SUSTAINING THE IMPACT OF CLIMATE CHANGE ON AUTOMOBILE TECHNOLOGY IN THE DEVELOPING ECONOMIES: STRATEGIC REVIEW

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ABSTRACT

Climate change is among the major global environmental problems threatening the survival of the entire human race with varying degree of changes and challenges. It intensity is speedily increasing because of human activities involving burning of fossil fuels, industrial production, and transport culminating into increase in greenhouse gas levels. Automobile industry is known for the production of the significant volume of CO_2 emission constantly release into the atmosphere hence the demand to drastically reduce it, if not totally eliminated. Research findings and innovative measures globally have indicated articulated developmental strides in the recent technologies, products, materials regarding measures to mitigate and fully adapt to the challenges of climate change. This paper is therefore aim at assessing the impact of climate change on automobiles as it affects the developing economies. It also highlight strategic measures of sustaining the impact of climate change through the introduction of hi-tech, hybrid and other vehicles which provides alternative fuels to control CO_2 emission.

Keywords: Alternative fuels, automobile technology climate change, carbon emission, strategic sustainability

INTRODUCTION

The environmental quality globally is characterized by threat and other uncertainties which have received significant concerns from the developed nations but still transiting in most of the third world countries. The desire of meeting the ever-increasing appetite for goods and services in recent times is greatly challenged and restrained by climate change impact to the earth together with the consequences for the health of ecosystems around the globe as it influence technology, economy, raw materials, energy, food, and even waste disposal processes (Smith, Burton, Klein and Wandel, 2000). Thus climate change is among the major global environmental problems threatening the survival of the entire human race with varying degree of changes and challenges. These challenges have resulted into temperatures, rainfall, droughts, high-intensity hurricanes and severe flooding events which are increasing and projected to continue as the world's climate warms, according to the National Climate Assessment for 2012. The Meteorological

Department further warned of other consequence during the rainy season as reported by the Public Health Ministry of Thailand as 34 persons lost their lives in less than two months from heat exhaustion and high temperatures. In 2011 the U.S. experienced 14 extreme weather-related events that caused loss of human life and cost the U.S. economy more than $55 billion. Furthermore, in Washington State, between 1990 and 2009, the Chehalis River experienced four "'100-year" floods and one "500-year" flood event, costing millions of dollars in cleanup and repair. Climate is rapidly changing with disruptive impacts, and that change is progressing faster than any seen in the last 2,000 years. Scientists project that these trends will continue and in some cases accelerate, posing significant risks to human health, our forests, agriculture, freshwater supplies, coastlines, technology and vehicles and other natural resources that are vital to economy, environment, and the quality of life of the people.

Technologically, the recent variations in climatic conditions which culminate into global economic crisis is currently exerting great impact on vehicle production, sales and also endangering nations that are still utilizing fleet of old vehicles with unchanging emission rate due to non-alignment to the new energy source which greatly help in reducing the pollution caused by the use of fossil fuels prevalence in the developing nations. Although the challenges attributed to the occurrence of climate change in automotive industry could be viewed both as a threat to the global existence, it also provide an opportunity to innovate and systematically create new technologies across the globe. To the developing economies, the threat outweighs the latter resulting in weak economic growth which affects every facets of life steadily with uncontrollable ratio of pollution.

Heavy and industrial firms are constantly submerged in the practice of releasing unquantifiable volumes of emissions to the atmosphere apart from fleet and commercial vehicles. Nison (2012) further pointed out that car "exhaust" alone is held accountable for 20 percent of carbon dioxide released on a global scale into the atmosphere. Since the knowledge about climate change has been increasing over time, and the demand for alternate fuels systems installed in developed nations and together with the production of hybrid and hi-tech vehicles. The paper objective is aim at clearly reviewing the impact of climate change and also outlining strategic technologies for sustenance of automobiles in the developing economies.

2. What is climate change?

Climate change, also called global warming, refers to the rise in average surface temperatures on earth which resulted in an extended alteration of the weather patterns attributed to human activities which results in degradation of an environment (Nwosu, 2012). Since it antecedent or drivers can be observed or measured over time, Ikehi and Zimoghen (2014) described it as the variation in the statistical distribution of the average weather conditions over a prolong period of time. According to the Intergovernmental Panel on Climate Change (2000), climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Global warming and the climate changes seen today are being caused by the increase of carbon dioxide (CO_2) and other greenhouse gas emissions caused by humans activities like the burning of fossil fuels, industrial production, and transport leading to the increase greenhouse gas levels. Computer models, ice core evidence as well as fossilized land and marine samples show that CO_2 is at its highest level in the last 3 million years and that CO_2 concentrations have increased because of human activities like fossil fuel use and deforestation (Van De Wal, De Boer, Lourens, Köhler, and Bintanja, 2011; San Diego, 2014). The United Nations Intergovernmental Panel on Climate

Change (IPCC) has concluded that most of the warming observed during the past 50 years is attributable to human activities. Additionally, extreme bush burning also cause changes to the climate. Natural processes such as volcanic eruptions, variations in earth's orbit or changes in the sun's intensity are also identified causes.

The United Nations Framework Convention on Climate Change (1997) indicated that climate change is the change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Specifically, CO_2 and other greenhouse gases are naturally present in the atmosphere, emissions from human activities have greatly amplified the natural greenhouse effect. For instance, its concentrations in the Earth's atmosphere have increased significantly since the beginning of the Industrial Revolution, and most especially in the past 50 years (The World Bank, 2010). This prompted Omoru and Okeke (2012) to state that climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or land use. Houghton (2009) and Kaounides (2011) jointly mentioned that most of the scientists now agree that climate change is due to the Greenhouse effect (GHE), a phenomenon originating from human activities involving CO_2 produced by combustion of organic material, and which re-radiate back to earth the heat coming from the radiation of the sun provoking climate changes as reported in detail, Houghton (2009) and Kaounides (2011) added. The phenomenon of climate change has globally been viewed as a threat which has become the most researched subject in science. It is highly controversial due to it divergent nature which must be tackled on a global scale. It is also considered as one of the major global environmental problems threatening the survival of the entire human race.

3. Climate change and automobiles technology adaptation

Automobile today is controlled by various electronics sensors, circuits and computers making it mandatory for personnel to have sound knowledge of electrical principles and trouble-shooting procedures to diagnose and service many of the electrical problems found in automobile (Usman, 2009). Udofia (2016) posited that most of the hi-tech, hybrid and electric vehicles are entirely new products are posing operational and maintenance challenges in the developing economies especially the fuel and electrical systems which are connected to the Electrical Control Unit (ECU) also called 'brain box' and other auxiliary units. Beyond the power train, there are many other areas in which automotive technology can contribute to carbon reduction - for example, the use of new materials and technologies to reduce vehicle weight, low friction tyres, improved aerodynamics (Booth, 2006). Vehicle designers and engineers are currently working toward the introduction of aluminum body structures in the Jaguar brand which have resulted in CO2 emissions for the XJ series. According to Booth, 2006) investigations into CO2 performance reduction in vehicles across brands and across regions in the areas mentioned below:

- Clean diesel
- Advanced direct injection gasoline
- Weight stabilization and reduction
- AFV and FFV vehicles and developing superior AFV technologies
- Hybrid power packs and research into plug-in hybrid technology

- Hydrogen ICE and hydrogen fuel cell
- Key features of forthcoming detailed technology roadmaps

Driving success (2013) indicated that examination of research challenges and an analysis of UK capability led to the identification of five strategic technology themes where the UK could show leadership through specialization (Driving success, 2013. These include internal combustion engines; electric machines and power electronics; energy storage and energy management; lightweight vehicle and power train structures; and intelligent mobility. These strategic technologies are further broken down to integrate the innovative and creative unit that will greatly reduce carbon emission as shown in table below:

Table 1: Strategic technologies in automobile

Roadmap	Key themes
Internal Combustion Engines	The roadmap defines future priorities to improve engine thermal efficiency, improvements in systems efficiency and enabling technologies. Key focus areas are: ■ Integration of combustion engines and electric machines to reduce cost and increase utility ■ Downsizing and down speeding including more sophisticated charge air/boost systems ■ Fuel injection and variable valve and actuation systems ■ Waste heat recovery to shaft power or electricity production ■ Low carbon liquid fuels
Power Electronics & Electric Machines	Mixed technology motors such as Permanent Magnet Switched Reluctance machines as well as Switched and Synchronous Reluctance machines are key features of the roadmap. Focus areas include improvements in: ■ Advanced lower cost control electronics ■ Conductivity in windings ■ Topology and innovative configurations ■ Thermal management & conduction
Energy storage	Significant Improvements in existing battery chemistries, achieving in excess of 400Wh/kg at a cost of less that US$250/kWh, next generation chemistries & other storage technologies Key areas for progress are: ■ Electrolytes, catalysts, decants, additives, surface modification and coatings ■ Scale up technologies to move from laboratory to prototype cells for in-field development ■ Innovative storage technologies that offer improved cost, energy density & packaging
Lightweight Vehicle and Power Train	To meet vehicle CO2 targets, substantial vehicle weight reductions can be achieved through: ■ Migration of motorsport/aerospace technologies initially into the premium sector and ultimately into high volume vehicle manufacture ■ Advances in manufacturing/joining technologies for advanced low weight materials to achieve automotive scale and cost requirements

	■ Next generation multi-physics computer aided engineering for weight optimisation ■ New vehicle topologies enabled by advanced materials
Intelligent Mobility	Increased road user demand will require more intelligent & safer mobility to deliver a robust transport system. This will require improved communication, control and vehicle systems together with modal shift and demand management. Key technologies will include: ■ Advanced data processing & acquisition systems for multi-modal journey planning/optimization ■ Vehicle sensor fusion & processes for safety critical on-board software development ■ Communication systems/protocols for both vehicles and infrastructure ■ Next generation driver assistance systems and autonomous control technologies

Adapted from: Automotive Council, UK, July 2013, Udofia, 2018.

Udofia (2016) stated that working on today's cars requires an understanding in the science and technology that goes into the modern, highly-sophisticated automobile - the Hi-tech and the Hybrid vehicles. This implies that an alternative engineering designs and construction techniques must be developed and implemented to accommodate the effects of climate change. Evidently, automobile industry is known for the production of the significant volume of CO2 (Carbon dioxide) which pollute the atmosphere hence the demand to drastically reduce the amount of CO2 emission.

Significantly, research findings and innovation currently observed globally showcased articulated development strides in technologies, products, materials, and findings. Car makers to develop a new technology that is more environmental friendly, which can reduce the amount of green house gas emission. Chen (2016) noted that there is a growing integration of information technology, biotechnology, and technologies related to new energy and materials, triggering a new round of technological and industrial revolution leading to a shift away from the traditional model of production and high resource consumption at the expense of the environment. The adaptation and transforming form the traditional automobile production, maintenance and sales into a cultured-propagated technology means promoting the energy revolution by curtailing short-sighted needs, conserving energy, and improving efficiency; by controlling the total consumption of high-carbon energy sources and driving their clean low-carbon conversion; by vigorously developing non-fossil energy (renewable energy and nuclear energy) and natural gas (including unconventional natural gas); and by promoting distributed low-carbon energy networks in the process of urbanization, and improving the energy consumption structure in rural areas (Du, 2014).

Developed countries are pushing low-carbon energy development in order to lay the foundation for a new approach to development. Many developing countries have also embraced the concept of coordination and balance between poverty eradication and sustainable development by taking climate response as a new opportunity and a development orientation to drive low-carbon

industries and create new markets and jobs (Du, 2016). A variety of technologies related to pollution management, bio-remediation, and ecological restoration had since been installed in the developed economies. Mamalis, Spentzas and Mamali, 2013) rightly pointed out that in the poor and underdeveloped countries different priorities are set, permitting the use of a fleet of vehicles of an average age around 10–20 years with much higher emission levels. Socolow (2012) revealed that with the application of "technology leap" both carbon dioxide and nitrogen emissions can be decreased through the adoption of advanced technologies such as electric propulsion vehicles and zero emission-distributed power leading to significant compliance with the regulations for emissions by vehicles in developed economies has been achieved. Stressing further that main engineering method to protect the carbon cycle, carbon dioxide can be captured at a coal plant, then compressed and sent into porous rocks deep below ground.

Mamalis, et al. (2013) mentioned that the available technologies that have already been introduced into the market to control vehicle emissions through the use of:

- Hybrid Electric Vehicles (HEV)
- Plug-in Hybrid Electric Vehicles (PHEV)
- Battery Electric Vehicle with Range Extender (RE-BEV)
- Battery Electric Vehicles (BEV)
- Fuel Cell Electric Vehicles (FCEV)

Actually HEV, PHEV, RE-BEV and BEV are already in the market. The FCEV technologies have already been developed and are under evaluation testing. Beyond leading in scale on the switch to electric buses, China is also developing wireless induction charging technologies that mean the buses need never return to their depot other than for maintenance. Battery Electric Vehicles (BEV) constitute the technology to be adopted in order to reduce the contribution of vehicles to climate change, but, for an effective application of BEV technology in the market, a serious shift to green energy generation may be needed. It is also necessary to provide an effective adaptation of the electricity distribution network in order to handle the loads of the BEV charging, either off-pick or during high demand hours.

Undoubtedly, whilst awaiting the arrival of autonomous vehicles, the development of electric vehicles, and the greater provision of charging points is making these a realistic alternative. In the UK, an Arup-Mitsui joint venture in Milton Keynes is currently trailing an innovative approach to charging electric buses and this herald a quieter, cleaner future for public transport. Socolow (2012) clearly mentioned that new buses are able to recharge their batteries wirelessly through the day, which means that for the first time, electric buses are capable of carrying the equivalent load of a diesel bus. Nissan Company has been involved in improving the energy efficiency of its gasoline and diesel engines and also in developing and marketing vehicles that run on nonpetroleum based alternative energy sources. Examples of the latter include those using biofuel, fuel cell vehicles that run on renewable hydrogen, and electric vehicles. Since 2005 Nissan has been marketing flexible fuel vehicles in the North American market that can run on bioethanol.

Research development efforts have also been directed toward the successful development of fuel cell vehicles that perform on a par with gasoline ones. Nissan have begun marketing electric vehicles in Japan and elsewhere in 2010. More so, hybrid vehicles now utilize rechargeable batteries to run and a minor amount of gasoline. These vehicles produce much less emissions than regular gasoline powered vehicles. In 2010, Carlos Ghosn introduced a 100 percent full electric vehicle which has no exhaust/tailpipe and requires not a single bit of gas to operate

which means zero emissions leading to his award 2011 world car of the year award. Switching to hybrids and full electrics will significantly improve the world's carbon emissions. The technologies contained in these vehicles are expected to play a big role in reducing the consumption of fossil fuels and mitigating the impact of automobiles on ecosystem services and biodiversity. Nison (2012) stressed that the automotive industry has always been preparing for climate change since the earlier periods. Switching to hybrids and full electrics will significantly improve the world's carbon emissions. Clearly, a lot of actions that help reduce the in-use GHG emissions of our vehicle fleet -- from expanding our hybrid lineup, to encouraging more use of ethanol fuel, to shifting our mix of products to more fuel efficient cars, to improving the efficiency of conventional gasoline and diesel engines, to raising the awareness of consumers. Scientist and vehicle manufacturers had long developed an alternative fuel, most generally defined, is any fuel other than the traditional selections, gasoline and diesel, used to produce energy or power. The emissions impact and energy output provided by alternative fuels varies, depending on the fuel source. The United State Department of Transportation (2005) provided a list of such alternative fuels which include biodiesel, ethanol, electricity, propane, compressed natural gas, and hydrogen which efficiently replace gasoline and diesel.

Conclusion

Of the many problems generated by our economic and industrial progress, climate change is one that dominates media headlines in recent memory. The sustainability of the impact of climate change involves conscious adjustments in behavior or economic structures that reduce the vulnerability of society to changes characterized in the climate system. Smith, Burton, Klein, and Wandel (2000) mentioned that the adaptations to climate is the process through which people reduce the adverse effects of climate on their health and well being, and take advantage of the opportunities that their climatic environment provides. Clearly, transport is seen as difficult as far as combating climate change is concerned, due to the strong trend growth in CO2 emissions and its significant position in the economy and vocational provisions (Rigg, 2009). It is strongly agreed that no country will remain unaffected, thus making it clear that climate change mitigation and adaptation are necessary to address one of the greatest challenges faced by the world today (Smith, et al. 2000). The threats of climate change brings together expertise in diverse areas ranging from science and technology to agriculture, transport, forestry and disaster risk reduction, to address both mitigation and adaptation. The initiatives to combat the challenge of climate change have been significantly addressed considering the introduction of highly-sophisticated automobile - the Hi-tech and the Hybrid vehicles, the electric vehicles and the fuels used which is aim at achieving zero emission in vehicles by reducing the amount of green house gas emission. Additionally, this also reduce the adverse effect of carbon dioxide and other poisonous gasses on humans which continuously pollute the earth surface.

Recommendations

The United Nations, of which Nigeria is a member, with other international organizations as partners, are in the forefront to make the world a better place for habitation through several innovative and encompassing projects. It is that effective policies outlined during a reasonable time-period can not be the same for all the countries, but it must be adapted to the local conditions and take into consideration the local availability of raw materials, the existing level of technology, the actual energy mix and obviously the local economic conditions (Mamalis, et al. 2013). The following points are considered as valid as recommendations based on the review.

- Conscious creation of awareness and enlightenment programme concerning climate change and its impact on automobiles, now and future.
- Conscious creation of awareness and enlightenment programme concerning recent vehicle technologies and changes leading to a diversion from the source of energy use in industrial and fleet management.
- Stringent environmental policies can stimulate the alignment of policies for the Transition to a Low-Carbon Economy.
- Innovation for the low-carbon transition through the creation of new businesses, the restructuring or the phasing out of old ones, the emergence of nascent technologies and business models and the right support frameworks for innovations to be widely adopted (Gallehr, Lambing, Merkle, Schuhmacher, 2009).
- Avoiding misalignments between climate mitigation instruments "In bridging the gap, governments should undertake an inventory of policies that explicitly and implicitly price carbon, and assess the impact of the policies and their interactions in order to ensure that they are mutually supportive in achieving CO2 reductions as well as other social and economic objectives." (OECD, 2013c)
- Reducing greenhouse gas emissions (especially CO2 from fossil fuels) by setting out policies to address the potential distributive effects.
- Adoption of the rapid improvements and measures installed by international bodies regarding climate change and mitigations strategies which can help in eradicating or significantly reducing the progression of climate change and
- Fast-track actions by reducing CO2 emissions through energy efficiency in the utilization of alternative fuels.

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