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Assessing the effect of Liquid Petroleum Gas (LPG) car conversion system in petrol car by local Artisans in Ghana.

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ABSTRACT
Conversion of petrol to LPG fuelled vehicles is often carried out by mechanics who are not professionally traine d in Ghana. Therefore this study was carried out to assess the effects of conversion systems of petrol cars to LPG by local artisans. Data was collected through three techniques namely observation (i.e. Fifteen LPG installation garages), survey (112 questionnaires) and interviews with LPG installation expert from Don Bosco Training Cen tre in Tema, and local workshop owners. A total of 112 questionnaires were administered to LPG installation me chanics and drivers sampled randomly from the study area.
The study clearly shows that most of the apprenticeship trainings were carried out by unprofessionally trained L PG installers under trees and in open garages which were not standard automobile repair workshops. Most of the vehicles do not have any safety detectors installed in them. According to the drivers, it was very difficult to detec t leakage unless they smell the odour of the gas.
Keywords: LPG, LPG conversion, Vehicles, Local artisans, Ghana

1.1 INTRODUCTION

Autogas is widely used as a "green" fuel as it decreases exhaust emissions. In particular, it reduces CO_2 emission s by around 35% compared to petrol. One litre of petrol produces 2.3 kg of CO_2 when burnt, whereas the equival ent amount of autogas produces only 1.5 kg of CO_2 when burnt SLB on HRV, (1996). LPG is synthesized by refi ning petroleum or "wet" natural gas, and is usually derived from fossil fuel sources, being manufactured during t he refining of crude oil, or extracted from oil or gas streams as they emerge from the ground. It was first produce d in 1910 by Dr. Walter Snelling, and the first commercial products appeared in 1912. It currently provides about 3% of the energy consumed, and burns cleanly with no soot and very little sulphur emissions, posing no ground or water pollution hazards.
Globally there is an increasing number of vehicles being manufactured to run on LPG. Studies show that as at 20 10, there are about 12.7 million natural gas vehicles worldwide Annual Report, (2010). In the U.S as at 2009, t here were a fleet of 114,270 using compressed natural gas (CNG), mostly buses and 147,030 vehicles running on LPG Annual Report, (2010).

According to Tyler (2010), autogas enjoys great popularity in numerous countries and territories, including Unite d States of America, China, Australia, Croatia, Lithuania, the European Union, Hong Kong, India, Philippines, th e Republic of Macedonia, South Korea, Serbia, and Turkey. It is also available at larger petrol stations in several countries. In the Republic of Armenia, for example, the transport ministry estimates as many as 20 to 30% of veh icles use autogas, because it offers a very cheap alternative to both diesel and petrol, being less than half the pric e of petrol and some 40% cheaper than diesel.
Autogas is the third most popular automotive fuel in the world with approximately 16 million of 600 million pas senger cars powered using the fuel, representing less than 3% of the total market share Approximately half of all autogas-fueled passenger vehicles are in the seven largest markets (in ascending order): Turkey, South Korea, Po land, Italy, and Australia. (Inigo, 2009)

Autogas is widely used as a "green" fuel as it decreases exhaust emissions. In particular, it reduces CO_2 emission s by around 35% compared to petrol. One litre of petrol produces 2.3 kg of CO_2 when burnt, whereas the equiva lent amount of autogas produces only 1.5 kg of CO_2 when burnt Tyler, (2010). It has an octane rating (MON/RO N) that is between 90 and 110 and an energy content with higher heating value (HHV) that is between 25.5 meg a joules per litre (for pure propane) and 28.7 mega joules per litre (for pure butane) depending upon the actual fu el composition (Tyler, 2010).

According to the World Liquefied Petroleum Gas Association (WLPGA, 2005) more than 9 million vehicles in 38 countries at that time operated on LP gas. The idea of using propane to power vehicles is one that has been around for decades. The benefits include reduced emissions**,** quoted by WLPGA (2005), as 50% less carbon monoxide, 40% less hydrocarbons, 35% less nitrogen oxides (NOx) and 50% less ozone forming potential compared to gasoline. With government incentives and tax breaks figured in, LP gas used in cars known as **autogas** can be much cheaper than gasoline. Even without the incentives, it is usually much cheaper. Autogas is a high-octane fuel, offering performance comparable to gasoline and diesel, and many owners claim that autogas runs more smoothly, resulting in less wear and tear on engine components SAEHRB, (2005).

Conversion of petrol fuelled vehicles to LPG is often carried out by mechanics who are not professionally trained in Ghana. Although this practice is on the increase with a lot of vehicle owners opting for this, though the commercial car (taxi) owners make a lot of profit after converting petrol car to use LPG as fuel, they are facing the challenge regarding safety issues associated with the practice. In addition, the efficiency of the converted fuel supply system of the LPG is also questionable. This is because, most of the LPG mechanics do not have the standard diagnostic tools and conversion kits needed for the conversion hence could easily lead to system failure thus affecting the performance of the vehicle. Therefore this study attempts to determine how mechanics install the LPG equipment in vehicles and safety measures in the LPG converted vehicles.

2.0 METHODOLOGY

2.1 Study area Description

The study was carried out in the Tema Municipality in the Greater Accra Region of Ghana. Tema is a city along the coast of Ghana lying 25 kilometres (16 miles) east of the capital city, Accra. It was estimated that the population of Tema is about 506637 (Ghana Population Census, 2010). The city was built in 1960 as a man-made harbour. With the opening of the artificial harbour in 1961, Tema developed from a small fishing village to become Ghana leading seaport, an industrial centre and the busiest city in Ghana. It is a commercial town with most people being formally employed by government and private companies. The commonest means of transportation in the municipality is by commercial mini buses which ply between the town and other major cities. However, Taxis are the main cars being used within the city. Most of these taxis are imported from foreign countries and run on gasoline fuel. They are, however, converted to LPG conversion system. In the municipality, it is estimated that there are about 4000 commercial vehicles out of which 2600 are Taxis. The estimate shows that about 1200 taxis are using LPG as fuel constituting 75% of taxis plying within the municipality.

2.2 Techniques used for Data Collection

Three main methods were used in data collection namely observation, interview and survey. These approaches were used to complement each other hence allowing for more reliable data to be collected. This is because combination of these methods would incorporate strengths and weaknesses concerned with each method since no single data collection technique has a complete advantage over each other.

2.2.1 Observation

Observational study was carried out in the 15 LPG installation garages within the study area. This was done to gather information on the actual installation procedures and other technicalities involved. It included conversion technique, problems, safety and precautionary measures.

2.2.2 Survey

The questionnaires were administered to LPG installation mechanics and some LPG vehicle drivers. Both closed and open ended questions formed part of the questionnaires. In all, 112 questionnaires were administered to both LPG installation mechanics and drivers sampled randomly. Questions were centred on work experience, installation techniques, safety measures and economic benefits.

2.2.3 Interview

Information from an LPG installation expert from Don Bosco Training Centre was collected through in-depth interview. This was because the respondent was formally trained and working in a standard garage with standard conversion kits. To allow respondents to express themselves freely and fully, unstructured interviews were used in some cases. The interviewee's answers to questions were recorded on a sheet of paper.

2.3 Data Analysis

The data was edited, coded and entered into the computer using Statistical Package for Social Scientists (SPSS) version 16. Data was categorized and tabulated according to concepts in order to address the purpose of the study

. Pie and bar charts were also used for result representation.

3.0 RESULTS AND DISCUSSION

3.1 Demographic characteristics of respondents

The entire LPG installation mechanics who participated in the study were males (100%) as shown Table 1. This i s because mechanical jobs are male dominated in Ghana and majority (36.6%) of the respondents were between 26-30 years. This is not surprising since people belonging to this age category form the core of youths in most G hanaian cities. However, majority of these respondents (47%) were married and this work was their source of liv elihood. Most of the LPG installation mechanics interviewed have up to basic education (57.1%) and were not ab le to further their education. Because of this reason, they have learned the trade of LPG installation and are practi cing this as a trade.

Table 1: Demographic characteristics of respondents

Characteristics	Frequency	Percentage
Sex		
Male	112	100
Female	0.0	0.0
Age categories		
19-25	18	16
26-30	41	36.6
31-35	33	29.5
41-45	15	13.4
46 and above	5	4.5
Marital status		
Married	53	47
Single	50	45
Divorced	9.0	8.0
Educational level		
Informal	5	4
Basic	63	56
Secondary	32	28
Tertiary	13	12

3.2 Working Experience

Because majority of respondents had little education, they were advised by their parents (60.7%) to learn LPG in stallation as a trade (Table 2). Based on the advice of their parents they took apprenticeship as mechanics special izing in LPG installation. However, some respondents also entered in LPG mechanics based on advice from both relatives and interest from friends.

Table 2: Motivation to take up the apprenticeship

Advisors for apprenticeship	**Frequency**	**Percentage**
Parents	68	60.7
Friend	10	8.9
Relation	20	17.9
Interest and exposure	14	12.5
Total	**112**	**100.0**

The study also shows that majority of respondents (73%) learnt the trade of LPG installation in vehicles under ap prenticeship training (Figure 1). This is the most common means of learning a trade in Ghana. This is in line wit h a study carried out by Biscoff et al (2012) where majority of the LPG mechanics (83.3%) were trained mechani cs that learnt the job through apprenticeship and had passed out. They owned workshops where they had apprenti ces working or studying under them.

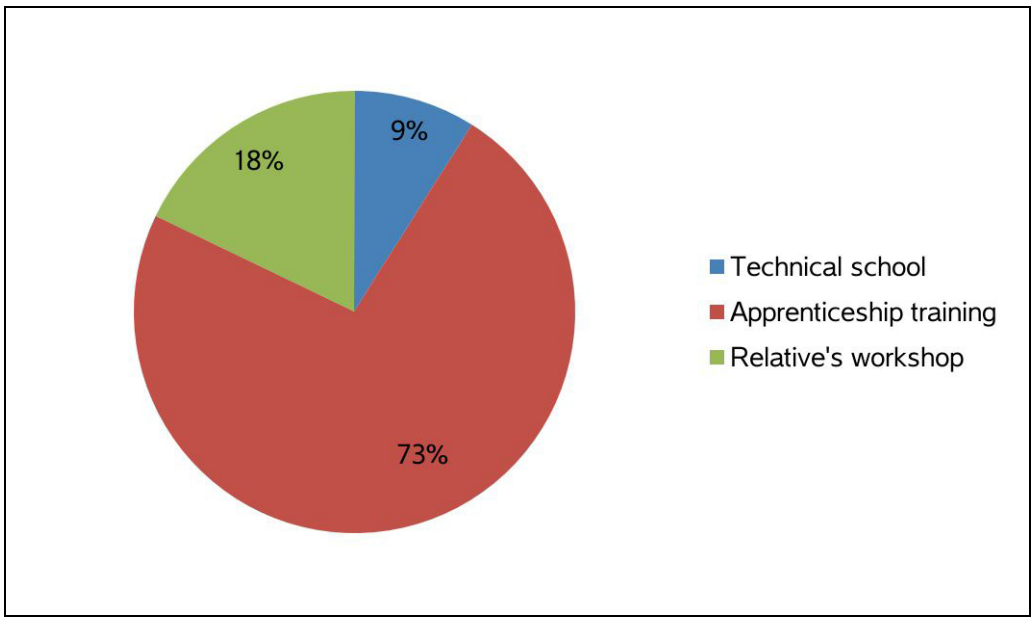

Figure 1: Distribution according to where respondents learnt their trade

3.2 Duration of apprenticeship training

Duration of learning a trade under apprenticeship training varies from trade to trade in Ghana depending on the t ype of trade. For instance, the duration for learning tailoring differs from that of an automobile mechanics. In thi s study, most respondents (58%) mentioned that they learn the trade for 3 years (Table 3). According to some wo rkshop masters, the 3 years is enough for someone to be able to learn LPG installation and practice it confidently . In addition, majority of the respondents (61.6%) stated that they owned workshops while 38.4% did not. They worked under some master mechanics that have their own workshops.

Table 3: Duration of apprenticeship training

Duration of apprenticeship training (years)	Frequency	Percentage
1	5	4.5
2	5	4.5
3	65	58.0
4 years and above	37	33.0
Total	**112**	**100.0**

3.3 Type of workshop owned by respondents

Respondents who owned workshops were categorized into three namely A, B and C. Category A workshops were the ones well equipped with all the standard facilities needed for installation. Category B workshops are made of wooden structures without any first aid boxes and other safety facilities while Category C workshops are open workshops under trees and open places where mechanics work. Based on these classifications, most (74.1%) of the workshops owned by respondents belong to category C (Table 4). This implies that respondents use open places as their garages where they install LPG for vehicles. This is not surprising because they are the commonest automobile repair workshops in Ghanaian communities.

Table 4: Type of workshop owned by respondents

Types of workshops	Frequency	Percentage
Category A	9	8.0
Category B	20	17.9
Category C	83	74.1
Total	**112**	**100.0**

3.4 Period for practicing LPG conversion

Working experience is another factor used in the automobile industry. This is because people with more experience are perceived to be good mechanics and masters thus good LPG installers. According to the study, most respondents (70.5%) have been practicing LPG installation in vehicles for 1-5 years (Table 5) hence should be considered as masters in LPG installation.

Table 5: Period for practicing LPG conversion

Duration practicing LPG conversion (years)	Frequency	Percentage
Less than 1	5	4.5
1-5	79	70.5
6-10	18	16.1
11- 15	5	4.5
16-20	5	4.5
Total	**112**	**100.0**

3.5 Installation and spare parts used by Mechanics

Petrol and LPG are fuels used in automobiles. The study indicated 80.4% of respondents know the distinction bet ween petrol and LPG as automobile fuels. Out of the respondents who know the distinction between petrol and L PG, 13.6% said they used the cost of the fuel to distinguish between them. The remaining 86.4% used burning ch aracteristics to differentiate between the two fuels. They said LPG burns faster and more dangerous than petrol. All the respondents mentioned gas pipe, gas valve, gas motor, gas cylinder, electrical wires, electrical valves, ele ctrical switch, galvanized pipe, bolts, nuts and water hoses as the spare parts used in converting petrol fuelled ve hicle to LPG system.

Similar study carried out in Ho, Ghana (Biscoff et al., 2012) also shows that in the opinion of LPG mechanics, g as filters, gas motors, valves and hoses were the major components of the LPG conversion system, which often b reaks down and need servicing. These spare parts needed for LPG installation in vehicles are obtained from open market (95.5%) and international dealers in spare parts store (5%). In Ghana, the use of second hand spare parts is very common than the use of brand new parts. This is because second hand spare parts are very cheap as comp ared to the brand new ones. Most respondents (88%) also mentioned that the spare parts needed for LPG installat ion is not always available in the market (Figure 2). Because it is not always available, the customers have to wa it for it (90.3%) when their mechanics ordered them from their spare parts clients. According to the survey, custo mers who are financially sound also often order spare parts from outside Ghana through their agents or companie s in Ghana (9.7%). However, this approach is not very common.

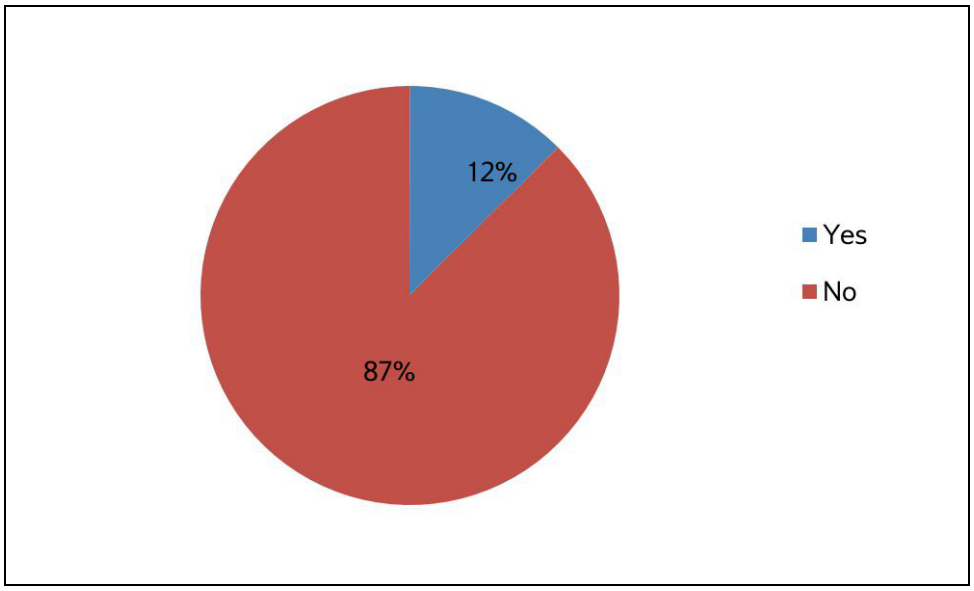

Figure 2: Distribution of responses concerning availability of spare parts in the market

According to the results, most LPG mechanics preferred slightly used spare parts (62.5%) for LPG installation (Figure 3). This is not surprising since Ghana is not a vehicle manufacturing nation and import spare parts from automobile nations such as USA, Japan, etc. Thus slightly used spare parts are often available. According to one of the LPG mechanics:

"*I like slightly used spare parts because they last longer than the brand new ones*".

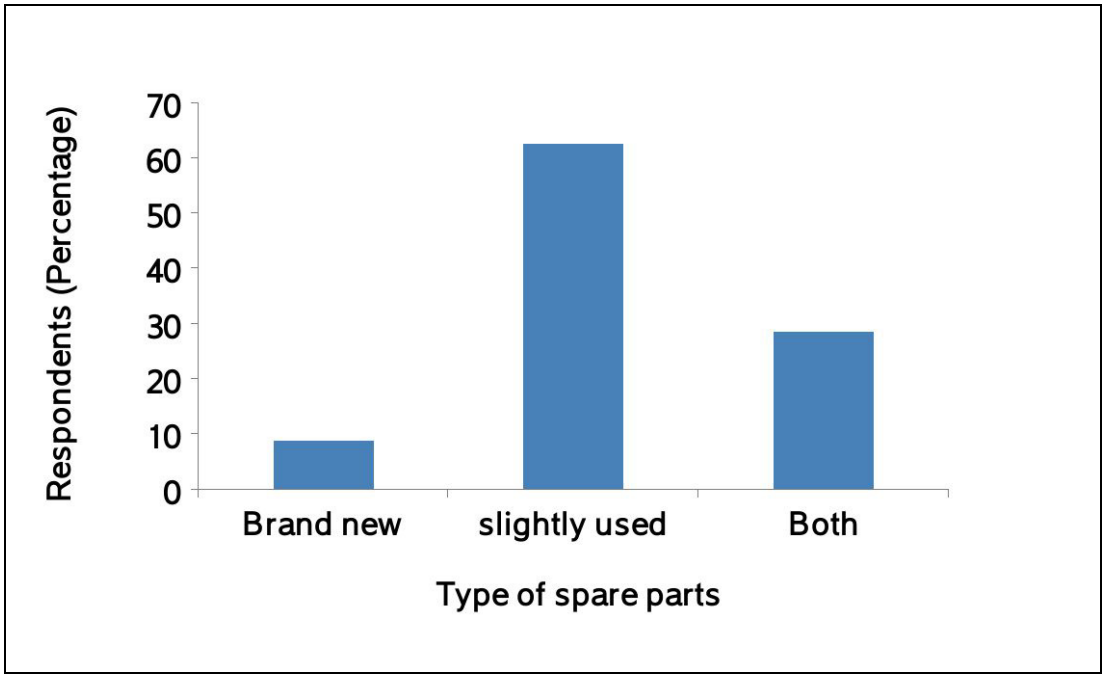

Figure 3: Distribution of responses concerning preferred spare parts for installation

Majority of LPG installers (83%) in vehicles also mentioned that they sometimes purchased used spare parts even if the brand new parts are available. This is because they are very cheap, durable and always easily affordable by their customers.

The study shows that most LPG mechanics (69.6%) used three days to completely install LPG systems in vehicle

s (Table 6). However, the study carried out by Biscoff et al (2012) shows that almost all the LPG mechanics inter viewed mentioned that conversion to LPG system takes 1–2 days. The researcher observed that this duration dep ends on other factors such as the type of vehicle and the generation of the car. LPG installation technology devel oped through four generations. First generation: mechanically controlled, open loop LPG system, suitable for car buretor engines. Second generation: electronically controlled, close loop, single point injection LPG system, suit able for early Electronic Fuel Injection (EFI) gasoline engines. Third generation: multipoint injection LPG syste m. Fourth generation: Multipoint Sequential injection also known as the Sequential Gas Injection (SGIS) is the most appropriate type of LPG conversion for vehicles built after 1999 (Biscoff et al 2012).

Table 6: Duration taken to completely install LPG in vehicles

Duration for LPG installation (Days)	**Frequency**	**Percentage**
1	4	3.6
2	20	17.9
3	78	69.6
4 days and above	10	8.9
Total	**112**	**100.0**

According to an interview with a workshop supervisor at Don Bosco Training Institute, an institution for training automobile engineer's installation of LPG in a vehicle normally takes only one day. This is because their garage is well equipped with the standard conversion kits which enable installations to be easier and efficient at the inst itution. Furthermore, they have diagnostic kits which would be used to check the electronic and electrical syste m of the vehicle before installation commences. This, however, is lacking at the road side garages which often us es "trial and error" approach. But the cost of LPG installation at the Don Bosco training school at Tema is quite high relative to that of roadside mechanics although more efficient. The result also indicated that the original fuel (petrol) supplying system is not condemn when the LPG supplying have been installed. Most LPG installers (67 %) said they maintain the dual fuel supply system so that in case of shortage of any of the fuel the other could be used. However, changing from petrol to LPG especially when one is being used could have a detrimental effect on the engine. This is because LPG burns at higher temperature so changing suddenly to petrol that burns at low er temperature normally would change the performance of the engine.

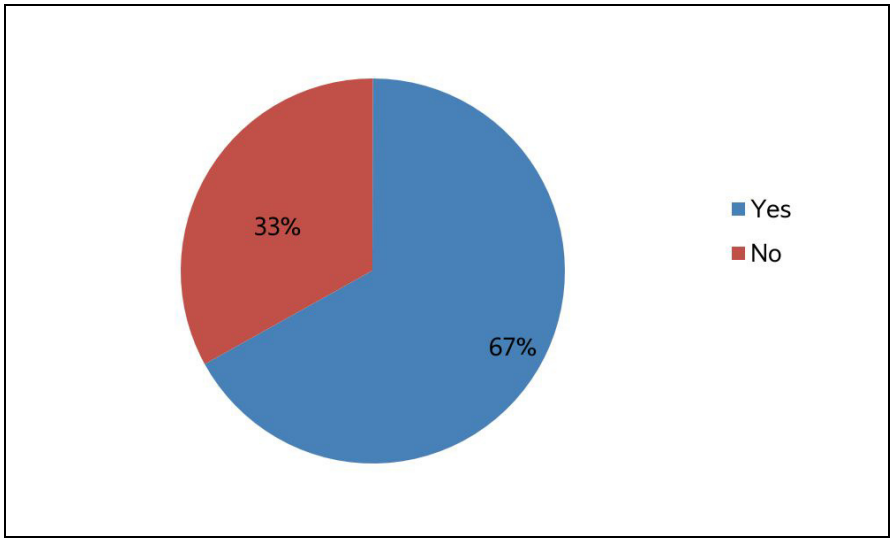

Figure 4: Distribution of responses concerning maintaining of dual fuel supply system

4.0 Conclusions

This section presents the conclusions related to LPG usage in vehicles. The study clearly shows that it is a male d ominated occupation with most of them having up to basic level of education. And because they were not able to further their education most respondents were advised by their parents to learn the LPG installation through appr enticeship training. The apprenticeship trainings were carried out in open garages which were not standard auto mobile repair workshops. This has affected the quality of apprentice trainees turned out which have significant in fluence on their work output when they graduate and establish their own garages or working under a master. The y lack the appropriate steps in installing LPG in vehicles and normally resort to trial and error approach based on their experience. However, to a large extent most of the LPG mechanics are not professional LPG installers rath er automobile mechanics carrying out LPG installation because that is a favourable job currently.

The study also indicated that there is no clear safety measures put in place during and after LPG installation in ve hicles. For instance detection of leakages is carried out by pouring soapy water along the laid gas pipe. This appr oach is not accurate to determine any leakage hence very risky when the vehicle is being used. In addition, most of the vehicles do not have any safety detectors installed in them. Most drivers said it was very difficult to detect leakage unless they smell the odour of the gas. This could also easily cause vehicular fire. The mechanics also d o not have a clear approach in determining the effectiveness and performance of the LPG fuel supply system inst alled unless through the sound of the engine, backfiring and jerking which could also be caused by other factors. Hence there is the need for standard conversion kits which could address some of these challenges.

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