Energy Shortage, Climate Change and the Challenge of Intelligent Transport System (ITS) Adaption in African Countries

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Abstract

The transport sector of every economy generally depend on the combustion of fossil fuels that generates sulfuric, carbonic, and nitric acids, which are now contributing greatly to global warming. The threats of climatic change and the swamp of urban traffic flow problems necessitated the development of Intelligent Transport System (ITS) as panacea for urban traffic menaces. In this paper, the dwindling trend in fossil fuel deposit and the search for alternative fuel globally is examined as it affect African nations. The paradigm shifts in sustainable transport definitions are examined using a combination of existing theoretical constructs. The study assessed the Federal Road Safety Corps (FRSC) and police operations that are ITS compliance in Abuja and Minna. The result shows that there are no modern ITS infrastructure and that about 65% of the road signalling devices are either dead or malfunctioning due to power failure. The paper concluded that African countries like Nigeria need adequate budgetary planning and man power development for effective ITS adaptation.

Keywords: Climate Change, Fossil Fuel, ITS, Sustainable Transport, Urban Traffic.

1. Introduction

Climatic change and global warming are two growing related phenomena that are now threatening all the environmental spheres and posing challenge to most scientists due to the impacts it has on people and the ecosystems on which they depend. Greenhouse gases, such as carbon dioxide is said to have increased significantly since the Industrial Revolution, mostly from the burning of fossil fuels for energy, industrial processes, and transportation. Post industrialization cause injection of excess carbon dioxide into the atmosphere of which about half of this excess is absorbed by the ocean, plants, and trees, and the rest accumulates in the atmosphere, amplifying the natural greenhouse effect, [1].

The burning of fossil fuels produces around 21.3 billion tonnes (21.3 gigatonnes) of carbon dioxide per year, but it is estimated that natural processes can only absorb about half of that amount, so there is a net increase of 10.65 billion tonnes of atmospheric carbon dioxide per year (National Academies Report, 2008). The invention of the internal combustion engine and its use in automobiles and trucks greatly increased the demand for gasoline and diesel oil, both made from fossil fuels. Road capacities in urban areas are reaching saturation or even 'gridlock' in some cities as in plate 1; the need to improve the balance between different transport modes, and the needs to improve safety and mitigate the impact of transport on the environment are some of the key challenges set out in the European Commission's White Paper on Transport "European Transport Policy for 2010: time to decide" [2].

Plate 1. Typical Urban Traffic Flow that depend on fossil fuel

Two trends are said to have emerged from the biofuels scene. On one hand, fossil fuel-importing nations like US are seeking an immediate solution to reduce their growing energy expenditures, and on the other hand, countries which are seeking to be biofuels raw material exporters like Nigeria and Malaysia, are attempting to position themselves strategically within the global energy market, [3].

It is no longer news that Sub-Saharan Africa is suffering from biodiversity loss, alongside poverty, war, conflict, hunger, starvation, poor infrastructure, population pressure, and other development challenges. Africa will undeniably need adequate energy to meet the Millennium Development Goals. But the proposed role of agrofuels as a suitable means of meeting regional and global energy needs, however, raises serious questions about biodiversity conservation, food security, human and livelihoods

Intelligent Transport System (ITS) as a response to energy crises and climate change refers to the application of communications and information technology to transport infrastructure and or to vehicles to improve the efficiency of transportation networks [John N. [4]. One of the unique quality of ITS is its ability to address the basic movement needs of people in an urban environment as well as relating it to the resources which are consumed by transportation systems. ITS encompasses all of the applications of computers and telecom to road transportation by cars, buses, and trucks. Telecom impacts on transportation can be broadly categorized as:

i. changes in the volume, timing, destinations, routing, and mode characteristics of transportation demand, and
ii. changes in the quality of the performance in safety, speed, and reliability of transportation.

1.1 Aim and objectives.

This study aimed at examining the state of sustainable automobile energy supply transformation and ITS adaptation in African countries like Nigeria while still maintaining a balance energy and right to the sustainable social development through the following objectives:

i. Assess the effect of automobile fossil fuel utilization on the climate and the need for sustainable transport system,
ii. examine the various types of alternative fuel and their implications for Africa economy.
iii. Assess the state of the road signalling and ITS infrastructure in selected cities of Nigeria;
iv. Examine the FRSC and police patrol vehicle operations in relation to ITS compliance.

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2. The study Area

Abuja, the federal capital city of Nigeria is located in the centre of Nigeria, within the Federal Capital Territory (FCT). It is a planned city built in the 1980s, and officially became Nigeria's capital on 12 December 1991, replacing Lagos which is similar to Brazil building its capital at Brasília. At the 2006 census, the city of Abuja had a population of 776,298 [5]. Abuja's geography is defined by Aso Rock, a 400-metre monolith left by water erosion.

Abuja is known for being the best purpose-built city in Africa as well as being one of the wealthiest and most expensive; however, the people in the suburb areas are living in shanty towns such as Karu plate 2. Phase 1 of the city is divided into five (5) districts: Central, Garki, Wuse, Maitama, and Asokoro. There are also five districts in the phase2; which are: Kado, Durumi, Gudu, Utako and Jabi. Phase 3 Districts are: Mabuchi, Katampe, Wuye and Gwarimpa. There are also five suburban districts, which are: Nyanya, Karu, Gwagwalada, Kubwa, and Jukwoyi. Along the Airport Road are clusters of satellite settlements these are namely: Lugbe, Chika, Kuchigworo and Pyakassa. Other satellite settlements are Idu (The Main Industrial Zone), Mpape, Karimu, Gwagwa, Dei-Dei (housing the International Livestock market and also International Building materials market).

Plate 2. Abuja, Nigeria (Google extract)

3.Global Fossil Fuel Reserves

Oil reserves (known discoveries minus cumulative production) can be viewed from political and technical sources. Jean [2006] is of the view that Political data is always rising from 1950 till now, while from the technical sources, oil reserves has peaked since 1980. Also, oil discovery is less than oil production since finding new reserves is a nightmare for oil companies. In the area of coal, according to the International Energy Agency's Energy Technology Perspectives, coal supply in 2003 contributed around 24% of total (global) primary energy. And for instance, South Africa production of coal was 245 million tons in 2006, of which 28.6% was exported (primarily to Europe - 87%) with spot averaged market price at $60/ton, and this make it the third largest mineral export in South Africa with subsequent generation of R21.6 billion in foreign exchange earnings, [6]. Based on estimated reserves, and at current production rates, coal is projected to last for the next 134 years. The future contribution of coal will be heavily affected by ongoing international discussions on the often conflicting issues of energy security and climate change, [7]. See Fig. 1 for the world remaining conventional oil & gas reserves from political and technical sources.

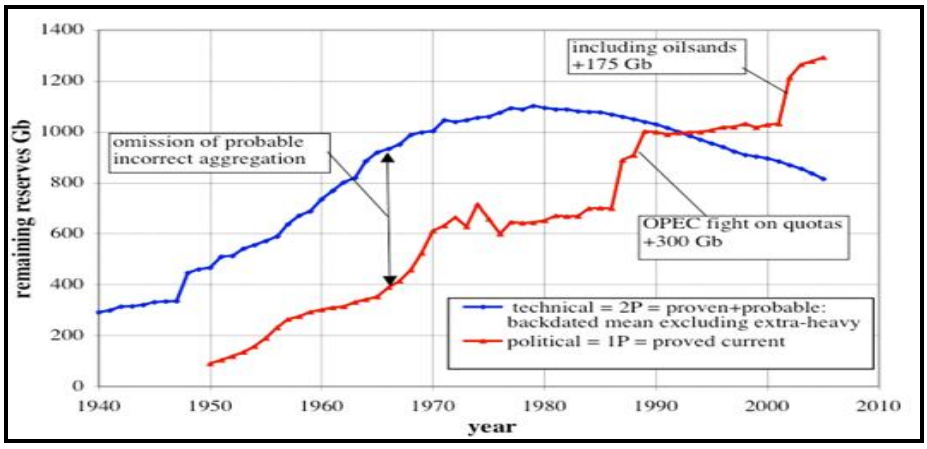

Figure 1. World remaining conventional oil & gas reserves from political and technical sources.
Source. After Jean, (2006).

The major issues from the foregoing discussion on global fossil reserve establish the following hard facts about conventional oil supply:

i. Fossil fuel consumption per capital is flat at 1,4 toe/cap since 1975 and will stay until 2025.
ii. Fossil fuels gap may be hard to fill without new generation alternative oil, [8].
iii. Saving energy will not be done with protocols or laws, but by convincing the consumer to change his way of life with ITS.

3.1 Automobiles Conventional Fuel Paradigm Shift

What appears to be new in climate change is the greater certainty that the rate of change is likely to be greater than at any time in modern history [9]; and that climate change will not necessarily occur gradually.

Climate scientists expect that higher temperatures will be amplified by normal variability in climate, leading to new extremes far outside current experience [e.g., the heat wave in Europe in 2003 [10] and the near record heat of 2006 in the United States. Higher temperatures are also likely to trigger surprises, such as more rapid than expected melting of Arctic sea ice and rising sea levels, (the New Orleans flood and tsunamis). Light-duty vehicles generate one-third of global CO2 emissions and about a third of U.S emissions. Capturing CO2 emissions from individual vehicles is effectively impossible, so reductions in the transportation sector can be effected only by improved fuel economy and/or replacement of current fuels with lower-carbon or zero-carbon fuels. For instance, in response to a congressional request in the Energy Policy Act of 2005 of USA, the National Research Council (NRC) study estimated the maximum practicable number of hydrogen fuel cell vehicles (HFCVs) that could be deployed in the United States by 2020 and beyond, together with the investments, time, and government actions needed to carry out this transition, [11].

The global awareness of the fossil fuel combustion contribution to GHGs has brought about the discovery of alternative fuels, known as non-conventional or advanced fuels. Some well known alternative fuels include biodiesel, bioalcohol (methanol, ethanol, butanol), chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane and natural gas, vegetable oil, and other biomass sources. The Africa Section of the Society for Conservation Biology (SCB) distinguishes the various terms often misused in the discussion of alternative fuel as follows:

a. A biofuel is any solid, liquid or gaseous fuel produced directly or indirectly from biomass, such as straw, grass, or processes such as collection of land-fill gas,
b. Agrofuels as products of agriculture biomass, by-products of farming, and/or industrial processing of agriculture-linked raw material. The term covers mainly biomass materials derived directly from crops and agricultural, agroindustrial and animal by-products such as dung, corn and soy,
c. While Woodfuels include all types of biofuels derived directly and indirectly from trees and shrubs which grow on forest and non-forest lands, including charcoal and methanol, [12].

4. Urban Sustainability and the Prospect of Green Mobility

Sustainable urban mobility policies and plans places emphasis on transportation systems that are more benign in terms of their impacts on the environment and that discussion on the sustainable transportation should be intertwining with the principle of redressing the imbalances in the cost-benefit analysis of the transport sector, [13]. Green automobile development is the interaction between mobility, sustainability and socio-economic system, as illustrated in Fig. 2.

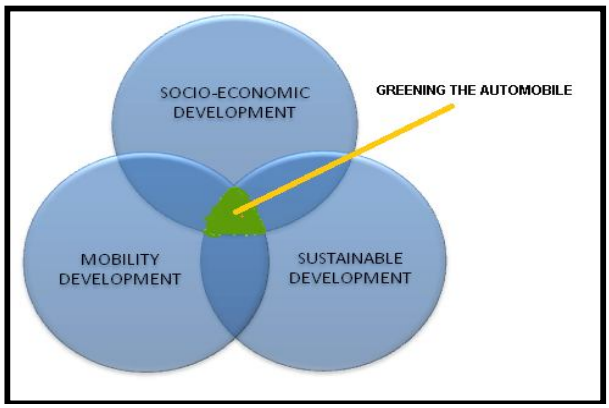

Figure 2. Cost-Benefit-Analysis of the transport sector and sustainable development.

Many attempts have been made to relate the concept of sustainable development to transportation. An often-cited definition is that of Daly, who argues that a physically sustainable society, from which a transportation system takes up a big share, should satisfy among other things that its rates of pollution emission do not exceed the assimilative capacity of the environment, [13]. In considering the Process aspect of the definition according to Deen and Skinner, it is a transportation system and a process for modifying or adapting the system that can accommodate expected population changes, growth in economic activity and changes in resource availability and yet meet environmental standards, [14]. While Akinyemi and Zuidgeest are of the opinion that a sustainably developed transportation system, is that system that meets the people's needs in terms of mobility, accessibility and safety within the available or affordable environmental, financial and social resources.[15].

5. ITS and Sustainable Transport Development

ITS vary in technologies application from basic management systems such as car navigation; traffic signal control systems; automatic number plate recognition or speed cameras to monitor applications, such as security CCTV systems; and to more advanced applications that integrate live data and feedback from a number of other sources, such as parking guidance and information systems; weather information; bridge de-icing systems; and the like [16].
A traffic enforcement camera system, consisting of a camera and a vehicle-monitoring device, is used to detect and identify vehicles disobeying a speed limit or some other road legal requirement and automatically ticket offenders based on the license plate number, see plate 3 for cameras in operation [17;18]. Applications include:

Plate 3. A red-light camera in use at Beaverton, Oregon

5.1 Traffic signal pre-emption

Traffic signal pre-emption is a type of system that allows the manipulation of traffic signals in the path of an emergency vehicle, stopping conflicting traffic and allowing the emergency vehicle right-of-way, to help reduce response times and enhance traffic safety. Sometimes it is also used at railroad at-grade crossings, and bus rapid transit systems for priority access through intersections [19].

5.2 GPS and Radio Signal System

A GPS-based traffic pre-emption system require software and a communications platform to determine where the activating vehicle is located, in which direction it is headed, which traffic lights should be pre-empted, and the ability for the central application to activate the desired traffic lights promptly. While Radio-based traffic pre-emption systems using a local, short-range radio signal in the 900MHz (33-cm) band, can usually avoid the weaknesses of line-of-sight systems as well as GPS systems. A radio-based system still utilizes a directional signal transmitted from an emitter, but being radio-based, its signal is not blocked by visual obstructions, lighting or weather conditions.

5.3 E-Call Emergency vehicle systems

The in-vehicle e-Call is an emergency call generated either manually by the vehicle occupants or automatically via activation of in-vehicle sensors after an accident. When activated, the in-vehicle eCall device will establish an emergency call carrying both voice and data directly to the nearest emergency point (normally the nearest E1-1-2 Public-Safety Answering Point, (PSAP). The voice call enables the vehicle occupant to communicate with the trained e-Call operator. At the same time, a minimum set of data will be sent to the eCall operator receiving the voice call.
In the pursuance of sustainable urban transport development and climate change, according to the U.S. Department of Transportation, ITS spending is 10 times more effective in providing road capacity than spending on road building. **Traffic congestion** is about $87.2 billion annual drain on the U.S. economy—more than $750 for every U.S. traveller. Americans waste 4.2 billion hours in traffic every year or nearly one full work (or vacation) week for every traveller [20].

6. Road Infrastructure Efficiency In Abuja, Nigeria

The Nigeria Federal Capital Territory (FCT) is well endowed with modern day road network as designed in the master plan with grade intersections but the city lagg behind in ITS infrastructure. The phase-1 of the territory is about 95% completed but the mass transit rout systems are still facing political setback, like the lightrail and the BRT.

6.1 Abuja Traffic Control Signalling and Sensors

Traffic control system in Abuja is still partially manual due to local environmental factor; particularly the erratic power supply. Although solar power and inverters are in place, some of the traffic lights are not functioning due to system malfunctioning or lack of power supply. Plate 4 is typical traffic control in Abuja.

PLATE 4a Ahmadu Bello Way (active) b. Traffic cop replaces signalling

The utilization of traffic sensors in Abuja is still in its infancy stage. For instance, the car used in bombing the UN building in Abuja could not be traced to a credible owner because there is no credible vehicle registration automation.

The major challenging issue is that neither the FRSC nor the traffic cop has the required ITS mobile infrastructure to commence vehicle tracking as envisage in the new plate number. At best, the commission has only established their own mini patrol van tracking for rescue operations and surveillance. A comparative assessment of the Nigeria's FRSC patrol car without Sensor and that of other countries like USA reveal the level of preparedness of the commission and the country at large for ITS, see plate 5.

Plate 5a. A mobile tracking system of the US Police. b. FRSC patrol vehicle of Nigeria

7. The Challenges for the African Countries

Africa countries generally over depend on the exportation of fossil fuel (where available) and aids for their foreign earning. The poor technological advancement has placed the continent in servant-hood position to the western world who directly and indirectly determine what, how, and when to produce particular goods. The volatility of the oil price is not unconnected to this type of relationship and the hungry nature of OPEC. It must be noted that the propagation of agrofuels in African countries to reduce dependence on fossil fuels must be regulated to limit the impact on food availability for rapidly increasing human populations, [21].

7.1 Conclusion

Sustainable energy and transportation development is an interdisciplinary activities that requires continuous research and development that is backed up with budgetary funding at governmental level [22]. The globalization of transportation standards and hybrid vehicles require the adoption of ITS principles and infrastructural development that must be strategically planed and not by piece-meal approach as it is in developing countries like Nigeria [23].

7.2 The Way Forward

In accordance with the NEPAD statement, African governments and policy makers need to ensure that any new energy-related developments reflect a balance between local human population needs and natural resource conservation.

All the major urban centres and highways in the country should be fully covered with current cadastral maps that are geo-reference for ITS compatibility. Most structures in some urban centres have no definite description of location and defined road network. It is recommended that the FRSC in conjunction with other relevant government agencies convene a standing technical advisory panel comprising individuals with backgrounds in the disciplines central to the design, development, and safety assurance of automotive electronics systems, including software and systems engineering, human factors, and electronics hardware. The panel should be consulted on relevant technical matters that arise with respect to all of the agency's vehicle safety programs, including defect investigation processes, and research needs assessments. A strategic long and short range plan should be evolved and doggedly implemented for the country.

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