GROWTH MODELLING OF THE TRANSPORTATION SYSTEM IN NIGERIA TO SUPPORT STRATEGIC PLANNING

Joshua O. Adegoke*
Dr Manjit Singh Srai
Birmingham City University, Birmingham, UK

1 INTRODUCTION

In every country, both in the developed and developing countries of the world, governments are striving daily to improve the economic standard of their populace. However, for every bit of improvement, energy will be consumed during exploration, production, movement, consumption and disposal of goods and services. With energy consumption comes climate change which also leads to the problem of global warming. It is, therefore, imperative for countries to source out means of balancing out the need for economic growth and at the same time, reduce energy consumption and lower emissions. Nigeria, despite ample but finite fossil fuel resources, is not excused from this global challenge.

1.1 Transport sector in Nigeria

Individuals make use of transport to access jobs, healthcare, education, markets, leisure, family and friends. It's vital for efficient movement of goods and services around the world. However, it comes with a lot of challenges such as road safety, congestion, natural resource depletion, energy security and emissions. And it accounts for 14% of global GHGs emissions by sector. Transport accounts for about 25% of the world energy demand. Its share of global oil consumption rose from 46% in 1973 to 62% in 2010 (IEA, 2010). In Nigeria, transport sector accounts for 80% of the total petroleum products consumption (IEA, 2008), making it the highest fossil fuel consumption by sector. Interestingly, road transport account for more than 90% by kilometers of passenger and freight movement (Oni 2010; CFA, 2005; Federal Office of Statistics 2004).

In the past, government in its national strategy; 'Vision 20-2020 intended to grow the economy to be one of the largest 20 economies in the world by 2020 (NPC 2009). Within 1999-2008, road sector experienced growth from 2.26% to 13.9% contributing about 3.35% to the national GDP. Because of this phenomenal growth and the potential for further growth, the strategy proposed an integrated and sustainable transport system with Public-Private investments in infrastructures to serve the envisaged future demands. A detailed and clear policy of the government on transport and low carbon initiatives is absent. Therefore the study is linked with the government-driven initiative and so would the findings of the research be made available to the government to influence decisions in the sector.

For the government to initiate low-carbon reduction strategy, there is need to understand the growth of energy consumption and emissions from this sector under different scenarios using models. Then, strategic steps could be taken to reduce emission, improved air quality and also extend the lifespan of the oil reserves. However, an alternative growth model based on the best data estimate is required. It should be a good representative of the plausible trend and demand in Nigeria towards a sustainable transport by 2050.

There have been few studies on ensuring data quality in health and information system databases in Nigeria (Forster et al. 2008; Chiemeke & Egbokhare 2012) but not known published on transport data.

1.2 Research background

This paper is part of an attempt by the researcher to resolve data quality issues generated from a set of transport data used by the Energy Commission of Nigeria (ECN) to develop Energy Calculator for the country within transport sector (ECN 2015). This paper focuses on generating alternative data set from the estimation of the vehicle fleet in Nigeria to replace the weak ones in the model to improve the prediction of the model.

The official data used in the model is assumed to be exaggerated and then unreliable. Its predictions regarding transport energy are tabulated with other similar models on Nigeria as shown figure 1. Others show some plausibility because of their agreement with one another but at variance with the trend and size of official predictions (grey). Other curves which are similar regarding rapidity with the official data comes from the agency of government, so propagation of data error is assumed. Therefore, the official trend shows unsustainable trends, non-typical of a growth pattern.

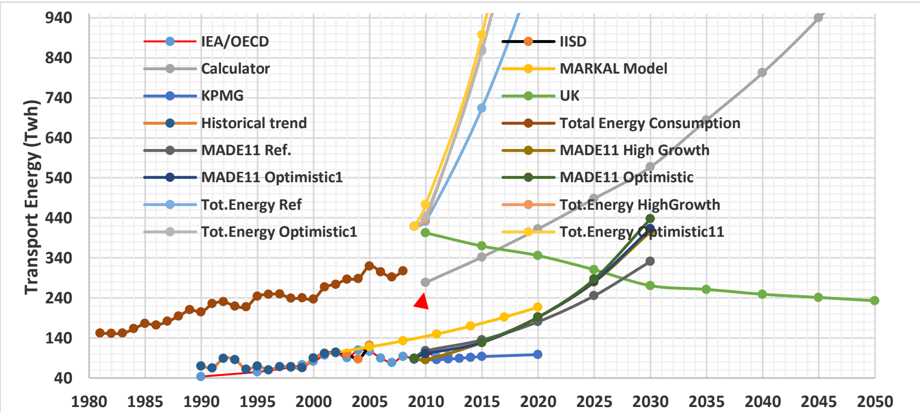

Figure 1: Analysis of the calculator (grey) results with the other known sources of transport energy in Nigeria

In order to tackle data quality concerns, the modelling of the growth data of Nigerian transportation using heuristic and deterministic approaches is undertaken.

1.3 Study assumptions, scope and limitations

In a bid to find the best estimate for the number of vehicles in Nigeria with which other parameters can be calculated for the desired results on energy consumption and emissions, the selection process for the growth models only considers 'time' as the independent variable. This limitation is propagated from sourcing the most reliable data available for the study which is a time series. Perhaps, a better accuracy could have been achieved if economic cost models or factors are included in the models to strengthen the plausible vehicle estimates by the year 2050. However, this may amount to, but a minor, random fluctuation on the trends predicted.

2 RESEARCH PURPOSE AND METHODS

The cost of field data collection remains high, difficult, and time-consuming. It is often, unreliable, so the use of growth models becomes imperative. This alternative approach allows the estimation of the number of vehicles based on past trends using a mathematical modelling technique. The chosen method applies theoretical modelling techniques using growth models to create plausible data, an approach which is not known to be in used in Nigeria for transport modelling. Some of the growth models explored used include Gompertz, Exponential, Poisson functions and a newly developed Physical model.

Firstly, the study models and analyses the various growth models to estimate each 'goodness of fit' to the historical data on some vehicles from 1960-2000. Secondly, the chosen model is super-imposes Lokta-Volterra (LV) type equations to explore the dynamics of fuel-switch scenario in the country.

2.1 The physical model

The curve fitting process chooses the physical model which is dynamic and evolved from the fuel consumption usage throughout the length and breadth of the country. From the law of conservation of mass,

$$Mt = Mc + M_0 \qquad \text{(Equation 1)}$$

Mt is the total mass of fuel imported and locally produced in Nigeria per year
M_o is the fuel loss due to theft, assumed to be negligible
M_c is the total mass of fuel consumed by the vehicle fleet in Nigeria per year

$$Mc = M_v * N_v \qquad \text{(Equation 2)}$$

where,
M_v is the average mass of fuel consumption per vehicle per year
N_v is the total number of vehicles in Nigeria per year
Using the product rule in equation 2,

$$\dot{M}_c = \dot{M}_v * N_v + M_v * \dot{N}_v$$

Substituting $\dot{M}_c$ into equation 1,

$$\dot{M}_t = \dot{M}_v * N_v + M_v * \dot{N}_v$$

$$\dot{N}_v = -\frac{\dot{M}_v}{M_v} * N_v + \frac{1}{M_v} * \dot{M}_t$$

$but\ \dot{M}_t = \frac{M_t}{\tau}\ since\ \frac{\dot{M}_v}{M_v} = 1/\tau$, where τ is the time constant and $\alpha = 1/\tau$ is the growth rate or the average annual percent change in the number of vehicles population.

M_t is the average fuel consumption per year

$$\dot{N}_v = -1/\tau * N_v + \frac{1}{M_v} * \frac{M_t}{\tau}$$

$$\dot{N}_v = -\alpha . N_v + \frac{\alpha}{M_v} . M_{t,} \quad \textit{(Equation 3)}$$

Finally, the mathematical equation is re-stated as follows,

$$\frac{dx}{dt} = -\alpha . x + bu \quad \textit{(Equation 4)}$$

The study also explores the dynamic interaction between the two fuels creating an improved scenario tool using a fuel-switch alternative pathway for the vehicle fleet in Nigeria. This approach aims to understand and address, in a modelling and simulation environment, the potential impact of a range of alternative transport policies, in this case, fuel switch that could be reasonably considered by the Nigerian government in transition to a low carbon society.

Prey, x, - CV growth while predator is y, NVG growth.

When multiplied out, the predator-prey equation becomes

$$\frac{dx}{dt} = \alpha x + \beta xy \quad \textit{(Equation 5)}$$

$$\frac{dy}{dt} = \delta xy + \gamma y \quad \textit{(Equation 6)}$$

Factoring the interaction between the two types of vehicle to extend the original model to represent predator-prey, the two equations become,

$$\frac{dx}{dt} = -\alpha x + bu_1 - \beta xy \quad \textit{(Equation 7)}$$

$$\frac{dy}{dt} = -cy + du_2 + \delta xy \quad \textit{(Equation 8)}$$

Equations 7 and 8 represent the rate of change of CV and NVG respectively. The equations parameters are define as follows;

α is the speed of increase per unit of time (growth rate) for the CV population
b is the rate of increase of CV

β is the fraction of CV will be displaced per unit of time depending on the number of CV and NGV

c is the decline rate of NGV specifying what fraction of it was lost per unit time.

***δ** is the efficiency factor to measure how much of the CV are converted to NGV out of the total that were displaced.*

$-ax + bu_1$ is the term that represents the original equations to represent the rate of increase of vehicles in Nigeria using conventional fuel. When NGV=0, the term will only represent the CV growth with assumed carrying capacity of nine million vehicles.

In its simplest form, the predator-prey model assumes no carrying capacity so the CV would have grown exponentially. However, in the modified equations, the country's peculiarity is considered. Therefore, the amount of imported fuel available, u1 and k, acts as control over the number of vehicles that can be sustained per time in the country's fleet. The introduction of the term is necessary if the study would be useful in strategic and sustainable planning towards ensuring a target number of vehicles which the available fuel supply can sustain.

Similarly,
*$-cy + du_2$ will be the appropriate term to represent the rate of increase of vehicles using gas fuelling in the future. βxy is the term that represents the product of the number of both vehicles multiplied by a constant factor. It represents the attack rate with which CV covert to NGV. B is typically small <1.**δ**xy is the similar to the above but differs in what the factors represent. In this case, **δ** measures the efficiency of the conversion from CV to NGV that takes place per unit time.*

3 MODELLING AND SIMULATION RESULTS

3.1 Curve of best fit

In figure 2, all the models were plotted against the historical data to assess the goodness of fit of the curves to the data.

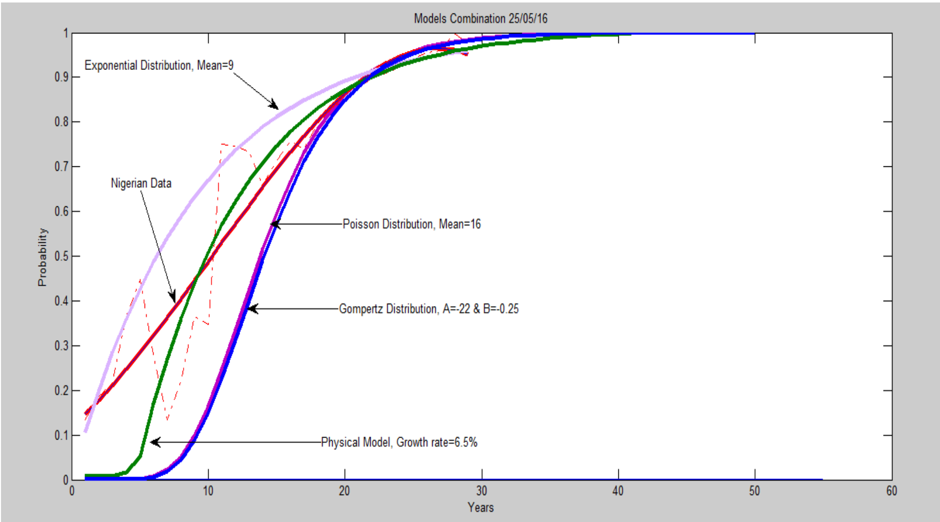

Figure 2: Growth curves showing the goodness of fit to the Nigerian data

Each of the curves in the figure seems to follows a theoretical S-shaped curve together with the data when plotted on a line of best fit (red). The iterations results show that among all the models considered against the historical data, overall, the physical growth model provides the ''best fit'', while at the early years, the exponential curve is close. The other curves have a varying degree of closeness to the data. The Physical model which has its origin from the law of conservation of mass and then to an ordinary differential equation results in the Growth model used in the study. Since it came out to be the best fitted to the historical data out of the four models, it became the model to be used for prediction of the number of the vehicles as can be seen.

3.2 Model validations

For validation, the physical model was populated with a figure from other countries like the United Kingdom and South Africa where data of quality can be found. This is achieved by comparing the forecasting results of such countries with current data.

The forecasts of the vehicle fleet in the UK from 1950 to 2010 were produced, and the actual traffic is compared in figure 3.

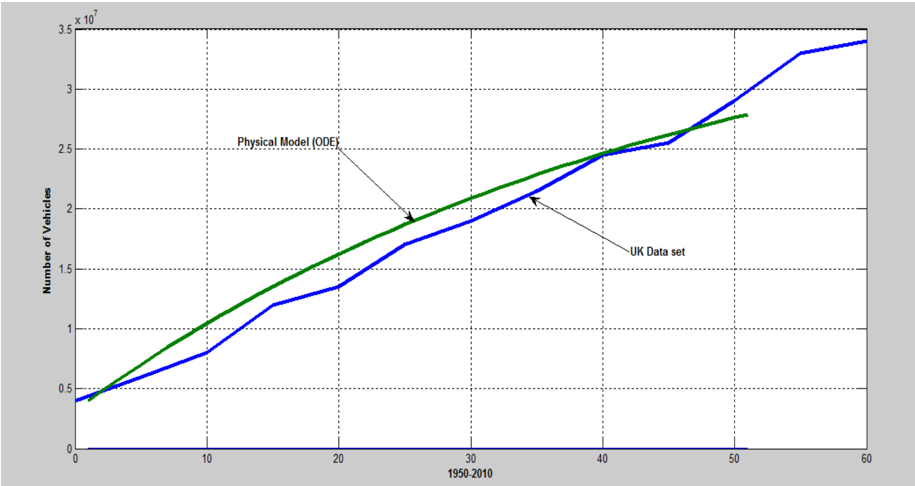

Figure 3: Physical Growth Model fitting to UK data

Here, the Growth model is validated by using inputs data from the UK transport system; the results correspond to the number of vehicles in the UK to be about 34-35 million in the year 2010.

Figure 4 shows the product of the simulation when the values of the amount of total liquid fuel consumption (represented with a red curve) are used in the growth model to generate the amount of vehicles (black) per year. According to WHO database (WHO 2015), The total number of registered vehicles in South Africa in 2013 was about ten (10) million similar to the amount estimated by the growth model in figure 11.

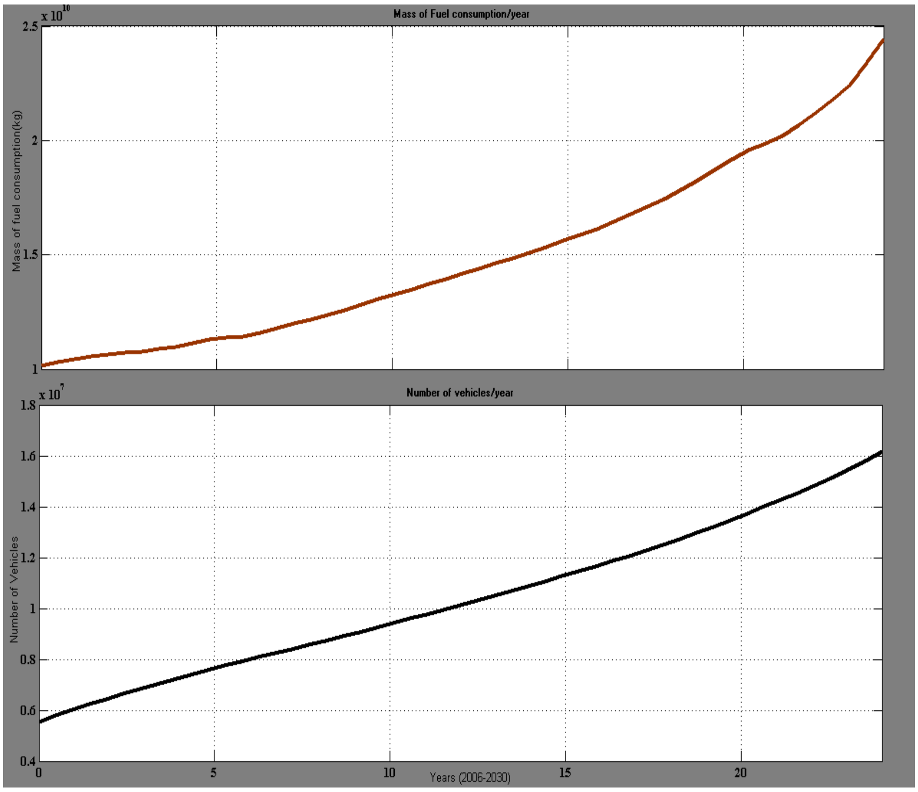

Figure 4: South Africa input data into the growth model

3.1 Further validation of the dynamic growth model using the static model, the calculator

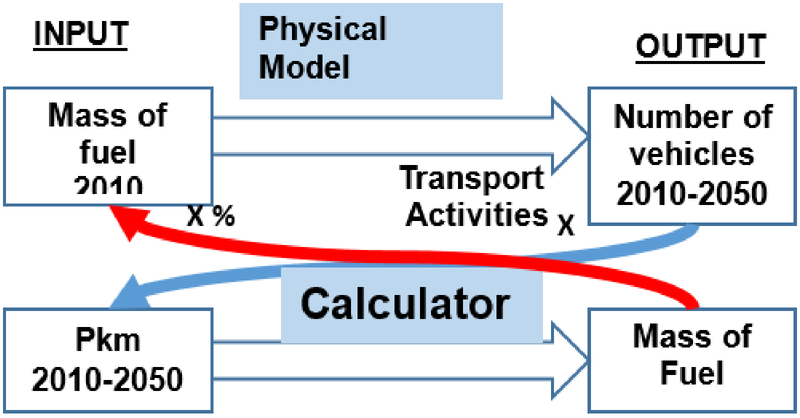

Figure 5: Validation of physical (dynamic) with calculator (static) models

In figure 5 format, in the first process, (blue), the output of the growth model (dynamic) forms the input of the Calculator (static) while in the second process (red), the output of calculator constitutes the input of the growth model. The graphs of correlation between the results of the two validation process are shown in the figures 6 and 7.

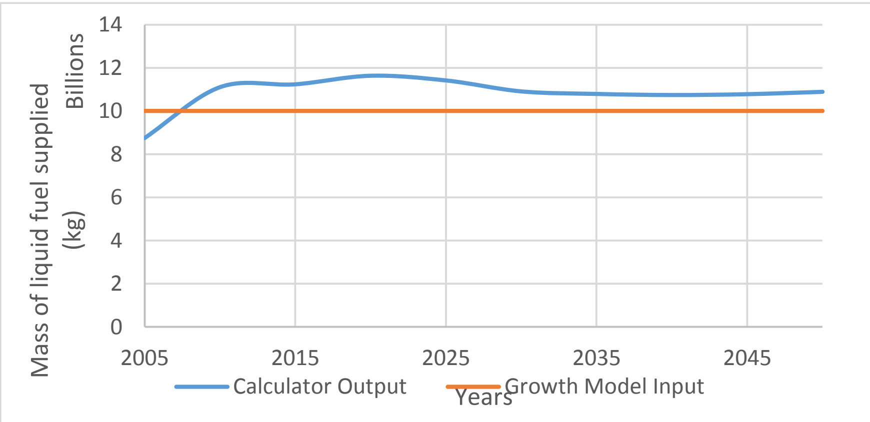

Figure 6: Growth model output as the Calculator input vs Growth model input

According to figure 6, the output of the calculator, the mass of fuel consumption (blue) behaves like that of the input into the growth model. The shapes are slightly different because of the value of fuel consumption used in the growth model is an average value which is assumed to be constant over the period under consideration but the output, the number of vehicles, are allowed to change over time. If peradventure that the fuel consumption of the growth model is allowed to vary slightly at a constant rate of change, the two curve might have shown a similar trend.

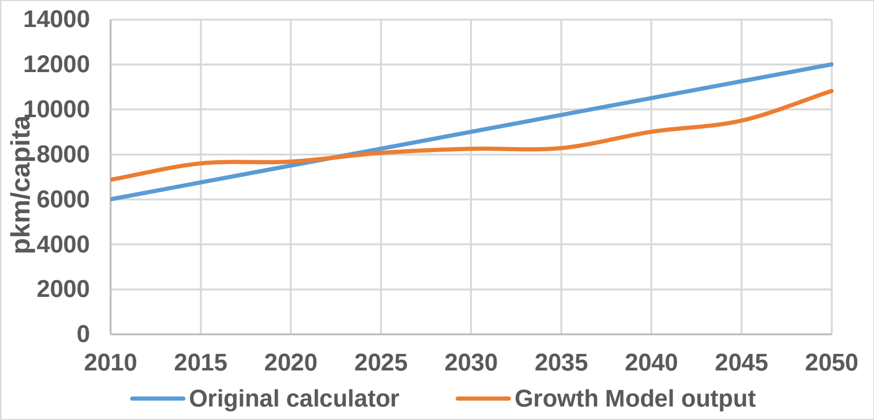

Figure 7: Official pkm/capita vs pkm in the model using official fuel consumption data

In figure 7, the model is subjected to validation process by comparing the results obtained when the graph of the pkm using the calculator and the pkm generated from the growth model. The calculator output regarding fuel consumption equivalent is inserted into the growth model to produce the equivalent of some vehicles that will need the amount of fuel. These vehicle numbers are now used as in previous work to develop the pkm.

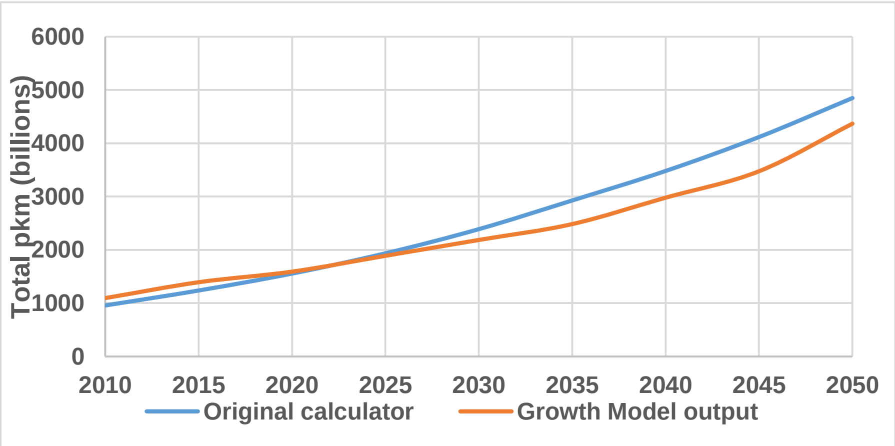

Figure 8: Official total pkm vs pkm from the growth model using official fuel consumption data

The same approach is used by multiplying the estimated population according to other projections to get an estimate of the total pkm per year over the duration under consideration, 2010-2050. The result is shown in figure 8 with the two graphs almost the same. It verifies that the growth model is plausible because it was possible to use the data from the static model (calculator) to generate an output of the dynamic which is equivalent to the original values and trends of the static model.

As can be seen in the two figures the static model confirms the dynamic growth model. Using the fuel consumption output from the official model into the growth model, new data (brown) is generated showing a correlation between the official prediction and the prediction of the growth model.

3.2 Replacement of official figure with physical model prediction

The new data from the growth modelling process served as input into the calculator and used in place of the official figures, and the results are shown in this section. Also, the results are compared with other external results on the transport energy growth in Nigeria.

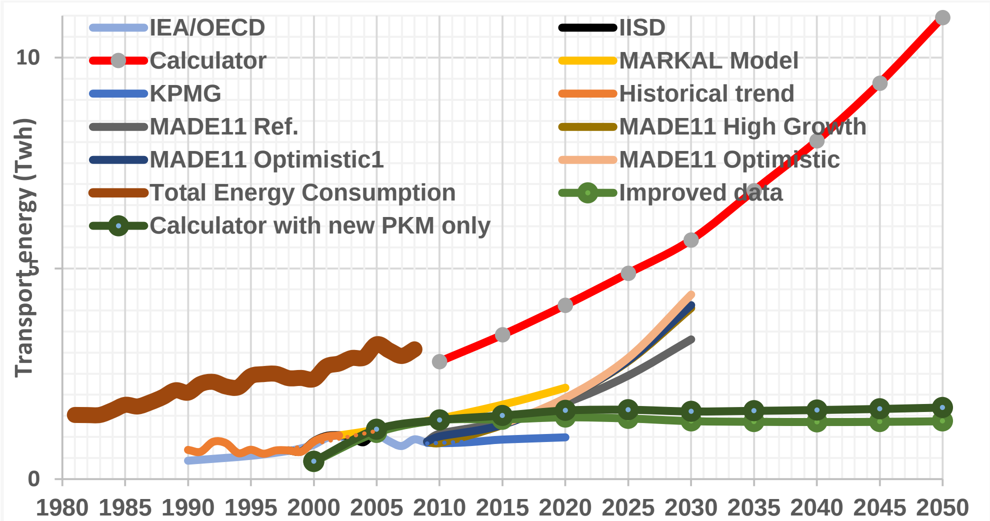

Figure 9: Improved data (green) from the growth model in comparison with Official figures (red) and other external data sources

A closer look at figure 9 shows that the shape of the physical model (green) have similarities with other some known models from 2000-2020 (Dayo et al. 2004; IISD 2012; KPMG 2013; IEA 2014; Global Finance/IMF 2014) supporting the fact that the model is plausible for future prediction.

3.3 Fuel Switch Scenario results

The model results from section 3.2 form the baseline scenario that describes a possible CV growth based on historical trends. However, in section 3.3, three different scenarios were extracted from the table 1 to represent a range of possibilities in the fuel-switch to gas in the transportation system. *Business as-Usual* (No Switch) scenario assumes that the pattern of growth as predicted by the chosen model is sustained. The Moderate scenario assumes a reasonable switch from liquid to natural gas. Finally, the *Extreme* scenario foresees a significant shift with gas displacing liquid fuels as witnessed in countries like Iran.

***Table 1*:** Model simulation output at various amount of gas fuel supply

S/N	Total Mass liquid fuel	Total Mass gas fuel	NGVs	Liquid Vehicles	Total No of Vehicles	Ratio of Gas Vehicles	Ratio of Liquid Vehicles
1	1.00E+10	0	0	8.97E+06	8.97E+06	0.00%	100.00%
2	'	1.00E+05	2.58E+02	8.97E+06	8.97E+06	0.00%	100.00%
3	'	1.00E+06	2.58E+03	8.96E+06	8.96E+06	0.03%	99.97%
4	'	1.00E+07	2.58E+04	8.96E+06	8.98E+06	0.29%	99.71%
5	'	1.50E+07	3.87E+04	8.95E+06	8.99E+06	0.43%	99.57%
6	'	5.00E+07	1.29E+05	8.91E+06	9.04E+06	1%	99%
7	'	1.00E+08	2.56E+05	8.85E+06	9.11E+06	3%	97%
8	'	1.00E+09	2.37E+06	7.96E+06	1.03E+07	23%	77%
9	'	1.10E+09	2.59E+06	7.87E+06	1.05E+07	25%	75%
10	'	1.20E+09	2.80E+06	7.78E+06	1.06E+07	26%	74%
11	'	1.25E+09	2.91E+06	7.74E+06	1.07E+07	27%	73%
12	'	1.50E+09	3.43E+06	7.54E+06	1.10E+07	31%	69%
13	'	1.00E+10	1.60E+07	4.20E+06	2.02E+07	79%	21%

From the table 1, more possible scenarios of the vehicle fleet in Nigeria by 2050 could be explored based on the amount of fuel imported as represented in figure 10

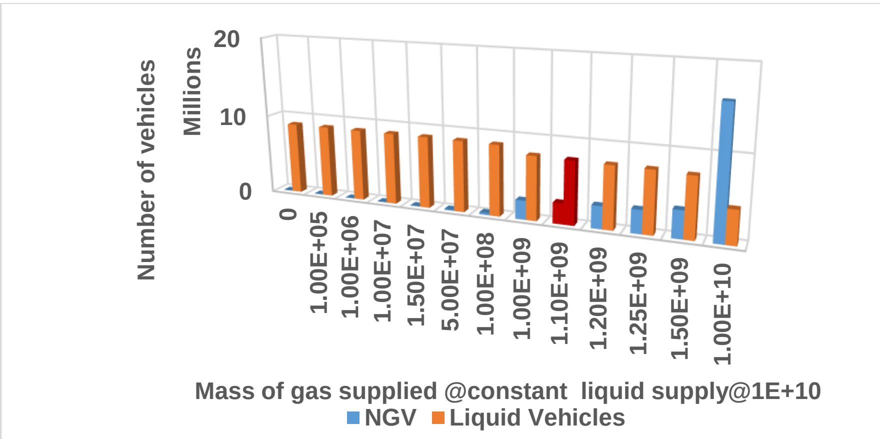

Figure 10: The model responses to different amount of gas supply if other variables remain constant

However, only three scenarios of fuel switch as explained earlier are modelled and simulated here.

The 'No gas' interruption scenario is like business-as-usual concerning the amount of fuel consumption per year in the country. It also assumes vehicle growth rate in Nigeria will last for some time in the future till 2050. This scenario as seen in the figure 11 represents the simulation results using the model where the predator is zero. In the figure, the prey, CV population grow exponentially since NVG is zero.

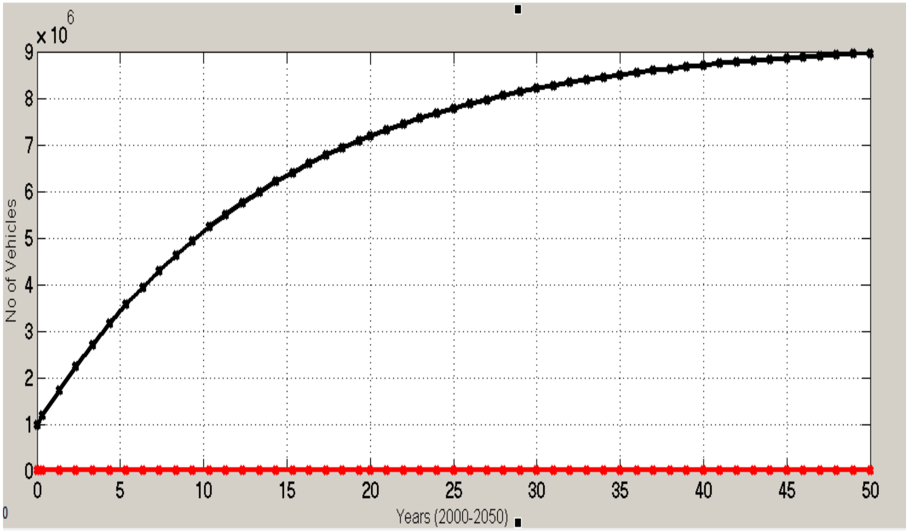

Figure 11: Growth curve of the vehicles' fleet in Nigeria

The scenario of 'no intervention' is represented in the previous section 3.1, a set of data used to replace the low-quality data. It is a 100% continuous domination of conventional fuel producing a total of about 9 million vehicles in circulation if the mass of total oil per year is at a constant rate of 1E10kg/year from 2000-2050. The value assumes no change in the domestic oil consumption in the country. The logic of this scenario is that though oil still dominates, the growth trend is sustainable factoring a saturation level in growth. This is useful for planning and control in such a way that the country oil consumption can be capped at a level. Moreover, if they are going to be any need for more transport need, it can be catered for in the succeeding scenarios where gas fuelled vehicles can meet the demand in the sector. It is with this scenario that short-term measure such as improved IC engine technology efficiency (section) as suggested by the energy experts in the survey will be useful. To curtail carbon emission, the country needs to move towards implementing a stricter Euro Emission Standards because currently, the majority of the vehicles do not conform to the Euro 11 as required since 2010. However, this scenario will only be feasible if the government returns to her fuel subsidy policy that encourages buying fuel at the significant meagre prices even in the face of a global increase in crude oil prices.

Figure 12 shows 'moderate intervention'. This scenario is based on the assumption that transport demand will increase, but the need will be met through the gas fuelling option. This scenario represents a split of 25% for NVG (predator) and 75% for LBV (prey) producing a total of about 11 million vehicles in the circulation by 2050. In the figure, the predator is introduced when the prey population is about 7 million. NVG growth curve shows a sharp change growing linearly while that of CV is less gradual with a tendency to decrease over time.

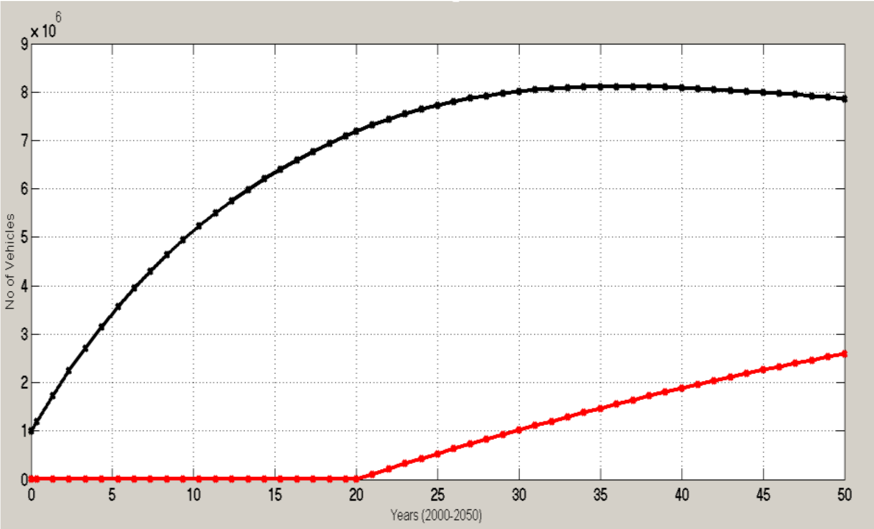

Figure 12: Moderate switching over time to gas fuel with CV (black) and NGV (red).

Figure 13 shows the rate of change of the options under moderate change. The trajectories converge at a strong, stable equilibrium after just one oscillation, five years after the introduction of natural gas into the vehicle fleet.

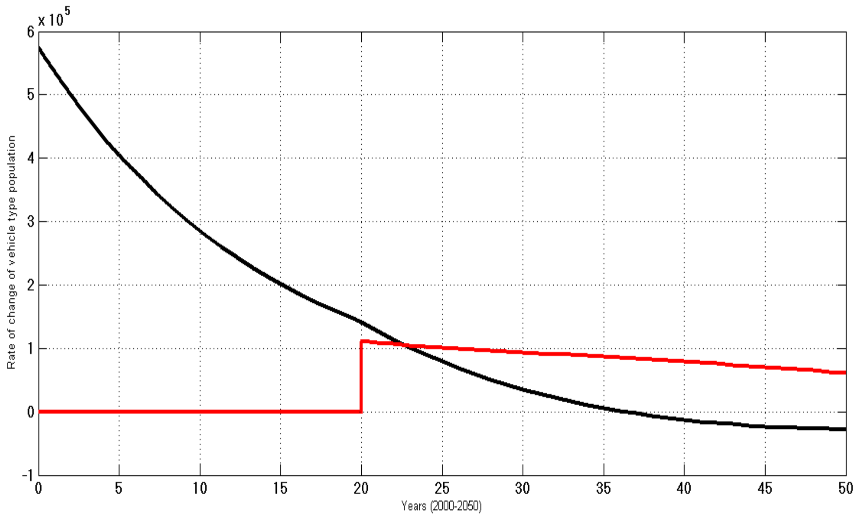

Figure 13: Moderate scenario of rate of change of Predator-Prey dynamic relationship between NGV and CV

The ‘Extreme intervention is considered in figure 14. The scenario represents an extreme split where 80% of the vehicle fleet is NVGs and 20% CV producing a total of about 20 million vehicles in circulation. As a predator, NVG, population increases, they put greater strain on the prey populations, CV, and can be used in the transport policy to act as a top-down control, pushing the CV toward a state of decline. Keeping the amount of liquid fuel constant, thus the amount of gas fuel available and the predation pressure affect the number of CV populations left in the country’s vehicle fleet. From the start to about 6.5 million of CV, the predator impact is not felt. Right after this point, the number of NGV start picking up at a fast rate until it reaches a peak number of about 2.6 million vehicles. At the same time, CV settles for a marginal increase in its number reaching a peak of 8 million and then dropping to finish about 7.8 million. The individual vehicle fleet as it changes with time is layout in figure 20. This is a representation of the number of each type of vehicles the nation would have in his fleet in a particular year between 2010 and 2050.

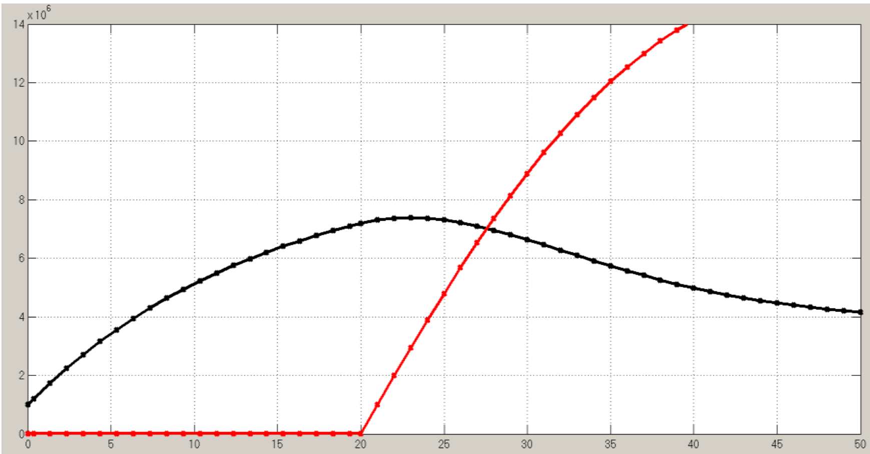

Figure 14: Extreme interruption of gas fuel with CV (black) and NGV (red) over time

Figure 15 shows the rate of change of each type of vehicles as the year progresses from 2020 where the switch is assumed to have a significant start. The rate of change of NGV is reduced to extremely low. However, CV shows a tendency for recovery after 2050.

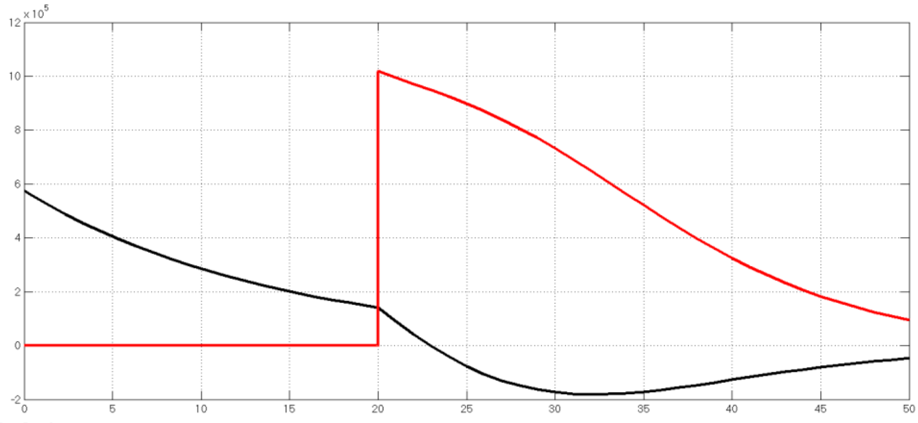

Figure 15: Extreme scenario showing the rate of change of NGV and CV over the years

The overall impacts of fuel switch dynamic of the country's fleet are illustrated in figure 16 and 17. The scenarios are made to have the starting year of 2020 when the current fuel domination is interrupted with the introduction of natural gas. The intervention could happen through retrofitting of existing CV to run on CNG or LNG, or dedicated to run only on natural gas or the engine design to run as bi-fuel (running on either gasoline or natural gas).

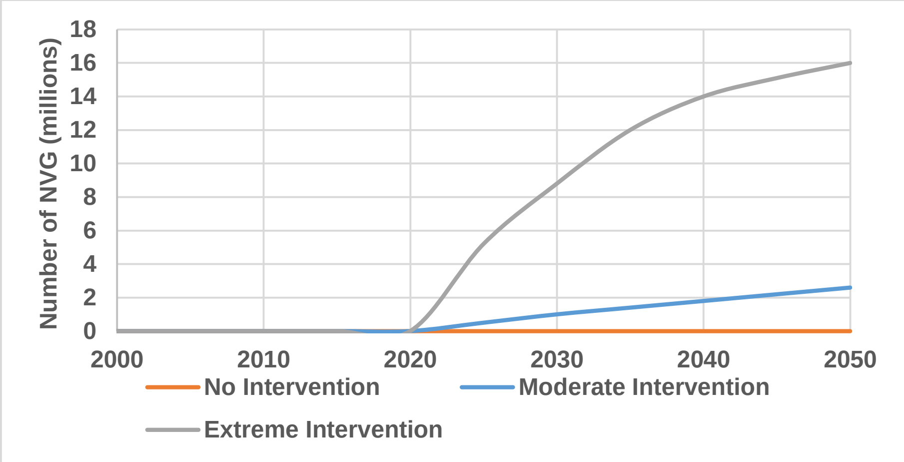

Figure 16: The NVG growth per year at gas fuel interruption per year

According to figure 16, 'moderate scenario' reflects a positive linear growth with its peak at about 2.5 million NGV in 2050 joining the country's fleet. The Extreme Intervention looks more like a typical growth curve peaking at sixteen million (16) vehicles in 2050.

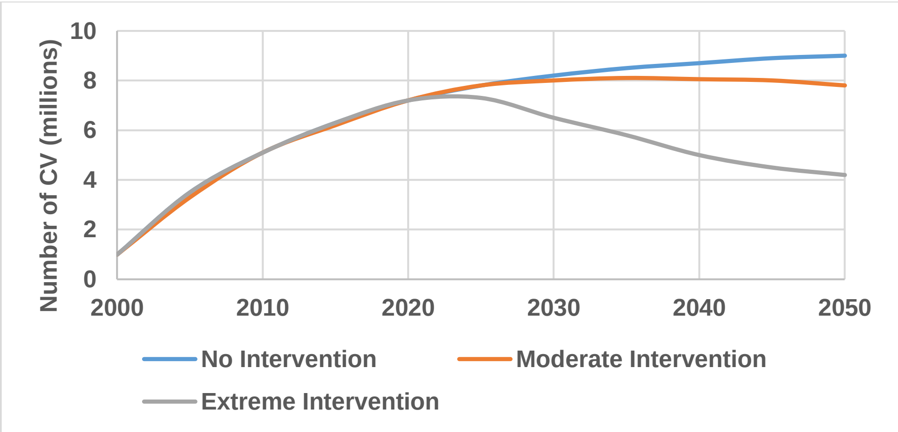

Figure 17: The CV growth per year at gas fuel interruption per year

In figure 17, the CV domination is reduced in the moderate scenario from nine (9) million of CV to about 7.8 million by 2050. A further decline to four (4) million CV is seen in the extreme scenario. Since Natural Gas (NG) is known for his lower carbon content of methane as seen in the scenarios, a proportionate potential reduction in carbon and greenhouse gas emissions is expected when used in place of gasoline or diesel.

4 POLICY IMPLICATION AND CONCLUSION

4.1 Policy Implication

With more reliable transport data from the above study and a modelling of fuel switch potential in Nigeria, there is an opportunity for the government and researchers to have a tool to support sustainable transport planning and modelling. Moreover, for the private investors, an instrument for making a strategic decision towards a global need to impact climate change in the transport sector in developing economies.

Several ministries in Nigeria manage the issues of transportation concerning data gathering, modelling, planning and carbon emissions. This is sometimes direct or indirect creating ambiguity with often poor communication and interactions between intergovernmental agencies. These ministries and MDGs include the Ministry of Transport, Energy Commission of Nigeria, Road Safety of Nigeria, Nigeria Railway Commission, Federal Inland Water Ways, NNPC, Ministry of Environment, Nigeria Bureau of Statistics, and several others agencies both at the state and local levels. The situation is worse with road transportation because unregulated private sectors activities dominate. There is a lack of coordination at all the levels, and it results into duplicity of efforts and waste of resources. So it is not always the problem of the absence of data but sometimes accessibility to ensure quality control. The government has a vital role to play in regulation, legislation and monitoring to ensuring compliance with data recording directives.

From the findings from the data estimation modelling through growth patterns, fuel switch model and other previous surveys, the study concludes that the following considerations will be useful to kick-start sustainable transport planning within the government, academia and private sectors. This is more relevant to stimulate fuel switch from conventional liquid fuel to natural gas market development and expansion.

There is a need for a well-coordinated and efficient intergovernmental communications and data sharing to improve transport data collection mechanisms. The approach will reduce duplicity and wastage, and overall quality can be enhanced. The Nigerian Bureau of Statistics (NBS) could stand as the centralised body where other sub-transport agencies submit transport data for normalising, cleansing and integrating into the government database made accessible to all. With increased knowledge about big data, a logical move will be for the review of transport data management through policy formulation and legislation to reflect current challenges. Historical growth model as used in the study has helped to build models that predict travel demands and vehicular growth on a yearly basis which is good for planning. This historical approach needs to be complemented with an effort from the government at all levels to gather real-time data which can give a complete view of current travel demand and usage. The provision of such data will contribute significantly to reduce traffic congestions and other challenges associated with transport in the cities.

It is evident that the fuel switch to Natural gas has potential in Nigeria to reduce emissions, elongate crude oil reserve and diversify the economy. Therefore, it is imperative for the government through its agencies to promote such initiative through policy formulation, legislation, infrastructural development (such as CNG stations) and to create a conducive environment for private sector investments as already witnessed in the natural gas upstream development in Nigeria Liquefied Natural Gas (LNG), Bonny Island, River State. Stringent government and industry safety standards should be put in place to cover the compression, storage, fuelling and normal operation and accident of NGV.

There is a need for government to come up with a transport policy which truly incorporates sustainable transport system where alternative cleaner fuels would be advocated and promoted. The downstream NG market could greatly benefit from such a policy reform which is expected to capture issues such as NVG operation and safety standards, requirements, regulations concerning infrastructure, vehicular emissions, and pollutions. Such drive will open up the market to make NG available for domestic use. This is essential to replace unclean fuel wood used in cooking in most homes in Nigeria. It is estimated that up to 79,000 deaths per year are as a result of indoor air pollution from burning biomass. 90% of such deaths affect children younger than five years because they suffer from acute lower respiratory infection while adults suffer chronic obstructive pulmonary disease from indoor air pollution. It is important too for the government to provide tax incentives to NGV users especially heavy vehicles in urban areas which by reason of their emissions has become a health risk to road users. Such initiative will lower their operating costs and in turn reduce pollution from trucks and buses.

This study set out to assess and introduce sustainable transportation systems to Nigeria; focusing on how to reduce transport energy and carbon emissions through various reduction strategies that are not readily available in the country while at the same time bearing in mind the issues around data quality as part of a holistic approach to low carbon adoption. The overall purpose is to stir discussions and provide platforms for sustainable transport policy planning in the country that will lead to emission reduction and cleaner air. Five objectives guided the study in a quantitative approach of using survey and scenario development in a modelling and simulation environment to predict a growth model for the transportation system in Nigeria. It started with engaging energy and transport stakeholders for data gathering and modelling scenario development. However, when the data collected could not be relied on further, a growth data of Nigerian transportation using heuristic and deterministic approaches was employed. The models developed result in plausible agreement with reliable data but at variance with official figures, which has shown unsustainable trends. It is then valid to consider an alternative method of resolving the data issues to enhance planning and decision making.

A further extension of the chosen model was carried out to capture fuel-switch scenarios in the country's vehicle fleet from the dominant liquid fuel to the adoption of natural gas fuel using predator-prey equations. The resulting model can be classified as a bottom-up simulation forecasting model, where transport energy demand is driven by the technological composition of the vehicle stock, in this case, the fuel type. The study develops different scenarios based on the variability of the main input parameters which is the mass of fuel imported per year, the mass of fuel consumed per year per vehicle and that of individual travellers, pkm per year. The simulation supports the creation of various scenarios that represent the dynamic interaction between CV as prey and NGV as a predator with induced fuel change in the vehicle fleet. The scenarios considered are: non-intervention, moderate intervention and extreme intervention with different shares of 100% CV domination, 75% CV & 25% NGV and 20% CV & 80% NGV respectively in the country's vehicle fleet. The results highlight how the fuel change dynamics influence the emergence of the total number of each vehicle fuel type. The interruption of natural gas will naturally reduce emissions from conventional liquid fuel and indirectly impact on preserving crude oil resources, the main source of foreign exchange in Nigeria. Also, such intervention will boost and widens investment NGV market thereby making it readily available for domestic use.

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