

The Future with LP Gas

Whether **energy needs** are in developing or developed economies,
LP Gas is a proven provider.

No citizen should be without access modern energy.

Governments can assist in our collective quest of making available a dependable, efficient,
environmentally friendly fuel by formulating consistent policies that encourage development.

Suppliers, investors and the World LP Gas Association (WLPGA) stand ready and welcome
the opportunity to build on the long history of the LP Gas industry to make the world's most
multi-purpose fuel available to everyone.

This is a publication of the WLPGA, **the international organisation that exists
to unite the broad interests** of the vast worldwide LP Gas industry.

The WLPGA's mission is to promote the use of
LP Gas as a clean, all-purpose and efficient fuel.



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LP Gas, A Clean and Multi-Purpose Energy for All





LP GAS : A CLEAN & MULTI-PURPOSE ENERGY FOR ALL

LP Gas was discovered in the early 1900s. Throughout the years thousands of applications have been developed to make use of this clean burning, all-purpose, readily available, and efficient fuel. Although the uses of LP Gas are widespread throughout the world, many are not as familiar with it as they are of the more familiar natural gas, electricity, gasoline (petrol), and diesel. Yet LP Gas provides the same benefits to consumers as these other energies safely and efficiently to tens of millions of everyday users.



What is LP Gas ?

Consider this : Only this single fuel, LP Gas, can serve such a wide variety of uses as cooking fuel for the family in Brazil and the restaurant owner in India, refrigeration for the shop owner in Ireland, Autogas for taxis in Tokyo, heat for the family home in Canada, flame weeding for the rancher in Texas, heat to provide lift for the first solo non-stop round the world balloon trip, hair spray for the Hollywood starlet, and life saving fuel for Mt. Everest climbers. Even the Olympic torch is LP Gas powered. That's is why it is sometimes referred to as the world's most multi-purpose fuel. This publication is intended to provide information on the multiple uses and recent developments of this reliable source of energy.

LP Gas (or LPG) stands for "Liquefied Petroleum Gas". It is the term widely used to describe a family of light hydrocarbons called "gas liquids". The most prominent members of this family are propane (C_3H_8) and butane (C_4H_{10}). Other members of the LP Gas family are ethane and pentane. These latter fuels have their own distinctive markets and are not further discussed here.

The term "liquefied gas" may seem a contradiction in terms since all things in nature are either a liquid, a solid or a gas. Yet, it is the unique character of LP Gas that makes it such a popular and widely used fuel. LP Gas at normal temperature and pressure is a gas. It changes to a liquid when subjected to modest pressure or cooling. In liquid form the tank pressure is about twice the pressure in a normal truck tire.

The reason LP Gas is liquefied is to make it easy and efficient to transport and store. One unit of liquid has the same energy content as 270 units of gas. If left as a gas the container to hold the fuel would be 270 times larger than what is required as a liquid. In other words, LP Gas has density (compactness) for storage and transportation, yet all the benefits of a clean vaporous fuel when used at the burner tip.

LP Gas usually consists of a mixture of propane and butane for standard heating and cooking purposes. Propane starts vaporising above $-45^{\circ}C$, so it is more versatile for general use. Butane starts vaporising above $-2^{\circ}C$ requires a propane/butane mixture in cold environments as it will not vaporise as readily as propane. LP Gas can also be used in specialised applications that require a more rigorous specification. Such applications include food processing, aerosol propellants and automotive fuel.

Where Does LP Gas Come From ?

LP Gas is a derivative of two large energy industries : natural gas processing and crude oil refining.

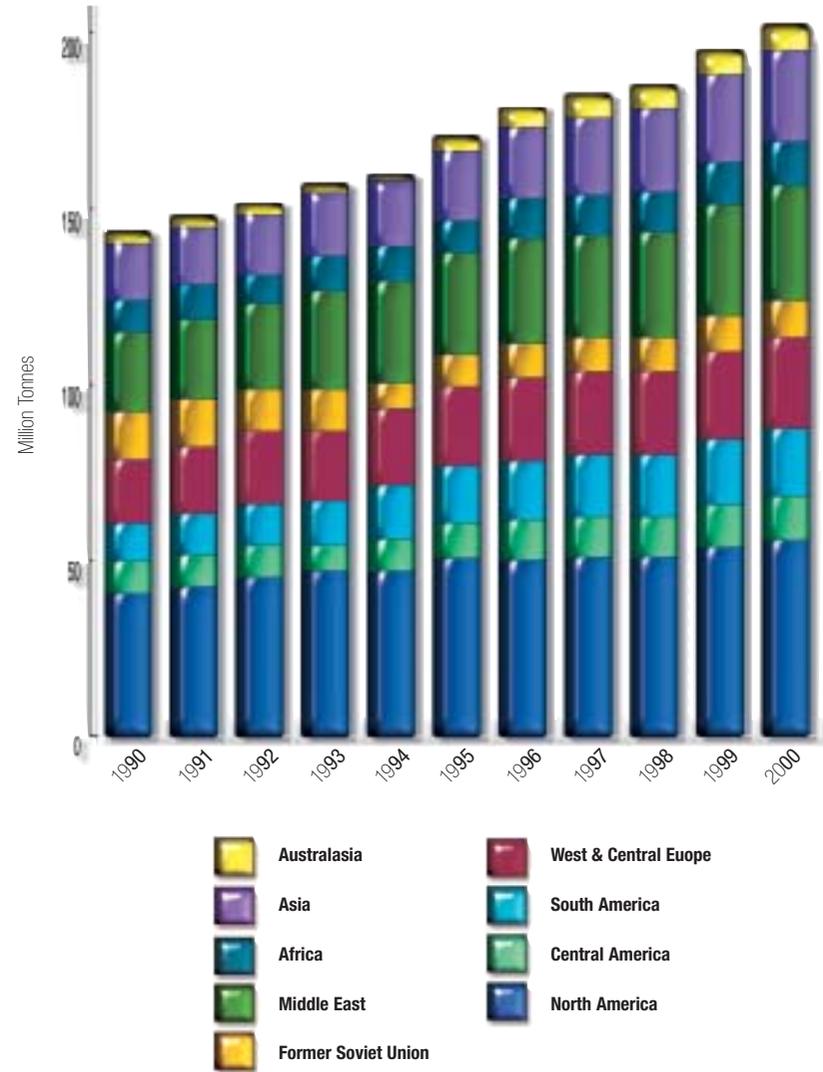
When natural gas is drawn from the earth, it is a mixture of several gases and liquids. Methane, which is sold by gas utilities as “natural gas” constitutes about 90 percent of this mixture. Of the remaining 10 percent, 5 percent is propane and 5 percent is other gases such as butane and ethane. Before natural gas can be transported or used, the LP Gases (which are slightly heavier than methane, the major component of natural gas) are separated out. Depending on the “wetness” of a producing gas field, gas liquids generally contain 1%-3% of the unprocessed gas stream. Some LP Gases are also trapped in crude oil. In order to stabilise the crude oil for pipeline or tanker distribution, these “associated” or “natural gases” are further processed into LP Gas. Worldwide, gas processing is a source of approximately 60% of LP Gas produced.

In crude oil refining the LP Gases are the first products produced on the way to making the heavier fuels such as diesel, jet fuel, fuel oil, and gasoline. Roughly 3% of a typical barrel of crude oil is refined into LP Gas although as much as 40% of a barrel could be converted into LP Gas. Worldwide, crude oil refining is the source for the other roughly 40% of LP Gas supplies although the ratio between gas processing and refining varies among regions.

LP Gas production from these sources is a natural derivative. That means production of LP Gas is assured since the primary motive for gas processors and refiners is to produce fuels other than LP Gas but first

the LP Gases are produced. Although tied to the production of natural gas and crude oil, LP Gas has its own distinct marketing advantages and can perform nearly every fuel function of the primary fuels from which it is derived.

Global LP Gas Production



LP Gas Operations

LP Gas Transportation and Distribution System

From natural gas and crude oil production facilities LP Gas moves by pipeline, rail car, barge, truck transport and local delivery truck to the ultimate user in specialized containers. Refrigerated ships deliver into equally refrigerated storage terminals in marine transport. Worldwide movement of LP Gas cargoes is a sophisticated, well-developed industry spanning more than 40 years. In most cases LP Gas is transported and is stored as a liquid. The only time LP Gas reverts to its natural vaporous state is prior to its end use.

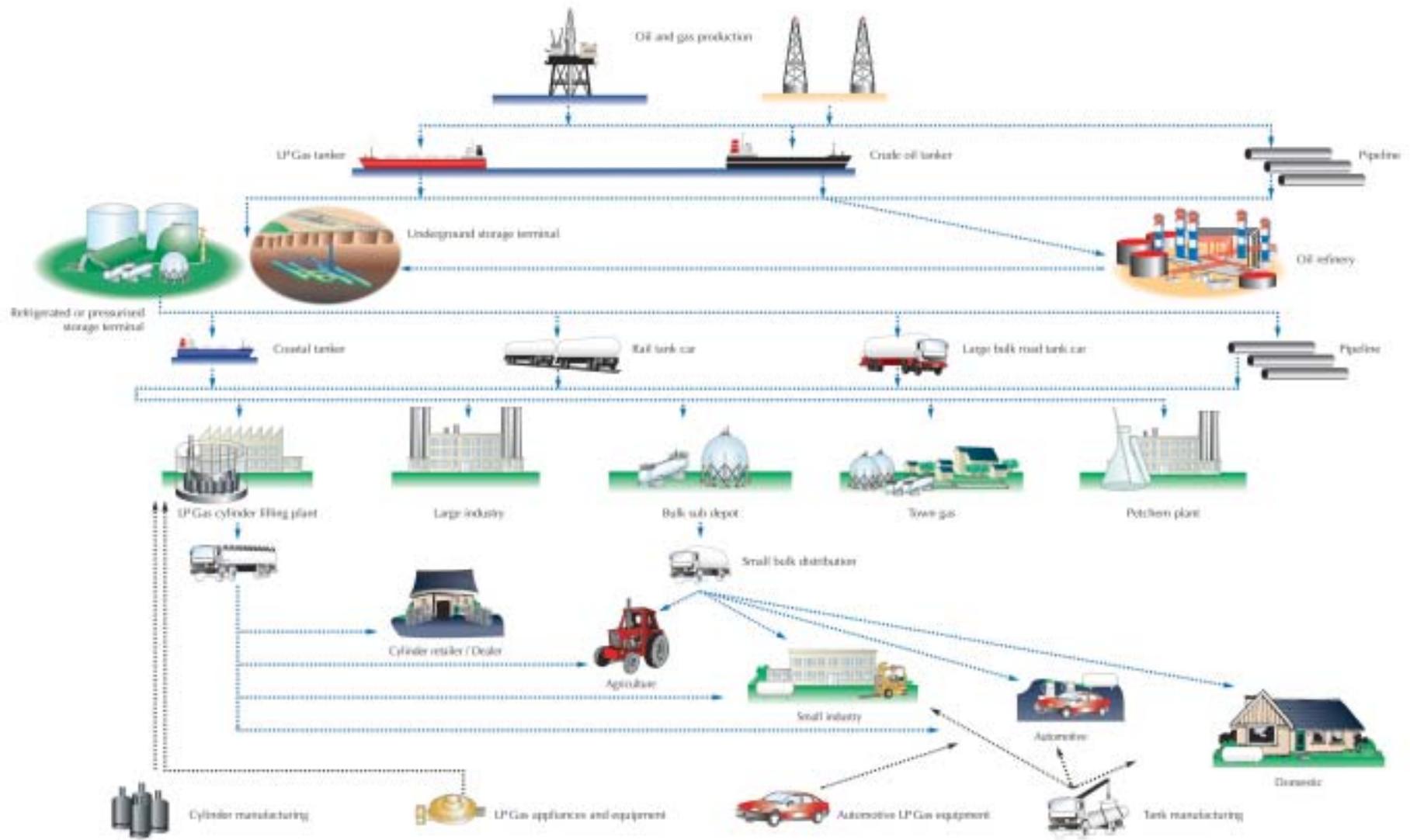


Storage Containers and Equipment

Customer storage can be as large as required or as small as practical. From simple decorative candles and butane lighters to huge underground caverns, storage requirements can be accommodated. Storage containers may be aboveground or underground depending on local codes and conditions. Worldwide, the most popular storage for small usage is 6-20 kilo cylinders or "bottles". Larger residential, commercial, agricultural and industrial users generally require tanks of 500 to 4,000 litres. Depots or terminals in the distribution chain use storage tanks as large as economically necessary to satisfy customer demand cost-effectively.



LP Gas Distribution Chain



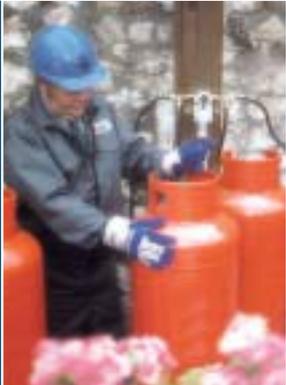


How Does the LP Gas Industry Work ?

LP Gas exists as a gas at normal atmospheric pressure and temperature, only existing as a liquid at low temperatures or under modest pressure.

Normally the gas is stored in liquid form under pressure in a container made either of steel or aluminium. Tanks are filled to no more than a recommended maximum liquid capacity allowing space for the LP Gas in liquid form to expand in response to changes in temperature. Therefore, the LP Gas within the tank is in both a liquid and gaseous state. As LP Gas in its gaseous form is drawn from the tank some of the pressure in the container is released. This causes some of the remaining liquid LP Gas to turn gaseous drawing heat from tank.

Because the pressure of the LP Gas in the container varies with the surrounding temperature, and because the pressure is much higher than is needed by the appliances that use it, a pressure regulator controls the flow to suit the appliance that is being fuelled. LP Gas draws heat from the surroundings in order to vaporise so it is important that the correct size of container is chosen which will satisfy the off-take all year round with varying temperatures.



LP Gas Codes and Standards

Production, storage, transportation, use and handling practices of the fuel and related equipment are subject to strict standards and regulations by many international, national and local authorities. Because of LP Gas' long history of use, codes and standards continue to evolve as new uses are found and new technologies are developed.

When properly handled and used LP Gas is a safe fuel. Characteristics of LP Gas include low flammability range, high ignition temperature, a fuel under pressure requiring sealed containers and fuel systems, immediate vaporisation upon exposure to the atmosphere, a foul-smelling, non-poisonous odour in case of a leak, and non-toxic. These inherent characteristics of the fuel itself help make it possible to experience all the benefits without incident.

From its earliest days founders of the industry recognized the unique properties of LP Gas and began developing standards and codes of practice even before 1920. As the industry grew and more uses developed constant attention has been spent on upgrading standards and regulations. Each new application and means of transport may require review so that codes and practices incorporate new technologies. Professional organizations and industry experts are constantly engaged to ensure safe practices for every possible application of LP Gas.

As with all forms of energy, LP Gas requires proper handling and use in order to avoid accidents. During its more than 80 years of providing heat, light and power, LP Gas can rightfully claim an excellent safety record. However, it is essential that those properly trained in safe practices handle LP Gas. Likewise customers should be aware of the basic characteristics of the fuel and how equipment operates. Of utmost importance is knowing what to do in case of an emergency. Education and awareness precludes incidences and their consequences. Those handling and using LP Gas should be properly trained.



LP Gas standards and codes embody the technical expertise of a mature industry that constantly seeks to improve its safety performance within all sectors of the industry. There are many such standards and codes referred to in the World LP Gas Association's joint publication with the United Nations Environment Programme entitled **"LP Gas Safety – Guidelines for Good Safety Practice in the LP Gas Industry."** Consideration should be given to adopting standards and codes which have achieved international recognition rather than undertake the laborious work of preparing new ones.

Major Uses of LP Gas

Choosing LP Gas as an energy source represents a valuable contribution to the ongoing fight to conserve energy and protect the environment. With a wealth of applications, LP Gas offers numerous ways to provide energy and combat pollution at the same time.

LP Gas has literally thousands of uses around the home, on the farm, in commercial business, in industry and transportation. Wherever heat, light or power is required, LP Gas can be used.

The residential and commercial markets where it is used for cooking, heating, water heating, drying, and refrigeration consume some 50% of the world total LP Gas retail sales. When LP Gas provides heat, power, and light together, the combined system is a very cost effective total energy source.

Residential

**Cooking • Central heating • Space heating
Hot water • Air-conditioning • Gas barbecue
• Patio heaters • Camping • Boats • Gardening
Swimming Pools • Clothes drying**



Commercial

**Heating (offices/premises) • Portable warm air blowers
Sanitary hot water • Fixed warm air heaters
Refrigeration • Radiant heating • Clothes drying
Swimming pools • Balanced flue heaters
Terrace heaters • Central heating
Air-conditioning**





Agriculture

Agriculture and horticulture industries around the world know that LP Gas is the “growing” fuel, not only the “green” fuel. Greenhouse heating, flame weeding, crop drying, waste incineration, and powering equipment are among the ways LP Gas works in agriculture.

Flame weeding • Crop drying
Greenhouses • Distilling

LP Gas as a Transportation Fuel

LP Gas is the preferred alternative automotive transportation fuel. Recognised early on in the search for viable alternative fuels, autogas is today the most important and accepted alternative fuel in the automotive sector with more than 7 million vehicles operating worldwide. There are reasons why LP Gas is so popular. Driving range is equivalent to gasoline, engines last longer, refuelling infrastructure is affordable, and in many countries the fuel is less expensive. Above its technical and economic advantages, LP Gas is clean and helps combat urban air pollution.

New hi-tech fuel systems work in consort with on-board emission control systems making it possible to meet even the most rigorous emission standards.



In industry metalworking, ceramic and glass, textile, paper, construction industries and many others use LP Gas. These industries value this fuel that provides controllable heat only where wanted and leaves no residue after combustion. Whether across the street or across the oceans, moving goods is widely dependent on LP Gas powered forklift-industrial trucks.

Industrial Applications

Ceramic manufacture • Glazing of pottery • Glass manufacturing • Metal heating and processing • Laundry • Painting (drying and curing) • Drying (cement, bricks) Cigarette lighter fuel • Pre-heating of material • Aluminium die-casting Laboratory (crucibles) • Remote emergency lighting • Thawing Pre-heating engines • Paint removal (burning) • Mobile & remote generators Clearing fog on airfields • Production of film • Feedstock for production of chemicals

Leisure Industry

Even the leisure industry is greatly dependent on LP Gas. Outdoor grill users prefer LP Gas because there is no messy charcoal to deal with, temperature control is instantaneous, and no residual fire that may harm some one or property. Whether for home, restaurants, or party venues patio heaters are commonly dependent on LP Gas. Even outdoor pest control is possible using LP Gas equipment.

Whether providing heat, light and power for the camper in a national park or for the climbers to the top of Mt. Everest, LP Gas is there.



Non -Fuel Uses :

Aerosols • Refrigerants

Major Benefits of LP Gas

LP Gas is Available

LP Gas is available now. There is nothing exotic to invent or improve. The transportation system that moves it is in place, the tanks that store it are available today. Annually, more than 200 million tonnes are used worldwide. LP Gas is derived from gas processing and crude oil refining. As long as oil and gas are the primary fuels on which our lives and economies depend, (a likely scenario for at least the next 75 years), LP Gas will be available.



LP Gas is Portable

Portable means it can be stored, transported, and used virtually any place on the globe. It has infinite “shelf life” which means that LP Gas does not deteriorate over time. Whether stored in large pressurized or refrigerated tanks, in cylinders for domestic and commercial use or in small butane cigarette lighters, its benefits are the same. It is the only fuel frequently used in remote locations principally because of its portability. The latter is also an advantage when considering capital costs. If end-use demand patterns change or cease, equipment can be easily moved to other sites.

LP Gas is sometimes referred to as a “pipeline on wheels” offering all the benefits of natural gas without infrastructure and capital cost constraints.

LP Gas is a Modern Energy

In developing and developed countries, LP Gas is an essential fuel. Access to modern fuels instead of relying on traditional fuels such as wood, dung or charcoal becomes a social issue when consumers are denied access to modern fuels and a healthy home environment. LP Gas is the perfect solution: available now, low cost access, dependable, and clean.

A compact basic heating, cooking, and lighting system supplied from a portable bottle gives the low-income family access to many of the basic living essentials of more affluent societies. Later, as economies grow and standard of living increases, refrigeration and electric power generation can be added. Ultimately a central distribution LP Gas system can provide all the basic necessities and conveniences for an entire community. Community planners will find they need not wait for the natural gas or electric grid systems to be installed in order to give citizens modern energy. Facing large capital outlays investors are reluctant to spend the money until there is sufficient energy demand. LP Gas can build load incrementally until the demand merits the investment in these utility infrastructures.

LP Gas is Friendly to the Environment

LP Gas is clean burning. In a world heavily impacted by environmental concerns, LP Gas stands above most fuels and can compete with the cleanest. It is clean burning because of its simple chemical make-up. When properly mixed with air to form a combustible mixture it produces virtually no soot (particulate matter), low carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx.), which are the basic precursors of ozone sometimes known as “smog”. Because LP Gas is stored and transported under modest pressure, the transportation and storage system is closed to the atmosphere preventing any evaporative emissions. LP Gas impacts greenhouse gas (GHG) emissions less than any other fossil fuel when measured through the total fuel cycle. LP Gas is colourless, odourless, tasteless, non toxic and contains no additives. Small amounts of an odourant are added to create a foul smell to aid in detection of leaks. In the event of a leak, LP Gas will readily vaporise and dissipate into the atmosphere and will not contaminate aquifers or soil as do most liquid fuels.

LP Gas is a Partner with Other Energies

Some energies are friendlier to the environment than others. Non-fossil fuels such as solar and wind are particularly friendly but have reliability limitations. Solar works only when the sun shines, wind machines only when there is wind. Both depend on

battery or thermal storage for non-functioning periods. Often this energy storage is unreliable or costly.

The flexibility of LP Gas makes it possible to partner with these other energy sources. When solar or wind are not producing energy, LP Gas can supplement the basic energy supply. Automatic switching equipment makes it possible to have LP Gas as a silent and reliable partner adding heat or power whenever needed. Both the environment and the customer benefit from this unique partnership.

LP Gas is a Partner in New Technologies

Technology for space travel now comes to earth in the form of fuel cells. Fuel cells create power and heat from fuels through a electrochemical process rather than burning. The cell converts the chemical energy of hydrogen and oxygen into electrical energy. The by-products of this process are water vapour and heat. Nitrogen oxides and sulphur emissions are negligible and greenhouse gases are less than half that of internal combustion engines. Because LP Gas (C₃H₈) contains hydrogen it is an excellent candidate for powering fuel cells.

Another advantage of fuel cells is the potential to achieve high-energy efficiency. That means extracting the maximum energy out of the fuel that feeds the cell. Generating electricity from the cell itself, then capturing the waste heat from the conversion process makes it possible to achieve an efficiency level of nearly 85%. Various fuel cell technologies are under development and some demonstration units are now operating. Although the fuel cell is not yet cost effective for residential and commercial use, the LP Gas industry is committed to supporting this technology by aggressively participating in several developmental projects.

Another exciting technology is the micro-turbine. This LP Gas powered device provides electric power by driving a generator and the exhaust heat can be used for either heat or cooling. Advantages of the micro-turbine over the typical internal combustion engine are low maintenance, long life, and low emissions while providing either portable or stationary power. Meanwhile efforts also continue to develop efficient LP Gas air conditioning and heat pumps.

