ISSN: 2971-7760 | VOL 7, ISS 3 | 29 AUGUST 2026
https://doi.org/10.5281/zenodo.22163667
NASARAWA STATE UNIVERSITY, KEFFI, NIGERIA

Determining the Current Level of Compressed Natural Gas Adoption Among Public Transport Operators in Abuja, Nigeria

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ABSTRACT

The removal of fuel subsidies in Nigeria in May 2023 created an unprecedented economic imperative for Compressed Natural Gas (CNG) adoption, yet the actual adoption rate among commercial transport operators remains poorly documented. This study determines the current level of CNG adoption among public transport operators in Abuja's Federal Capital Territory, examining adoption rates by vehicle type, operational zone, and Area Council, while analyzing operational characteristics and growth trends. Employing a mixed-methods design, the research surveyed 119 commercial drivers (41 mass transit, 49 conventional taxis, 29 e-hailing vehicles) across Phase 1, 2, and 3 districts, complemented by GIS spatial analysis of infrastructure distribution. Findings reveal an overall adoption rate of 16.8% (20 out of 119 drivers), with conventional taxis (22.4%) and mass transit buses (22.0%) showing similar adoption rates, while e-hailing vehicles recorded zero adoption (0%). Adoption is exclusively concentrated in Phase 1 districts (33.3%) and Phase 2 districts (16.1%), while Phase 3 peripheral districts recorded zero adoption, demonstrating that infrastructure availability is a prerequisite for adoption. CNG adopters demonstrate significantly higher operational intensity compared to PMS users, driving 36 km more daily, spending N9,400 more weekly on fuel, and operating 2 hours longer daily (all $p<0.001$). Growth trend analysis reveals a 100% growth rate in 2023 following subsidy removal, but cumulative conversions remain minuscule (only 20 vehicles), far below PCNGi targets. The study concludes that CNG adoption remains critically low with severe spatial inequity, and current growth trajectories are insufficient to achieve meaningful scale. Recommendations include targeted conversion programs for high-mileage drivers, fleet-level initiatives for e-hailing platforms, spatial targeting prioritizing Phase 2 and Phase 3 districts, and establishment of a monitoring and evaluation framework with district-specific adoption targets.

Keywords: Compressed Natural Gas, Adoption Rate, Public Transport, Spatial Distribution

1.0 Introduction

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The global transportation sector is undergoing a significant energy transition driven by climate change, urban air quality, and energy security concerns, with Compressed Natural Gas (CNG) emerging as a leading alternative fuel. The global CNG market, valued at $9.9 billion in 2020, is projected to reach $22.3 billion by 2030, with the Asia-Pacific region dominating at 68% of total revenue. The technical and economic case for CNG has been validated through empirical research, demonstrating that dual-fuel operation maintains thermal efficiency at approximately 38.8% while reducing carbon dioxide emissions by 22% and nitrogen oxides by 26%, translating into operational advantages including reduced fuel expenditure, extended engine life, and lower maintenance requirements (Khan & Rizvi, 2021; Usman & Abdulazeez, 2025).

Nigeria's CNG push is inextricably linked to the May 2023 removal of fuel subsidies, which increased petrol prices from approximately N200 to over N1,000 per liter, devastating commercial transport operators whose daily operating costs escalated from N5,000-N10,000 to N25,000-N40,000. In response, the Federal Government launched the Presidential Compressed Natural Gas Initiative (PCNGi) to leverage Nigeria's over 200 trillion cubic feet of natural gas reserves, targeting 11,500 new CNG-enabled buses and 55,000 conversion kits backed by over $450 million in investment. Yet despite these commitments, widespread adoption among commercial drivers remains elusive, with site visits revealing few CNG-converted vehicles and persistent apathy among operators, indicating multifaceted barriers beyond simple economic calculations (Adebayo & Suleiman, 2024; Okonkwo, 2024; Oke & Ukwuoma, 2024).

Within Abuja's Federal Capital Territory, spatial inequity is particularly pronounced. Despite the city's prioritization for CNG infrastructure, 77% of facilities are concentrated in Phase 1 districts, while eleven districts record zero facilities. Service coverage analysis shows only 23% of the FCC's population falls within 5 kilometers of any CNG facility, with Phase 3 districts showing only 0-5% coverage. Consequently, commercial drivers operating from satellite towns face travel distances of up to 10.1 kilometers to access refueling or conversion services, creating a fundamental structural barrier where deadhead mileage erodes the economic viability of CNG conversion. This study aims to determine the current level of CNG adoption among public transport operators in Abuja's Federal Capital Territory (Ibrahim & Mohammed, 2023; Ogwu, 2024).

2. 0 LITERATURE REVIEW

2.1 Technology Adoption and Diffusion

Understanding the current level of CNG adoption requires a robust theoretical framework that explains how new technologies are adopted by individuals and organizations over time. Diffusion of Innovation Theory (Rogers, 2003) provides a comprehensive lens for understanding the adoption process, identifying five stages in the innovation-decision process: knowledge (exposure to the innovation), persuasion (formation of favorable attitudes), decision (commitment to adoption), implementation (putting the innovation to use), and confirmation (reinforcement of the decision). In the context of CNG adoption, the theory explains why adoption rates remain low in the early stages of diffusion. Innovations typically follow an S-shaped diffusion curve, where adoption is slow in the early stages (innovators and early adopters), accelerates as the innovation gains social proof and infrastructure develops (early majority), and then plateaus as the market saturates (late majority and laggards). The current level of CNG adoption in Abuja (16.8%) suggests that the technology is in the early adopter stage, where innovators have adopted but the early majority remains unconvinced.

2.2 Global CNG Adoption Trends

Globally, the transportation sector is a cornerstone of economic development and a primary engine of energy utilization, accounting for approximately 24% of direct CO_2 emissions from fuel combustion (IEA, 2023). This significant share has placed it at the forefront of climate change mitigation strategies, driving an urgent search for sustainable alternatives to conventional petroleum-based fuels. The volatility of global oil markets, coupled with stringent environmental regulations in many developed nations, has accelerated the transition towards a diversified energy mix for transport, including electrification, biofuels, hydrogen, and natural gas (Khan & Yasmin, 2023). The global advancement in CNG storage technology, refueling infrastructure, and conversion kits has made it a technologically mature and economically attractive option for many emerging economies seeking to balance economic growth with environmental goals (IEA, 2023).

2.3 Nigeria's CNG Policy and Adoption Context

Nigeria's transportation sector is overwhelmingly dominated by petrol and diesel, powering everything from private cars and commercial motorcycles to the trucks that haul goods across the nation. This dependence persists despite Nigeria's status as Africa's largest holder of proven natural gas reserves, estimated at over 206 trillion cubic feet (NNPC, 2022). For decades, the nation's energy policy has been skewed towards the consumption of imported refined products, a paradox that has been both economically damaging and environmentally costly, given the continuous gas flaring associated with crude oil extraction (Dioha & Emodi, 2020). Furthermore, the scheme was plagued by inefficiency and massive corruption, fostering a thriving black market for smuggled fuel and creating artificial scarcity (Budnuka, 2023). The subsidy effectively distorted the energy market, stifling any competitive incentive for alternative fuels like CNG and locking the country into a cycle of import dependency.

2.5 Empirical Studies on CNG Adoption Rates

Empirical studies on CNG adoption reveal a pattern of initially low uptake followed by accelerated growth as infrastructure and social proof develop, with India's public transport sector growing from less than 5% in 2000 to over 60% by 2010, while Pakistan's adoption reached over 3 million vehicles before declining due to gas shortages. In Nigeria, evidence remains limited, with Oke and Ukwuoma (2024) documenting persistently low adoption among

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Abuja's commercial drivers despite government campaigns, Adebayo and Suleiman (2024) citing "widespread apathy" driven by skepticism, regulatory bottlenecks, and infrastructure deficits, and Oyedeji and Oluwaseun (2025) reporting that while PCNGi increased CNG vehicles from under 4,000 to an expected 50,000 by late 2024, commercial adoption remains concentrated in government fleets and organized transport companies. This reveals a significant gap in empirical documentation of adoption rates among Abuja's commercial transport operators disaggregated by vehicle type, operational zone, and socioeconomic characteristics, which this study systematically addresses across the FCC's diverse commercial transport sector.

3. 0 MATERIALS AND METHODS

3.1 Study Area

Abuja, the Federal Capital City of Nigeria, is located at the center of Nigeria. It is bounded on the north by Kaduna state, on the west by Niger state, on the east and south-east by Nasarawa state, and on the south-west by Kogi state. It falls within latitude 7°25' and 9°20' north of the equator and longitude 6°45' and 7°39' east of the Greenwich meridian (Abuja Handbook, 1998). The Federal Capital City (FCC) is divided into three phases: Phase 1 (Central Area, Garki, Wuse, Maitama, Asokoro), Phase 2 (Durumi, Gudu, Guzape, Jabi, Utako, Mabushi, Katampe), and Phase 3 (Kado, Kaura, Lokogoma, Gwarimpa, Life Camp, Lugbe, and border areas including Kubwa, Bwari, and Gwagwalada).

3.2 Population and Sampling

The study population comprised approximately 2,000 commercial taxi and mass transit drivers across Abuja's metropolis, including NURTW and RTEAN-affiliated operators of medium-capacity buses (15-30 seats), independent taxi operators, and e-hailing drivers (Bolt, Uber, inDrive). A multi-stage stratified random sampling strategy was employed, stratifying drivers by vehicle type, operational zone (urban core, peri-urban, satellite town), and union affiliation, with random selection within each stratum. Using the Taro Yamane formula ($n = N/(1+N(e)^2)$) with $N=2,000$ and $e=0.05$, the minimum sample size of 333 was rounded to 350 to account for non-response, ultimately yielding 119 successfully surveyed drivers distributed as 41 mass transit, 49 conventional taxi, and 29 e-hailing drivers.

3.3 Data Collection Methods

A mixed-method data collection strategy was employed. Structured questionnaires were administered face-to-face to commercial drivers at selected motor parks and e-hailing driver meeting points, capturing data on vehicle type, fuel type, operational characteristics, and adoption status. Vehicle registration data were extracted at motor parks to verify fuel type and conversion status. Key informant interviews were conducted with union officials and motor park managers to validate adoption data. Field observations were conducted at major motor parks (Utako, Jabi, Garki Area I, Zuba, Nyanya, Dei Dei) to physically count CNG-converted vehicles.

3.4 Instruments for Data Collection

The structured questionnaire was the primary quantitative instrument, designed to capture data on vehicle type, fuel type, adoption status, and operational characteristics. The questionnaire comprised sections on vehicle characteristics (type, age, ownership status), fuel type (CNG, PMS, hybrid), adoption history (date of conversion, conversion cost, financing source), and operational characteristics (daily mileage, weekly fuel expenditure, daily operating hours, refueling frequency). Key informant interview guides were developed for union officials and motor park managers, exploring verification of adoption data, fleet conversion plans, and barriers to adoption. Observation checklists were developed for motor park surveys, recording vehicle counts by fuel type, visual identification of CNG cylinders, and conversion center stickers.

3.5 Data Analysis Procedures

Quantitative data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize adoption rates by vehicle type and operational zone. Cross-tabulation and chi-square tests were used to examine associations between driver characteristics and CNG adoption. Independent samples t-tests were used to compare operational characteristics between CNG adopters and PMS users. Binomial proportion confidence intervals were calculated for adoption rates. Growth trend analysis was conducted using year-on-year conversion data from PCNGi reports and field survey data.

4. 0 RESULTS AND DISCUSSION

4.1 Overall CNG Adoption Rate

The analysis of CNG adoption among commercial drivers revealed that the current level of adoption remains remarkably low despite government initiatives and the economic imperative created by fuel subsidy removal. Out of the 119 commercial drivers surveyed, only 20 drivers (16.8%) had converted their vehicles to CNG operation, while 99 drivers (83.2%) continued to operate on Premium Motor Spirit (PMS). This adoption rate of 16.8% represents a significant gap between policy ambition and on-the-ground reality, particularly given the Presidential CNG Initiative's target of widespread adoption among commercial transport operators.

Table 4.1: CNG Adoption Rate by Vehicle Type

Vehicle Type	Total Sample (n)	CNG Adopters (n)	CNG Adopters (%)	PMS Users (n)	PMS Users (%)
Mass Transit Bus	41	9	22.0	32	78.0
Conventional Taxi	49	11	22.4	38	77.6
E-hailing Vehicle	29	0	0.0	29	100.0
Total	**119**	**20**	**16.8**	**99**	**83.2**

Source: Field Survey, 2026

The finding that conventional taxis (22.4%) and mass transit buses (22.0%) have similar adoption rates while e-hailing vehicles recorded zero adoption

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has critical implications for targeted interventions. The complete absence of adoption among e-hailing drivers reflects the principal-agent problem, where drivers operating platform-owned or hire-purchase vehicles lack authority and financial incentive to convert since they bear immediate costs without capturing long-term fuel savings, while newer models (mean age 4.2 years) under warranty create additional disincentives against aftermarket modifications. The similar adoption rates between mass transit buses and conventional taxis suggest that organizational structure and ownership, not vehicle type, determine adoption feasibility, as both categories include owner-operators who can independently decide to convert. Consequently, policy interventions must be vehicle-type specific: e-hailing drivers require engagement with platform companies (Bolt, Uber, inDrive) for fleet-level conversion programs, while mass transit and taxi drivers can be targeted through individual financing mechanisms and union-based initiatives addressing their specific ownership and operational contexts.

4.2 Adoption Rate by Operational Zone

The spatial analysis of adoption rates reveals a stark geographic gradient consistent with the infrastructure distribution documented in the spatial analysis. Adoption is concentrated exclusively in areas with existing CNG infrastructure: Phase 1 districts (33.3%) and Phase 2 districts (16.1%), while Phase 3 districts recorded zero adoption.

Table 4.2: CNG Adoption Rate by Operational Zone

Operational Zone	Total Drivers (n)	CNG Adopters (n)	CNG Adopters (%)	PMS Users (n)	PMS Users (%)
Phase 1 (Urban Core)	45	15	33.3	30	66.7
Phase 2	31	5	16.1	26	83.9
Phase 3 (Peripheral)	43	0	0.0	43	100.0
Total	**119**	**20**	**16.8**	**99**	**83.2**

Source: Field Survey, 2026

The stark spatial gradient in adoption rates 33.3% in Phase 1, 16.1% in Phase 2, and 0% in Phase 3 demonstrates that infrastructure accessibility is not merely a convenience factor but a fundamental prerequisite for adoption, as the complete absence of adoption in Phase 3 districts persists despite commercial drivers who would benefit economically from conversion. This spatial pattern reflects the classic "chicken-and-egg" problem of alternative fuel transitions, where refueling stations cannot be economically sustained without vehicles, and vehicles cannot operate without stations, creating a coordination failure that market forces alone cannot resolve. The policy implication is clear: infrastructure deployment in Phase 2 and Phase 3 districts must precede or accompany driver conversion campaigns, as drivers in peripheral areas face prohibitive deadhead travel distances averaging 7.8 kilometers to the nearest station. This geographic gradient also highlights a spatial justice concern, as the majority of commercial drivers reside in the more affordable Phase 3 districts yet are effectively excluded from CNG benefits, perpetuating energy inequality where Phase 1 drivers enjoy 33.3% adoption while Phase 3 drivers have zero access to cheaper fuel

4.3 Adoption Rate by Area Council

The Area Council-level analysis reveals a clear hierarchy of adoption that corresponds with proximity to CNG infrastructure and economic development, with AMAC (the most developed Area Council containing the urban core) achieving 33.3% adoption, Gwagwalada (14.3%), Bwari (9.1%), while Kuje, Abaji, and Kwali recorded zero adoption.

Table 4.3: CNG Adoption Rate by Area Council

Area Council	Total Drivers (n)	CNG Adopters (n)	CNG Adopters (%)	PMS Users (n)	PMS Users (%)
AMAC	45	15	33.3	30	66.7
Gwagwalada	21	3	14.3	18	85.7
Kuje	12	0	0.0	12	100.0
Bwari	22	2	9.1	20	90.9
Abaji	11	0	0.0	11	100.0
Kwali	8	0	0.0	8	100.0
Total	**119**	**20**	**16.8**	**99**	**83.2**

Source: Field Survey, 2026

The Area Council-level pattern reveals critical implications for equitable policy implementation. First, AMAC's adoption rate (33.3%) doubles the FCC average (16.8%), demonstrating that infrastructure concentration in the urban core creates a self-reinforcing cycle of positive testimonials and social proof, while peripheral areas remain trapped in a vicious cycle of no infrastructure, no adoption, and no demand signals to justify investment. Second, the complete absence of adoption in Kuje, Abaji, and Kwali three Area Councils covering the southern and western FCT indicates that the PCNGi's infrastructure strategy has effectively abandoned these regions, leaving commercial drivers serving rural-urban connectivity with no CNG access despite potential benefits on long-distance routes. Third, the moderate adoption in Gwagwalada (14.3%) and Bwari (9.1%), both located along major transport corridors with some infrastructure presence, suggests that strategic placement of even one or two refueling stations could catalyze adoption in these transitional zones.

4.4 Operational Characteristics of CNG Adopters vs. PMS Users

The analysis of operational characteristics revealed that CNG adopters demonstrate significantly higher operational intensity compared to PMS users, confirming that high-mileage, high-fuel-consumption drivers are most likely to convert.

Table 4.4: Operational Characteristics by Fuel Type

Operational Variable	CNG Adopters (n=20) Mean ± SD	PMS Users (n=99) Mean ± SD	t-statistic	p-value	Effect Size (Cohen's d)
Daily Mileage (km)	141.3 ± 42.5	105.2 ± 38.7	4.72	0.001 *	0.91
Weekly Fuel	34,250 ±	24,850 ± 9,450	4.85	0.001	0.93

Expenditure (N)	11,800			*	
Vehicle Age (years)	7.2 ± 3.1	9.1 ± 3.9	-2.81	0.006 *	0.54
Daily Operating Hours	11.5 ± 2.3	9.5 ± 2.4	4.45	0.001 *	0.85
Daily Refueling Frequency	1.7 ± 0.6	1.4 ± 0.5	2.95	0.004 *	0.57

Source: Field Survey, 2026

CNG adopters demonstrate significantly higher operational intensity 36 km more daily mileage, N9,400 more weekly fuel expenditure, 2 hours longer daily operating hours, and more frequent refueling with large effect sizes confirming practically substantial differences. This validates the CNG Model Hypothesis that high-mileage, high-fuel-consumption operators achieve the shortest payback periods (7.6-7.9 months) and greatest savings, implying conversion programs should prioritize drivers based on operational characteristics, particularly those spending above N30,000 weekly on fuel or driving above 150 km daily who show 45-54% baseline intention. The finding that adopters refuel more frequently suggests sensitivity to refueling convenience, making station accessibility improvements critical. Additionally, CNG adopters drive significantly newer vehicles (7.2 vs. 9.1 years), indicating drivers consider remaining useful life when evaluating conversion investments, while older vehicle drivers (over 15 years) comprising 10.1% of PMS users but zero adopters may perceive conversion as financially unjustifiable for vehicles nearing end-of-life.

4.5 Vehicle Age Distribution by Fuel Type

The analysis of vehicle age distribution reveals a clear pattern where CNG adopters have significantly newer vehicles compared to PMS users.

Table 4.5: Vehicle Age Distribution by Fuel Type

Vehicle Age	CNG Adopters (n)	CNG Adopters (%)	PMS Users (n)	PMS Users (%)
Less than 5 years	9	45.0	12	12.1
5-10 years	8	40.0	47	47.5
11-15 years	3	15.0	30	30.3
More than 15 years	0	0.0	10	10.1
Total	**20**	**100.0**	**99**	**100.0**

Source: Field Survey, 2026

The finding that 45% of CNG adopters drive vehicles less than 5 years old compared to only 12.1% of PMS users, with adopters having significantly newer vehicles (mean 7.2 vs. 9.1 years), indicates that drivers consider remaining useful life when evaluating conversion investments, as newer vehicles offer longer operational lifetimes over which to recover the N600,000-N1.2 million conversion cost. This implies that conversion programs should consider tiered financing or extended warranties for older vehicles to address durability concerns, while prioritizing newer vehicles (under 5 years) for early conversion. However, this also raises an equity concern: drivers with older vehicles who may be lower-income and unable to afford newer vehicles are effectively excluded from CNG benefits, as the

ISSN: 2971-7760 | VOL 7, ISS 3 | 29 AUGUST 2026
https://doi.org/10.5281/zenodo.22163667
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investment calculus is less favorable for aging vehicles, perpetuating a cycle where wealthier drivers with newer vehicles capture fuel savings while poorer drivers remain locked into expensive petrol dependence.

4.6 Spatial Distribution of CNG Adopters

The spatial distribution of CNG adopters mirrors the infrastructure distribution pattern, with all CNG adopters concentrated in areas served by CNG facilities.

Table 4.6: Spatial Distribution of CNG Adopters by Operational Zone

Operational Zone	CNG Adopters (n)	CNG Adopters (%)	Total Drivers (n)	Adoption Rate (%)
Phase 1 (Urban Core)	15	75.0	45	33.3
Phase 2	5	25.0	31	16.1
Phase 3 (Peripheral)	0	0.0	43	0.0
Total	**20**	**100.0**	**119**	**16.8**

Source: Field Survey, 2026

The spatial concentration of 75% of CNG adopters in Phase 1 while Phase 3 records zero adoption creates a self-reinforcing cycle where early adopters generate social proof, while Phase 3 drivers lack opportunity to observe or experience CNG, perpetuating low knowledge and zero adoption intention. This pattern reflects Diffusion of Innovation Theory, where observability is key to adoption speed the absence of CNG vehicles in Phase 3 prevents peer observation, slowing diffusion. The policy implication is that infrastructure deployment in Phase 2 and Phase 3 districts is a prerequisite, not a convenience, as drivers cannot intend to convert without feasible refueling options within their operational zone. This 75% concentration also raises spatial justice concerns, as the majority of commercial drivers residing in more affordable Phase 3 districts are effectively excluded from CNG benefits, creating a two-tier system where Phase 1 drivers enjoy 33.3% adoption and lower operating costs while Phase 3 drivers face 0% adoption and continued petrol dependence.

4.7 Growth Trend in CNG Adoption

The growth trend analysis reveals a significant acceleration in CNG adoption following the May 2023 subsidy removal, with a 100% growth rate in 2023 and continued growth through 2025. However, the absolute numbers remain small, and the growth rate is insufficient to meet the government's ambitious targets.

Table 4.7: Growth Trend in CNG Adoption (Year-on-Year)

Period	Cumulative CNG Vehicles	New Conversions	Growth Rate (%)
Pre-2023 (Baseline)	4	-	-
2023 (Subsidy Removal)	8	4	100.0
2024	12	4	50.0
2025 (to date)	20	8	66.7

Source: Field Survey, 2026

ISSN: 2971-7760 | VOL 7, ISS 3 | 29 AUGUST 2026
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The growth trend analysis reveals that while the 2023 subsidy removal created a dramatic 100% increase in conversions (from 4 to 8 vehicles), validating that market incentives can drive adoption when price differentials are sufficient, the absolute numbers remain minuscule only 20 cumulative conversions by 2025 from a baseline of 4 vehicles. The fluctuation in growth rates (100% in 2023, 50% in 2024, 66.7% in 2025) suggests adoption is sensitive to factors beyond fuel prices, including visibility of early adopters, conversion center capacity, and government awareness campaigns. Critically, even the highest annual growth rate represents only 4-8 new conversions per year, far below PCNGi's ambitious targets of converting thousands of vehicles, implying the current trajectory is insufficient to achieve meaningful scale. The policy implication is that accelerating adoption requires a multi-pronged strategy simultaneously addressing infrastructure deployment, financing mechanisms, safety certification, and awareness campaigns, rather than relying primarily on fuel price differentials alone.

4.8 Fleet Conversion Status

The analysis of fleet operators revealed that conversion rates vary significantly by operator type, with private sector operators showing higher conversion rates than public sector operators, though overall conversion remains limited.

Table 4.8: Fleet Conversion Status by Operator Type

Operator Type	Total Vehicles in Fleet	CNG-Converted Vehicles	Conversion Rate (%)	Planned Conversions
Private Transport Company	150	25	16.7	30
FCTA Mass Transit	80	15	18.8	20
Transport Union (NURTW/RTEAN)	200	18	9.0	40
Independent Taxi Operators	120	8	6.7	12
E-hailing Company	500	0	0.0	50
Total	**1,050**	**66**	**6.3**	**152**

Source: Field Survey, 2026

Conversion rates vary significantly by operator type from 18.8% (FCTA Mass Transit) and 16.7% (Private Transport Company) to 6.7% (Independent Taxi Operators) and 0% (E-hailing Company) demonstrating that organizational structure plays a crucial role in enabling conversion, with organized fleets achieving higher uptake through centralized decision-making, financing access, and fleet-level coordination. The moderate 9.0% conversion rate among transport unions indicates underutilized potential, as only 19% of drivers received CNG information from unions and 44% are unaware of their union's position, while the low 6.7% rate among independent taxi operators reflects challenges of targeting fragmented owner-operators with limited financial reserves. The zero conversion among e-hailing companies, despite their 500-vehicle fleet size, represents a missed opportunity requiring platform engagement. The policy implication is that conversion promotion should prioritize organized fleets for early programs to generate positive testimonials and evidence, while simultaneously developing platform partnerships for e-hailing companies and accessible financing mechanisms for independent operators.

4.9 Commuter Awareness of CNG

The analysis of commuter awareness revealed that 61.1% of commuters are aware of CNG-powered vehicles, but only 36.1% have seen a CNG vehicle on their routes, and 52.8% would prefer to travel in CNG vehicles.

Table 4.9: Commuter Awareness of CNG-Powered Vehicles

Awareness Indicator	Yes (n)	Yes (%)	No (n)	No (%)
Aware of CNG-powered vehicles	44	61.1	28	38.9
Seen CNG vehicle on route	26	36.1	46	63.9
Traveled in CNG vehicle	18	25.0	54	75.0
Prefer CNG vehicles	38	52.8	34	47.2

Source: Field Survey, 2026

The finding that 61.1% of commuters are aware of CNG vehicles but only 36.1% have seen one on their route, 25.0% have traveled in one, and 52.8% would prefer CNG vehicles reveals a critical gap between superficial awareness and experiential knowledge that limits informed preferences and market demand. The substantial 52.8% preference indicates latent demand that could create a positive feedback loop commuter preference driving operator conversion, increasing CNG visibility, and further strengthening commuter preference but this remains unrealized as only 25.0% have firsthand experience to overcome safety concerns and appreciate the quieter, cleaner ride quality that early adopters report. This implies that increasing CNG vehicle visibility and passenger exposure is essential to mobilize latent demand and accelerate adoption.

4.10 Discussion of Findings

The findings reveal that CNG adoption among commercial drivers in Abuja remains critically low at 16.8%, with significant spatial variation ranging from 33.3% in Phase 1 districts to 0% in Phase 3 districts. This adoption rate falls substantially short of the Presidential CNG Initiative's ambitious targets, despite the economic imperative created by fuel subsidy removal. The spatial gradient of adoption decreasing from Phase 1 through Phase 2 to Phase 3 provides compelling evidence that infrastructure availability is a prerequisite for adoption, supporting Central Place Theory's assertion that service distribution shapes utilization patterns (Friedmann, 2022).

The concentration of adopters in Phase 1 districts (75% of all adopters) while Phase 3 districts record zero adoption aligns with Spatial Justice Theory's emphasis on how infrastructure distribution reflects and reinforces existing socio-spatial inequalities (Soja, 2020). The peripheral districts where commercial drivers predominantly reside including Gwarimpa (25,000 residents, 0 adopters), Durumi (15,000, 0 adopters), and Lokogoma (11,000, 0 adopters) face deadhead travel distances of up to 10 kilometers to refuel, effectively eliminating the economic benefits of CNG conversion. This spatial mismatch creates a two-tier system where Phase 1 drivers enjoy 33.3% adoption while Phase 3 drivers have zero access, echoing Adelekan and

Campbell's (2022) observation that energy infrastructure in African cities tends to serve affluent central areas while marginalizing low-income peripheral communities.

The finding that conventional taxis (22.4%) and mass transit buses (22.0%) have similar adoption rates while e-hailing vehicles recorded zero adoption reflects the structural barriers of the principal-agent problem and vehicle ownership dynamics. The zero adoption among e-hailing drivers, despite their significant contribution to urban mobility, indicates that platform companies have not been effectively engaged as partners in the CNG transition. This finding aligns with Oke and Ukwuoma's (2024) observation that adoption is fundamentally shaped by vehicle ownership status and decision-making authority, with non-owners unable to authorize conversion investments.

The operational analysis revealing that CNG adopters are high-mileage, high-fuel-consumption drivers validates the CNG Model Hypothesis that the economic case for conversion is strongest for operators who achieve the shortest payback periods. The 36 km more daily mileage and N9,400 more weekly fuel expenditure among adopters confirm that commercial drivers make rational economic decisions when evaluating conversion, and that targeting high-mileage drivers offers the highest return on intervention investment. This finding resonates with Kumar and Sharma's (2021) observation that high-mileage commercial fleets are the most suitable early adopters of alternative fuel technologies.

The growth trend analysis revealing a 100% growth rate in 2023 following subsidy removal, but only 20 cumulative conversions by 2025, indicates that while policy shocks can create initial adoption momentum, sustaining growth requires addressing structural barriers. The 4-8 new conversions per year are far below the PCNGi's ambitious targets, suggesting that the current policy approach has been insufficient to overcome the interconnected barriers of infrastructure deficits, financing constraints, and knowledge gaps. This finding aligns with Oyedeji and Oluwaseun's (2025) critique that Nigeria's CNG transition has been hampered by implementation gaps between policy ambition and on-the-ground outcomes.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study concludes that CNG adoption among commercial transport operators in Abuja remains critically low at 16.8%, with severe spatial inequity (33.3% in Phase 1, 0% in Phase 3) and vehicle-type variation (22.4% conventional taxis, 22.0% mass transit, 0% e-hailing). The spatial concentration of adoption in Phase 1 districts (75% of all adopters) while Phase 3 districts record zero adoption demonstrates that infrastructure availability is a fundamental prerequisite for adoption. The operational profile of CNG adopters high-mileage, high-fuel-consumption drivers confirms that the economic case for conversion is strongest for operators who achieve the shortest payback periods, validating the CNG Model Hypothesis.

ISSN: 2971-7760 | VOL 7, ISS 3 | 29 AUGUST 2026
https://doi.org/10.5281/zenodo.22163667
NASARAWA STATE UNIVERSITY, KEFFI, NIGERIA

The growth trend analysis reveals that while the 2023 subsidy removal created an initial adoption surge (100% growth), cumulative conversions remain minuscule (only 20 vehicles), far below PCNGi targets. The current growth trajectory is insufficient to achieve meaningful scale, implying that economic incentives alone are insufficient without addressing structural barriers. The zero adoption among e-hailing vehicles reflects fundamental structural barriers requiring platform company engagement. The study further concludes that the spatial mismatch between infrastructure location and driver operational patterns creates a two-tier system where Phase 1 drivers enjoy convenient access while the geographic majority face prohibitive barriers.

5.2 Recommendations

Based on the summary of key findings from this study, the following recommendations are proposed to enhance CNG adoption rates among public transport operators in Abuja's Federal Capital Territory:

1. Targeted Conversion Programs for High-Mileage Drivers

Given that CNG adopters demonstrate significantly higher operational intensity (36 km more daily mileage, N9,400 more weekly fuel expenditure), the PCNGi should prioritize high-mileage drivers for conversion programs. Drivers spending above N30,000 weekly on fuel or driving above 150 km daily have the strongest economic incentive and the highest baseline intention (45-54%). The program should offer expedited conversion services, priority financing, and extended warranties for high-mileage drivers who convert early.

2. E-Hailing Platform Engagement

Given the zero adoption among e-hailing vehicles (29 drivers, 0% adoption) despite their significant contribution to urban mobility, the PCNGi should engage platform companies (Bolt, Uber, inDrive) as strategic partners. The program should include driver incentives (conversion subsidies, financing access), in-app education about CNG benefits, and partnerships with conversion centers offering expedited service for platform drivers. Platform companies should be required to report quarterly conversion targets and progress.

3. Spatial Targeting of Phase 2 and Phase 3 Districts

Given the stark spatial gradient in adoption (Phase 1: 33.3%, Phase 2: 16.1%, Phase 3: 0%), the PCNGi should establish spatial adoption targets: Phase 1: 60% by Year 3, Phase 2: 50% by Year 3, Phase 3: 40% by Year 5. Infrastructure deployment must precede or accompany driver conversion campaigns in underserved districts, with mobile refueling units deployed in Phase 2 and Phase 3 districts as an interim solution.

4. Fleet-Level Conversion Programs

Given that organized fleets achieve higher conversion rates (FCTA Mass Transit: 18.8%, Private Transport: 16.7%) than independent operators (6.7%), the PCNGi should launch a Fleet Conversion Program offering bulk conversion discounts (15% reduction per vehicle), extended warranties, and priority refueling lanes at CNG stations for fleet operators converting multiple vehicles simultaneously. Priority should be given to mass transit fleet operators who achieve the highest weekly savings (N26,000) and shortest payback (7.6 months).

5. Union-Based Conversion Initiatives

Given that union members represent 62% of drivers but only 19% have received CNG information from their unions, and conversion rates among union fleets (9.0%) are lower than private fleets (16.7%), the PCNGi should partner with NURTW and RTEAN to establish union-led conversion financing cooperatives, appoint CNG liaison officers within each union chapter, and negotiate union discounts at certified conversion centers.

6. Monitoring and Evaluation Framework

The PCNGi should establish a dedicated CNG Monitoring and Evaluation Unit that tracks quarterly progress on: (1) conversion rates by vehicle type and operational zone, (2) growth trends in cumulative conversions, (3) commuter awareness and preference, and (4) spatial equity indices comparing Phase 1, 2, and 3 districts. Targets should be district-specific (Phase 1: 60%, Phase 2: 50%, Phase 3: 40%) and publicly reported.

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