

7. Reduce carbon emissions and cost of vehicle operation through the retrofitting of existing vehicles with Liquid Petroleum Gas (LPG) Systems.

SECTOR: TRANSPORT	
TECHNOLOGY: Reduce carbon emissions and cost of vehicle operation through the retrofitting of existing vehicles with Liquid Petroleum Gas (LPG) Systems.	
Introduction	When LPG is used to fuel internal combustion engines, it is often referred to as auto gas or auto propane. In Belize, it is called ‘butane’. LPG has been used since the 1940s as a petrol alternative for spark ignition engines. Research carried out in 2013 by Atlantic Consulting compared results for 1,251 models of bi-fuel vehicles and concluded that there was an average 11% CO₂ reduction when running on LPG compared to the identical cars running on petrol. [1] The research also indicates that LPG cars produce less Nitrogen Oxides (NO_x) than both petrol and diesel ones. In fact, when compared to diesel, five times less NO_x is emitted. LPG vehicles are significantly lower on particle emissions as well. Extensive independent tests showed that one diesel vehicle emits 120 times the number of fine particles as the equivalent LPG vehicle. It takes 20 LPG vehicles to emit the same amount of NO_x as one diesel vehicle. The above figures are sourced from the European Fuel Quality Directive which places LPG as part of the solution to decarbonizing the transport sector in Europe. [2] LPG has a lower energy density than either petrol or diesel, so the equivalent fuel consumption is higher but is one third the cost of regular petrol. This technology transfer intervention seeks to retrofit existing petrol (gasoline) vehicles in Belize to use LPG or butane, as it is called in Belize. The pilot will install butane kits on twelve (12) vehicles with V8 engines and twelve (12) vehicles with V6 engines. During the 12-month test, data on ease of use (convenience), fuel economy and vehicle performance will be collected and analysed.
Technology characteristics	LPG, also known as propane and auto gas, is a by-product of crude oil extraction and the refining process. Many people who consider LPG as an alternative to petrol do so because they believe that the combustion of propane results in lower CO₂ emissions. LPG burns cleaner than petrol and therefore emissions of particulates is very low. Moreover, LPG is non-toxic, non-corrosive and free of tetra-ethyl lead and additives. It also has a high-octane rating (The octane rating is a measure of how likely a gasoline or liquid petroleum fuel is to self ignite. The higher the number, the less likely an engine is to pre-ignite and suffer damage).

	Butane kits in Belize are currently offered in either manual or electronic type. The manual type as the name suggests – the user manually switches between using butane or regular fuel. The electronic type does the switching automatically. Note that the latter is more suited for late model vehicles that possess more electrical control engine management systems. [3] The kits include all necessary components including tubes, brackets, and storage tank, along with controllers and injectors. [3]
Costs, including cost to implement adaptation options	Currently the approximate cost to supply and install are as follows: Electronic Kit: BZ\$ 3,000.00 per vehicle Manual Kit: BZ\$ 2,500.00 per vehicle. Therefore, it will cost over BZ\$ 70,000 (US\$ 35,000) to install butane kits on the 24 vehicles to be placed under this pilot project.
Cost of not modifying the project	Continued use of petrol and diesel that emit at least 11% more carbon than when LPG is used.
Potential development impacts, benefits	Based on a 2008 statistic, there are approximately 175 vehicles per 1,000 populations. This translates to some 52,000 vehicles currently in operation in Belize. [4]
Economic	There are no statistics on the number of vehicles in Belize that have already converted to Butane. However, a proposed initiative to convert 15-25% of existing vehicles to LPG would create jobs for people to install and maintain these LPG systems. Other areas of potential economic benefits would come from the need to build more LPG refuelling stations. Lower operating costs would be beneficial to both the private and commercial sectors. See Table I below [6]. Note that from Table I, LPG is about 50% the cost of petrol [6]. Note that in Belize, LPG is closer to 45% the cost of petrol. As such the savings per annum in Belize is significant. Also, national cost savings arising from reduced imports of higher priced petroleum products would enable Belize to retain more foreign currency.

Table I: Example of LPG conversion cost savings (<http://tinleytech.co.uk>)**LPG Cost Savings**

A vehicle running on LPG will return slightly fewer miles per gallon than when running on petrol. However, the cost of running a vehicle on LPG will be about 40% less than the cost of running it on gasoline or diesel. Conversion costs can vary depending on vehicle type and tank arrangement required. Kit costs can be recouped in as little as 4,000 miles in fuel saving alone (based on Land Rover 2.25) [6].

LPG Cost Savings Example

	Fuel (Gasoline / LPG Diesel)	
Annual Mileage	20,000	20,000
mpg	34 mph	28 mph
Fuel Price	BZD 10.50/gallon	BZD 4.50/gallon
Fuel Cost p.a.	BZD 6,176.47	BZD 3,214.29

Saving in fuel cost alone BZD 2,962.18 per annum

(Source: Original cost savings example derived from <http://tinley.com.uk/>; TOMZA Ltd. LPG Converters, personal comm. Plant Director.)

Premium fuel and LGP fuel cost per gallon are July, 2017 rates in Belize.

Social

- (i) Increased income due to investment in LPG systems, employment through installation and maintenance.
- (ii) Capacity development of locals through training and capacity building in the use and maintenance of LPG systems.
- (iii) A better quality of life stemming from more financial freedom based on the lower operating cost of a private or commercial vehicle.

Environmental

According to the United Nations, road transport is the largest GHG emitter per kt¹ in the energy sector for Belize, and related emissions were 263.58, 275.94 and 330.55 kt CO₂ for the years 1994, 1997 and 2000, respectively. Road transport accounted for 44.2%, 44.6% and 51.4% of all energy-related activities countrywide, in the same reference years (May, 2007). [5] [7].

Vehicles converted to LPG will emit up to 11% less carbon than a similarly sized petrol vehicle. [1]; [6].

¹ Kt kiloton

Status	The technology and expertise currently exist in the country, but only on a limited scale. There are only two (2) known suppliers and installer of LPG conversion system. These are: LPG Gas from Spanish Lookout, Cayo District, and an unknown supplier/installer out of Shipyard Village in the Orange Walk District, northern Belize.
Barriers	i. Initial cost of the system. At a minimum of BZ\$ 2,500 per kit; this is outside the budget of many individuals. ii. A general negative public perception of using LPG. The fear of transporting a pressurized container with explosive contents. iii. Public ignorance about the potential cost savings from converting to LPG and fear of the damage it might do to their engines. iv. No national standards for installation and maintenance of LPG kits. v. Limited number of refuelling stations countrywide makes it inconvenient for the average customer.
Acceptability to local stakeholders	The main advantages of converting a vehicle to LPG are that they would emit less GHG, and are cheaper to operate and maintain. The technology's acceptability will be determined by the pilot project and promotion of the technology. It will also depend on whether the potential savings outweigh the innate fear of using LPG as stated previously. The LPGA Vehicle Conversion market has great potential in Belize because of the high cost of fuel, vehicle parts and the transport sector high carbon emissions.
Endorsement by experts	There are no known local experts that have endorsed this technology. However, international endorsements are evident from many sources, including: http://www.aegpl.eu/media/21020/atlantic%20consulting%20scientific%20review%20carbon%20footprint,%20ed.%202009.pdf http://tinleytech.co.uk/ http://www.go-lpg.co.uk/ http://www.drivelpg.co.uk/
Timeframe	The pilot project to install 24 butane (LPG) conversion kits would should be done within a 3-month timeframe and run for a minimum of 12 months. During these months data on ease of use (convenience), fuel economy (cost) and vehicle performance (power, maintenance) will be collected and analysed.
Institutional capacity	As stated previously, only two known suppliers and installers of such systems are presently known. While they may be enough to conduct the pilot project, there will be a need to encourage investments in the LPG engine conversion market.
Adequacy for current	Converting more petrol cars to use LPG will benefit Belize economically and environmentally. There would a reduction in the country's annual fuel bill and there

climate	would be a reduction in carbon emissions for these converted vehicles. However, the current investment climate needs addressing in the form of promotion and education about LPG conversion by relevant agencies such as CCCCC, Department of the Environment, and NGOs. More safety standards are recommended to put in place to ensure installations meet prescribed international standards. There should also be consideration for tax breaks and other incentives given to vehicle owners and companies that invest in an LPG conversion kit for their motor vehicles.
Size of beneficiaries group	Under the pilot project there will be 24 beneficiaries. The proposed LPG Conversion technology intervention will have benefits to 24 vehicle owners who are willing to participate in the pilot project, along with at least two LPG conversion/installation companies operating in Belize. Other beneficiaries could be one or two more companies that are will to invest in LPG Conversion market.
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