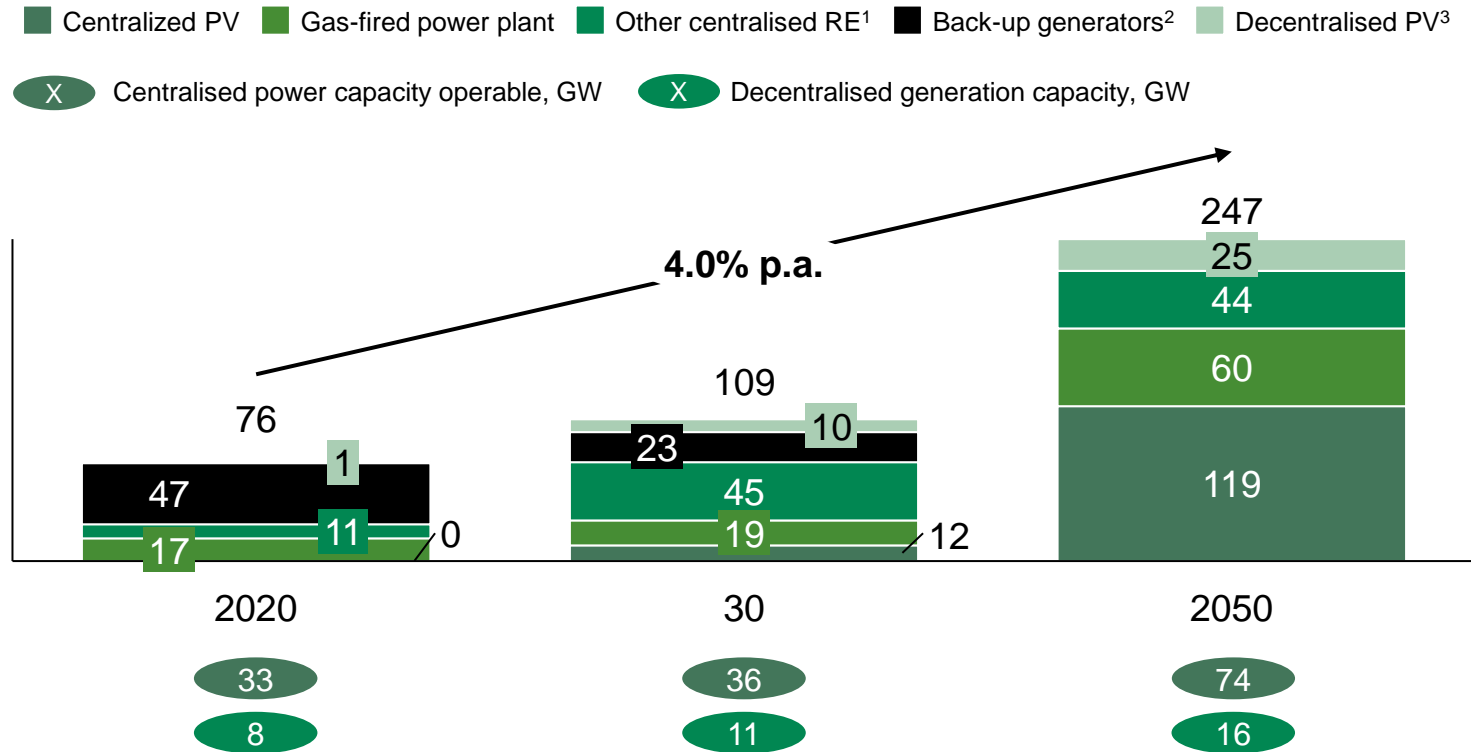
1. Coal and biogas

Meeting growing power demand without diesel generators requires more than doubling grid operational capacity and growing PV generation ~5 TWh/year



Preliminary

2020-50 Nigeria power generation distribution under NDC-guided scenario, TWh



1. Incl. hydro, biomass, wind
 2. Incl. centralised and decentralised generators, and gas turbines in O&G sector
 3. Incl. solar PV + battery, mini grid, SHS

Source: McKinsey Decarbonisation Scenario Explorer

Key takeaways

Growing power demand is met by centralised generation and decentralised PV while reducing diesel generators

Operational centralised generation grows by ~4% p.a. in 2020-50, aligned with an overall operational capacity of 74 GW

Diesel generators are no longer used for power generation in 2050





PV power generation grows by ~5 TWh/year in 2020-50

NDC-guided scenario : Activity level assumptions – macro activity and sector-specifics



Nigeria activity of key sectors

[Back up](#)

		2020 Baseline	CAGR 2020-30	CAGR 2031-50	Comment
Macrodrivers	Population, Bn	206	2.5	2.1	UN, medium population growth scenario
	GDP, Bn	448.1 ¹	2.3	2.1	IMF 2021-26 projections taken for 2019-2030, population growth used 2030-50
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	Ethylene, Mt	0.2	0.0	2.1	IHS projections to 2030 and growth in line with GDP 2030-50
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	Gas production, bcm	47	-3.8	0.0	Growth in line with McKinsey GIM modeled gas supply in Nigeria
	Oil refining, k bbl crude/day	0	N/A (650k in 2022)	-2.6	CAGR 2030-50 reflects domestic oil demand growth under global Accelerated Transition case
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	Residential Rural dwellings, Mn	27.8	1.4	-0.1	Estimated based on population growth and urbanisation rates
Power 	Grid capacity, GW	14	7.0	4.0	Increased capacity in line with RE share

1. 2019 GDP figure used due to Covid-19 impact on 2020 figure

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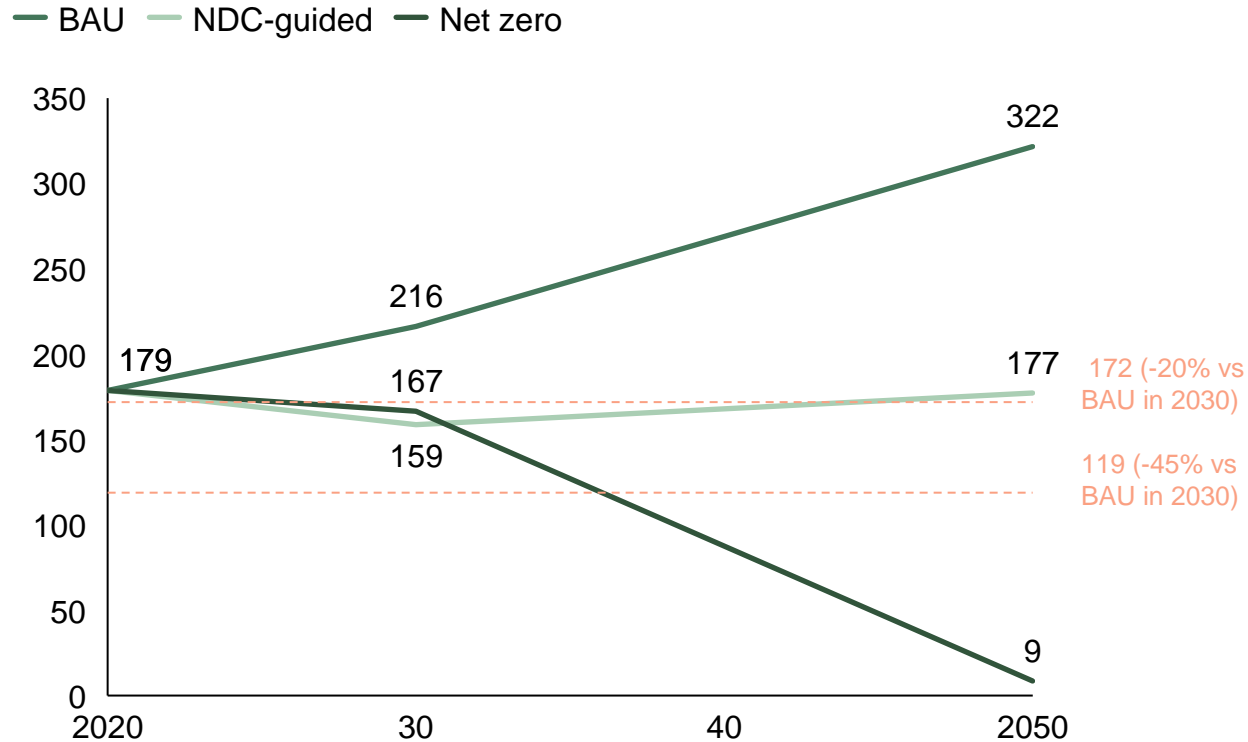
Decarbonisation scenarios – snapshots:

- BAU
- NDC-guided
- **Net Zero**

The second scenario Net Zero 2050 aims for Nigeria to be net zero by 2050 regardless of intermediary targets

ONLY ENERGY AND INDUSTRIAL PROCESSES INCLUDED

GHG emissions trajectory, MtCO₂e



1. Out-of-scope emissions reduction have not been modelled (e.g., agriculture, waste and other LULUCF) and account for 137Mt CO₂e of residual in 2050, based on a standard GDP growth applied to the 2020 amounts

2. Nationally Determined Contribution

Scenario description



BAU (Business As Usual)

Projects emissions based on current pathway for macroeconomic development and without decarbonisation effort



NDC²-guided

Incorporates current national programs with decarbonisation effects:

- Strong gas up take – 80% of vehicles to be CNG by 2050
- >50% of population using LPG for cooking



Net Zero 2050

Explores what it would take to get to Net Zero by 2050 to be aligned on 1.5°C pathway; main focus is a transition to full electrification of economy by 2050:

- ~250 GW of installed capacity; >90% renewable
- Electric vehicles making up 80% of fleet
- Clean cooking for >80% of the population



Scenario snapshot: Net Zero 2050

Preliminary

[Details available in back up](#)



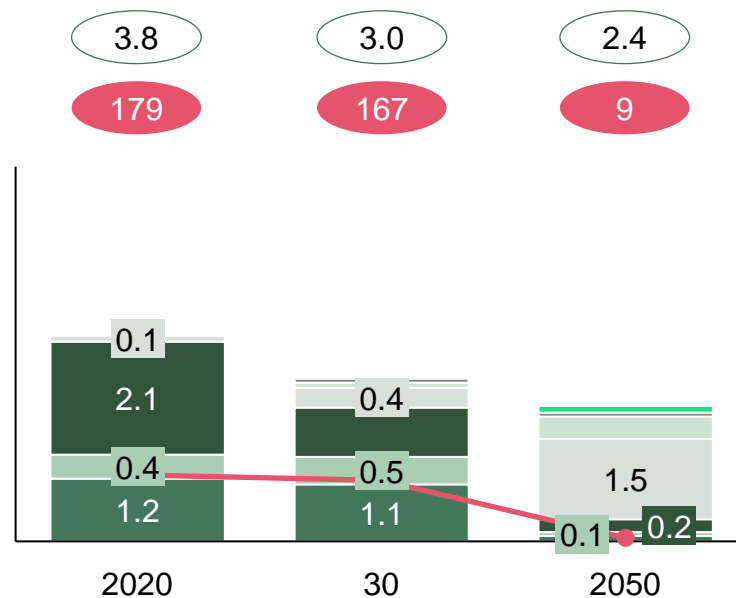
Scenario description

Explores what it would take to get to Net Zero by 2050 to be aligned on 1.5°C pathway, regardless of intermediate targets (strictly for the in-scope emissions, i.e., 179 Mt CO2e)

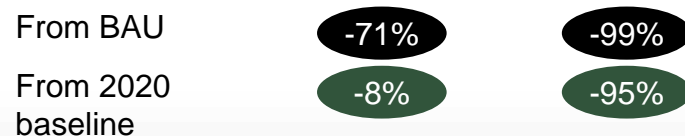
Key features

- Population growth 2.5% in 2020-30 and 2.1% in 2030-50
- Centralised power capacity increases from ~7 GW to ~34 GW 2020-50
- Switch to electric and biogas-based cooking
- Switch of 80% of passenger cars to EV by 2050
- Oil and Gas demand decreases with global demand under a 1.5°C pathway
- Industrial emission reduction amplified by roll-out of CCUS in cement

Fuel consumption and emissions, k PJ, Gt CO₂



Emission reduction



Implications

~-95%

Emission decrease by 2050 and both NDC and 1.5°C pathway commitments met

~x8

In on-grid electricity consumption by 2050

1. Based on World Bank 2017-18 deforestation rates grown in line with biomass increase 2018-50

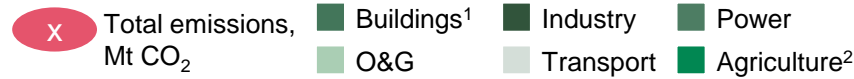
2. Primarily biogas

Source: McKinsey Decarbonisation Scenario Explorer

Net Zero technology choices result in continuous emission decrease, unlike NDC-guided where emissions start to increase post-2040

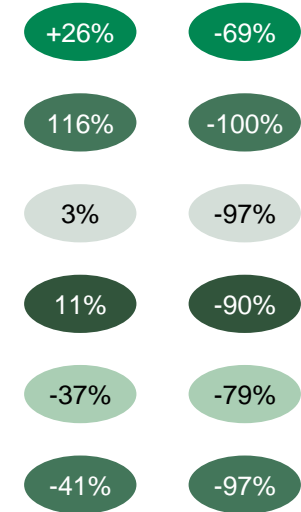
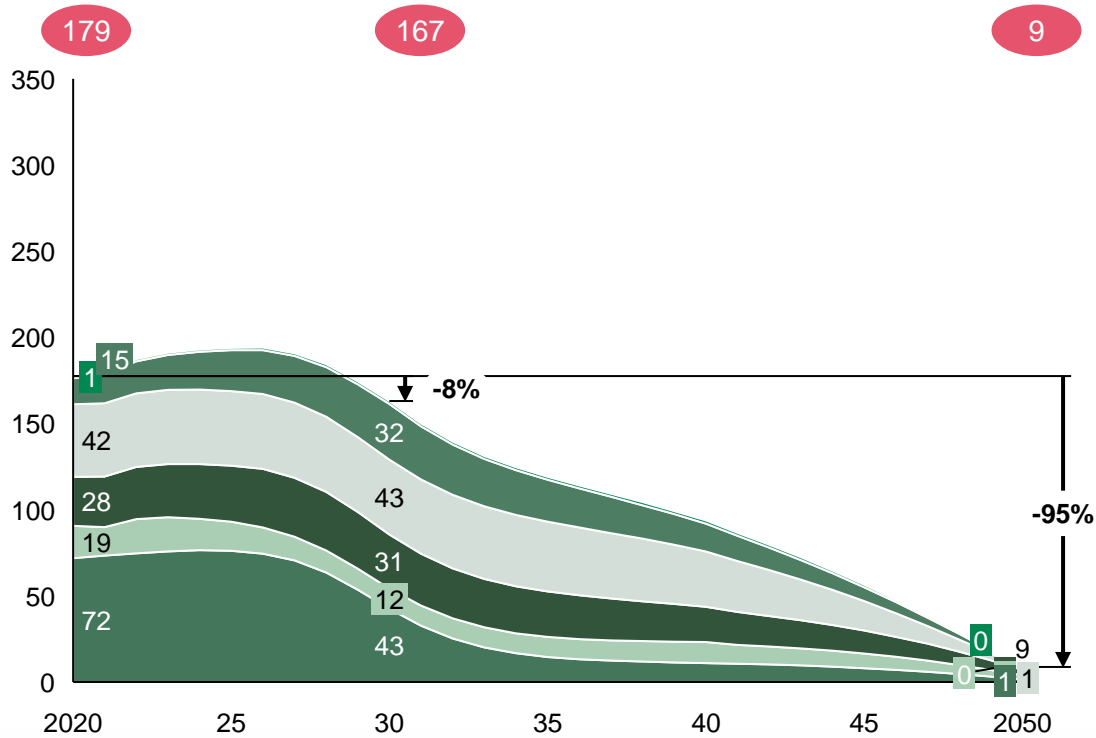


Preliminary



Emissions by sector³, MtCO₂

Emissions shift
2020-30 2030-50



Key drivers of emissions

- For each sector, Net Zero focuses on the technology that will maximise emission reduction
- Buildings: emissions decrease by ~98%** by 2050, is primarily driven by shift to electric and biogas-based cooking
 - Oil & Gas: emissions decrease by ~87%** by 2050 primarily driven by global response to climate change⁴
 - Industry: emissions decrease by ~97%** despite ~100% growth in industrial sector due to decarbonisation efforts in cement and ammonia production and 100% shift to zero emission fuels for heating
 - Transport: emissions decrease by ~97%** due to uptake of EVs in passenger car segment
 - Power: emissions increase of ~116%** by 2030 as gas use increases due to higher electricity demand. Post-2030 solar increases and starts to replace gas leading to 100% emission reduction by 2050

1. Includes LULUCF emissions from firewood removal
 2. Energy emissions only
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 4. Model for Net Zero scenario uses Nigerian oil production trajectory under a global 1.5°C scenario



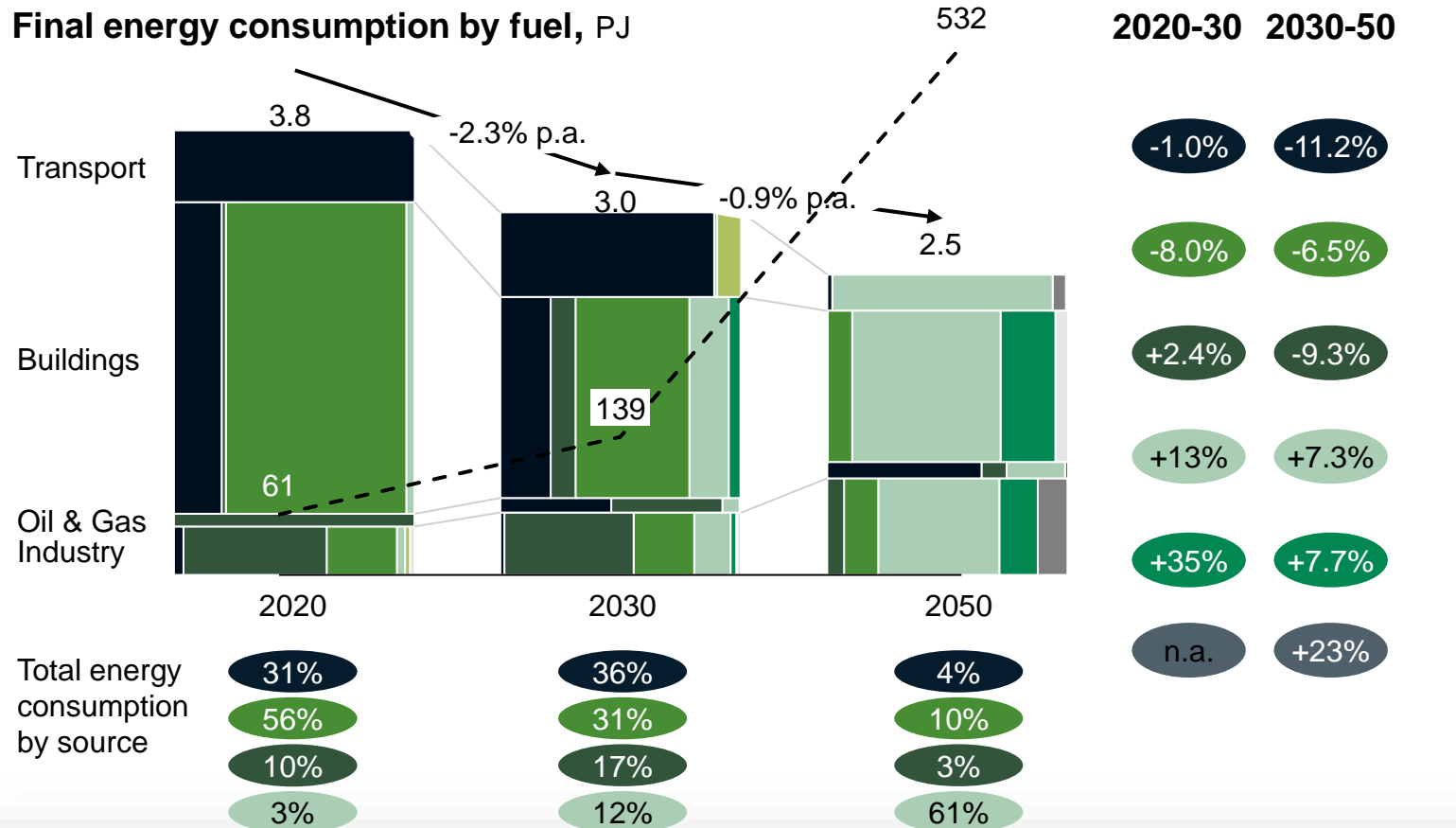
Electricity-based system minimises final fuel consumption while meeting 8x growth in power consumption

Preliminary

Oil, Firewood, Distributed generation -renewable power, Bioliqids, Natural gas, Electricity, Hydrogen, Other

Power consumption (TWh) - centralised and decentralised

Final energy consumption by fuel, PJ



Key drivers of consumption

Shifting to electricity¹-based solutions is key to decoupling increased power consumption from emissions growth. Power consumption increases to 532 TWh in 2050, primarily driven by grid access and electricity-based solutions to decarbonisation

8 times increase in on-grid electricity consumption is driven by electric heating in Industry, shift to passenger EVs in Transport and increased focus on electric solutions in Buildings (i.e., cooking)

1. Electricity is only aligned with the Net Zero approach if the power sector is fuelled by renewables

2. Biogas and coal



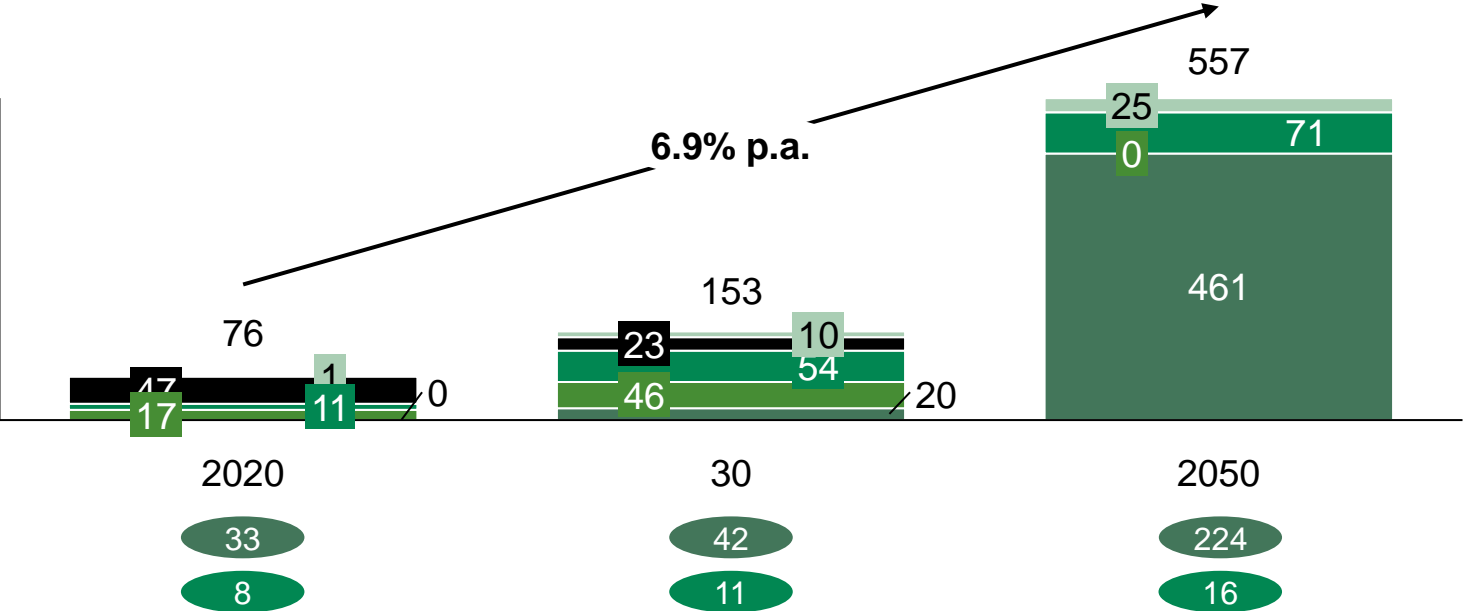
Net Zero ambition requires grid capacity to expand 20 times with full grid utilization

Preliminary

2020-50 Nigeria power generation distribution under NDC-guided scenario, TWh

■ Centralized PV
 ■ Gas-fired power plant
 ■ Other centralised RE¹
 ■ Back-up generators²
 ■ Decentralised PV³

X Centralised power capacity operable, GW
 X Decentralised generation capacity, GW



1. Incl. hydro, biomass, wind
 2. Incl. centralised and decentralised generators, and gas turbines in O&G sector
 3. Incl. solar PV + battery, mini grid, SHS

Source: McKinsey Decarbonisation Scenario Explorer

Key takeaways

Net Zero ambition requires concentrated effort on grid capacity expansion

Operational centralised generation grows 20x in 2020-50, aligned with an operational capacity of 224 GW

Diesel generators are no longer used for power generation in 2050





PV power generation grows by 16 TWh/year in 2020-50

Net Zero scenario : Activity level assumptions – macro activity and sector-specifics



Nigeria activity of key sectors

[Back up](#)

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