THE ROLE OF LPG IN HUMANITARIAN SETTINGS

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ACKNOWLEDGMENTS AND THANKS

The Role of LPG in Humanitarian Settings is an update of a document published in 2015 entitled the *Guide to LPG Use in Humanitarian Settings*. This latest publication highlights the need for a swift response to disasters when they occur and how LPG can provide this. It references recent humanitarian situations where LPG has provided immediate relief to millions of people during the past decade across the world.

The WLGA would like to thank everyone who participated in the original work and made valuable contributions. In particular, Glada Lahn (Chatham House), Ben Good (GVEP International), Paul Quigley (UNHCR), Kathleen Callaghy and Katherine Arnold (Global Alliance for Clean Cookstoves). Mr Makoto Arahata, Overseas Business Manager, Japan LP Gas Association, provided details of the impact of the 2011 Tsunami in Japan and the role LPG had in providing recovery services.

Finally, thanks to others, Zolboo Bold-Erdene, Energy & Environment, UNHCR Bangladesh, who provided the Foreword, and members of the HEEN working group who provided valuable input.

David Tyler, Director, WLGA, drafted this report and Michael Kelly, Chief Advocacy Officer, WLGA coordinated this project.

Foreword

UNHCR is pleased to support the WLGA with this report, which highlights the critical role of LPG in humanitarian settings worldwide. Today, more than **120 million people are forcibly displaced** due to persecution, conflict, violence, human rights violations and events seriously disturbing the public order. Among them, millions rely on solid fuels such as firewood and charcoal for cooking, leading to severe health risks, environmental degradation, and protection concerns—especially for women and children.

Access to clean cooking solutions is not just an energy issue; it is a public health, environmental, and gender equality imperative. The transition to LPG in humanitarian contexts has already demonstrated significant benefits, reducing household air pollution, mitigating deforestation, and enhancing safety by decreasing the need for women and children to collect firewood in insecure environments. However, despite these advantages, challenges remain, including affordability, supply chain reliability, and the integration of LPG solutions into energy policies.

UNHCR and its partners are committed to promoting the use of LPG in refugee and host community settings as a transitional approach pending the development of complete renewable energy solutions. This aligns with global climate commitments while improving energy access for displaced populations. LPG is already being used by thousands of families across refugee settlements in multiple countries, and efforts are underway to scale up its adoption through innovative financing mechanisms, public-private partnerships, and policy advocacy.

We welcome this initiative by the WLGA and look forward to collaborating more closely with governments, the private sector, and humanitarian actors to advance sustainable and equitable access to LPG for forcibly displaced populations worldwide.

Zolboo Bold-Erdene
Energy & Environment, UNHCR Bangladesh

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Executive summary

This document is one of a series published by the WLGA aimed at promoting the safe and sustainable use of LPG around the world (Simply Safety - World Liquid Gas (WLGA)). This subject addresses one of the most challenging situations that the world is facing today.

LPG – THE FIRST RESPONDER

This document sets out why and how LPG can provide immediate support to populations in need following natural and unnatural disasters.

The issue of humanitarian settings where populations face crises that threaten their lives and well-being. This might be caused by civil unrest and conflict, or natural disasters such as fires, earthquakes, volcanic activity and the consequences of extreme weather e.g. floods, and hurricanes (cyclones, tornadoes or typhoons).

The document sets out why and how LPG can provide immediate support to populations in need following these events. Case studies are included in Chapter Eight to illustrate this.

This document has been written with support from the Office of the United Nations High Commissioner for Refugees (UNHCR or UN Refugee Agency).

- Over 120 million people have been displaced from their homes by conflict and persecution
- This includes asylum-seekers, internally displaced people and refugees
- This is almost equivalent to the population of Japan
- Most rely on traditional fuels such as wood and charcoal as their primary cooking fuel
- Collecting traditional fuels causes serious social and environmental issues
- Burning traditional fuels creates serious indoor air pollution which can kill
- The UNHCR is a United Nations programme mandated to protect and support refugees
- LPG is a proven alternative to traditional fuels and is being used in some refugee camps
- There is an opportunity to increase the use of LPG for cooking and heating in this sector
- LPG can also provide immediate support to populations threatened by natural disasters
- Apart from providing meals and warmth, LPG can be used to provide power
- LPG has a big role to play in supporting populations in humanitarian settings

At the end of June 2024, over 120 million people, almost equivalent to the population of Japan, were displaced from their homes by conflict, violence, human rights violations or events disturbing public order. That equates to one in every 67 of the world's population.

The Office of the United Nations High Commissioner for Refugees (UNHCR), or UN Refugee Agency, is a United Nations programme mandated to protect and support refugees at the request of a government or the UN itself. It assists in their voluntary repatriation, local integration or resettlement to a third country. It was created in 1950, during the aftermath of the Second World War, to help millions of Europeans who had fled or lost their homes.

The firewood collected is often the small saplings that have no chance to mature (source: LPGas Business)

When these humanitarian events occur, help is required immediately. Sometimes the assistance is needed for weeks or months – after an earthquake or hurricane – at other times it may be needed for years – during civil conflicts.

Many of the people affected are living away from their homes, in remote communities with little or no access to modern energy. They rely on traditional fuels – such as wood and charcoal – as their primary cooking fuel.

Collecting this fuel is dangerous, time consuming and causes deforestation, especially as the wood is often small saplings which have no opportunity to mature. In parts of the world this also causes desertification that has an impact on farming and biodiversity.

Burning wood creates serious indoor air pollution. This is unhealthy and in some cases life threatening. The World Health Organisation (WHO) estimates that 3.2 m people die from indoor air pollution every year (Household air pollution). The burning of wood is also very inefficient.

This document presents the case for LPG to provide both the quick support needed by populations in the immediate aftermath of natural disasters – as the first responder – and also the longer term support required in prolonged situations where there may be conflict.

This report describes the case for LPG and provides a proposition for change. It also addresses how to deal with populations that have been forcibly displaced, and how to meet their basic energy needs, and what are the challenges facing the authorities that are responsible for them.

The Moving Energy Initiative (MEI) claim that refugees and internally displaced persons (IDPs) overwhelmingly use traditional biomass (primarily firewood) and kerosene to cover their basic energy needs and this is unsafe, unhealthy and inefficient. They carried out an energy survey in 2015 in the Dadaab refugee camps in Kenya which demonstrated this. The

research paper - The Energy Situation in the Dadaab Refugee Camps, Kenya - edited by Stephen Okello (GVEP International) Energy, Environment and Resources Department, was published in May 2016. https://www.chathamhouse.org/sites/default/files/publications/research/2016-05-19-mei-energy-situation-dadaab-refugee-camps-okello-final.pdf

According to UNHCR data at the time of the survey, there were 351,538 refugees and 83,277 households in the whole of Dadaab. This was at the time the fourth largest population centre in Kenya. Almost all the refugees used firewood as their main cooking fuel. The firewood rations distributed by the UNHCR covered only 10% of a household's monthly firewood demand, forcing them to procure tradition fuel from other sources. MEI concluded '…there is a demonstrated need for a more sustainable source of energy for the refugees…'

LPG can displace traditional fuels for cooking with significant benefits. Almost 50% of global

The collection and use of wood for cooking is one of the causes of desertification where a relatively dry land region becomes increasingly arid, affecting vegetation and wildlife (source: WLGA)

LPG demand is in the residential sector where it is used mainly as a cooking fuel (source: WLGA Statistical Review of Global LPG 2024 - Argus Media).

The Moving Energy Initiative (MEI) is a collaboration between GVEP International, Chatham House, the Office of the United Nations High Commissioner for Refugees (UNHCR), the Norwegian Refugee Council (NRC) and Practical Action Consulting. The MEI seeks to identify how innovation in policy and practice within the humanitarian sector can improve access to sustainable energy among displaced populations and camp operators. Funded by the United Kingdom's Department for International Development (DFID), the initiative seeks to develop, research and test appropriate sustainable energy solutions, as well as innovative delivery models for energy solutions.

Cooking with firewood is often the only option available to refugees (source: LPGas Business)

The increasing use of LPG in households is one of several pathways to meet the objective of universal access to clean cooking and heating solutions by 2030.

This is one of the three pillars of the UN Sustainable Energy for All (SE4All) initiative, along with doubling the global rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix.

In 2012, the WLGA launched the 'Cooking For Life' campaign to communicate the health benefits of switching communities from wood, charcoal, coal, dung and other traditional fuels, and kerosene, to LPG for cooking.

In October 2013, SE4All and the WLGA announced the goal to transition one billion people from traditional fuels to LPG.

To secure this, they agreed to support a multi-stakeholder partnership that would build on best practices and sustainable business models. The aim was to overcome the multitude of policy, market regulation, business environment and local financing bottlenecks inhibiting the ability of governments and the private sector to meet the need for LPG.

LPG is a clean-burning, efficient, versatile and portable fuel. It is a by-product from the refining of crude oil as well as, when natural gas is 'wet' and contains liquids, through the production of natural gas.

LPG is up to five times more efficient than traditional fuels. It produces less air pollutants than kerosene, wood or coal, about 20% less CO_2 than heating oil and 50% less CO_2 than coal; it also reduces black carbon emissions.

LPG can be transported in small or large quantities by sea, rail or land. Small quantities with as little as a few kg can be easily carried in cylinders, enabling the LPG to be used in the most remote and rural areas. However there has to be an LPG infrastructure in place to allow that to happen.

LPG has a very good safety record, but it is highly flammable and needs to be handled according to good safety practices.

It is hoped that this document will provide stakeholders with some encouragement and ideas to consider LPG as a safe alternative to traditional fuels and kerosene, especially for those people who have been forcibly displaced, either through conflict or natural disasters.

Refugee camps are temporary structures, often with limited services (source: UNHCR)

In 2020, the Global Platform for Action on Sustainable Energy in Displacement Settings (GPA) and Safe Access to Fuel and Energy (SAFE) Humanitarian Working Group structures agreed to join forces to strengthen the link between global and field levels and improve knowledge and expertise sharing among practitioners. The Humanitarian Energy Exchange Network (HEEN) was launched on 28th April 2021. The HEEN is the central platform for coordination and collaboration between humanitarian and development agencies working on improving sustainable energy access of displacement-affected communities at the country or regional level.

The document is seen as a first step towards securing partnerships between the LPG industry and organisations involved in managing these humanitarian settings, with the aim of replacing traditional fuels with LPG.

Communal cooking with LPG – source: Hindustan Petroleum, India (source: LPGas Business)

LPG being transported by boat in flood hit Bihar, India (source: Energy Asia)

01

Background

- The total number of displaced people in the world is equivalent to the population of Japan
- Most are burning traditional cooking fuels such as wood, charcoal and kerosene
- Transitioning to LPG would bring health, social and environmental benefits
- The LPG industry can work with the UNHCR and other organisations to achieve this
- LPG can also provide immediate relief to populations impacted by conflict and natural disasters

1.1 The Need for this Document

The purpose of this document is three-fold:

(i) It seeks to further the argument for LPG as an immediate solution for providing support to populations in natural disaster areas caused by civil conflict or extreme weather conditions

(ii) It presents the case as a long term solution for populations to transition away from traditional fuels in humanitarian settings, such as refugee camps

(iii) It aims to provide an understanding for stakeholders in the LPG industry of the challenges and opportunities for providing LPG into these communities

As the global organisation representing the LPG industry, the WLGA is committed to promoting the use of LPG as a clean and healthy alternative to traditional fuels such as firewood, charcoal, coal, animal waste and kerosene.

LPG is recognised as a very versatile and portable form of clean modern energy. Almost half of the global demand for LPG is in the residential sector where it is used as a cooking fuel and for heating homes and water.

Modern energy services are crucial to the well-being of individual health and a country's economic development. According to the International Energy Agency (https://www.iea.org/), 1.2 billion people are without access to electricity and more than two billion people are without clean cooking facilities.

More than 95% of these people are either in sub-Saharan African or developing Asia, and around 80% are in rural areas.

These people have to rely on traditional fuels as their primary source of heat for cooking. This results in health, economic, social and environmental issues. The use of wood and charcoal is also a major contributor to deforestation and desertification.

Many of these people live in remote rural areas, well away from the modern grid networks of electricity and natural gas, and are also on restricted incomes. Some live in peri-urban areas, on the outskirts of cities, often in slum areas.

An increasing number of the world's population is being forcibly displaced as a result of wars, conflicts or persecution. The UNHCR estimate that over 120 million people, or one person in 67 of the world's population, were displaced from their homes by conflict and persecution in 2024. Add to that number the people impacted by natural disasters such as fires, earthquakes, floods and tsunamis.

Although the UNHCR have refugee camps where LPG is already being used (refer chapter 8.1), traditional fuels - such as wood, charcoal and kerosene - are frequently the only forms of energy available.

Indoor air pollution kills 3.2m people annually (source: LPGas Business)

In addition to this, when natural disasters suddenly hit inhabited areas, power lines and piped gas networks are often damaged and supplies of electricity, water and gas are interrupted.

The portability of LPG, enabling it to reach even the most inaccessible locations, makes it an ideal and proven alternative to traditional fuels. Its versatility, and easily controlled, clean and powerful flame, is ideal for cooking, heating and providing light.

When used with gas powered generators, LPG can also provide electricity to the most remote areas.

Two of the challenges of providing LPG to refugee camps and areas hit by natural disasters are cost and availability. These and other issues will be explored in this document. Some examples of how these challenges have been overcome will be described in case studies.

LPG power generators can be small 1kw units or larger truck mounted ones (source: WLGA)

1.2 Who is the Audience for this Document?

There are two main audiences for this document.

The first audience comprises organisations who are responsible for, or involved in, managing populations who have been forcibly displaced as a result of wars, conflicts or persecution, and those affected by natural disasters. It is hoped that this audience can learn more about what LPG is, and how it can play a major role in immediately addressing some of the issues that are associated with energy shortages, and the use of traditional fuels. Especially in refugee camps and areas affected by natural disasters. The document includes brief details of where the larger refugee camps are, how many people are affected, and what resources they currently have.

The second audience for this document comprises stakeholders in the LPG industry who may not be fully aware of the scale of the humanitarian issue, and how, for example, refugees are coping with basic needs like as cooking food, heating water, and in some cases providing heat in their rudimentary accommodation.

1.3 The Traditional Fuel Challenge

According to the World Health Organisation (WHO) over two billion people today are still without access to modern energy. They rely on traditional fuels such as wood, charcoal and coal. Even animal waste and rice husks. In fact, anything that can generate heat and be burned is a target fuel for these impoverished people. The more fortunate amongst them will use kerosene. But kerosene is hazardous to store around the home.

The majority of people who rely on traditional fuels live beyond the reach of natural gas and electricity grids, leaving LPG as the only real opportunity to use a modern fuel.

LPG is a proven alternative to these traditional fuels and an obvious candidate for providing rapid clean energy during emergencies, especially from humanitarian settings following natural and man-made disasters.

Indoor air pollution kills 3.2m people annually (source: WHO)

1.4 The Case for LPG

The ease of handling, cleanliness, energy concentration and portability of LPG means that it can be an essential benefit to people who have no access to modern fuels, and it can transform their lives.

With LPG, there is no need to spend many hazardous hours a day collecting firewood, especially for the woman and children, who are normally tasked with that job.

Using LPG removes the frustration of trying to light a fire with damp fuel on a wet day.

The appalling polluted air inside the kitchen, caused by the burning of these traditional fuels, along with the health risks affecting an entire family, can be stopped.

There is no need to sustain the wood fire throughout the day to cook the evening meal because LPG stoves can be turned on and off when required. There is also evidence of LPG stopping gender-based violence when it displaces wood as a cooking fuel (WLGA's Geneva Highlights: Engaging with UNHCR, IOM, and UNITAR - World Liquid Gas (WLGA)).

There is a high risk of fire in the home when cooking with wood (source: LPGas Business)

Kitchens that use solid fuel require storage areas that must be designed to keep the fuel dry, especially during winter months or monsoon seasons. These are vulnerable to theft.

Kerosene is frequently purchased in small quantities, often in soft drink bottles creating a risk of accidental poisoning (source: LPGas Business)

Using kerosene brings its own hazards, especially to children, as it is often stored in bottles that resemble water or soft drink containers (see picture above). Kerosene can be mistakenly drunk by children and this is one of the most common causes of paediatric poisoning (Lang, et al., 2008). Kerosene is also highly inflammable and poses a serious fire risk when used carelessly.

Using LPG can still make a compelling case even if there is access to a gas grid or a reliable electric power supply. By mixing LPG with air to match the combustion characteristics of natural gas (WLPGA SNG INFOGRAPHIC) allows LPG to be used in support of natural gas grids.

Synthetic Natural Gas = LPG + Air (source: WLGA)

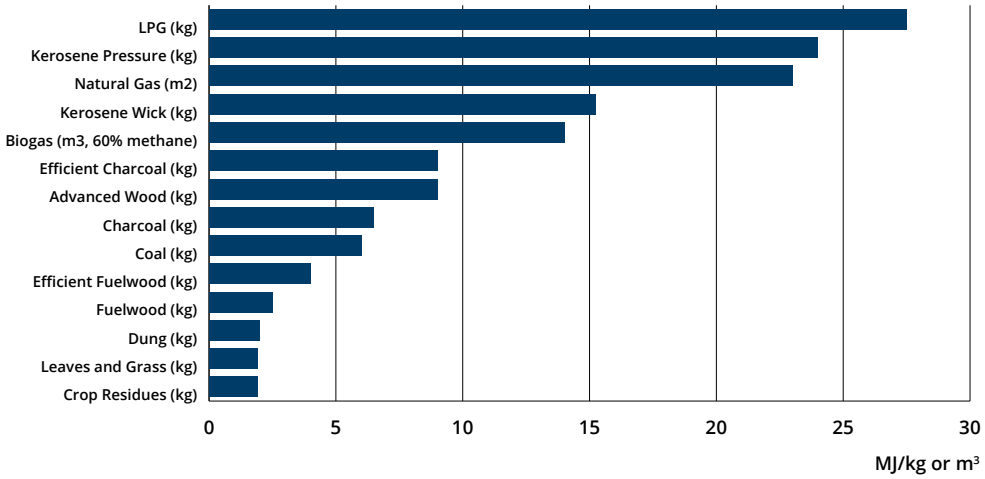
LPG has a very hot flame which is easily controlled. It can be used with both woks and simmering pans, and is very clean, both to use and burn.

If a natural disaster does occur then whole infrastructures are taken out leaving populations with no energy, no fresh water and no food.

The versatility of LPG allows it to be not just used as a cooking fuel. It can also be used for portable room heating, for fuelling engines to generate electricity for refrigerators and lighting, and for transporting goods and people. LPG powered pumps can also access fresh ground water from deep, uncontaminated, below ground, sources.

The table above shows some indicative energy values for various types of fuel and LPG typically always leads when comparing gross energy content. If the relative efficiencies of the stoves are taken into account, the gap is

COMPARATIVE ENERGY TABLE WITH DIFFERENT FUELS



Source: O'Sullivan and Barnes, 2007 in World Bank, 2011

wider. An LPG stove can be quickly shut down when not in use. Unlike traditional stoves that have to be kept alight to sustain the fire, wasting energy and generating unnecessary emissions.

The pressure required to liquefy LPG is relatively low allowing it to be stored in convenient pressure vessels designed for moderate pressure.

These pressure vessels are generally made of steel but more recently, the use of composite plastics has been used to reduce the weight of the container, resist corrosion, and in some cases allow for the contents to be seen.

For bigger operations LPG can be supplied in larger cylinders, or if the demand warrants it, small bulk tanks.

Large cylinder installations are designed to ensure continued operation even if one of the cylinders becomes empty.

This is done by having a changeover device that detects when one set of cylinders are becoming empty and switching across to the full ones automatically, maintaining continuity of supply (see the figure below).

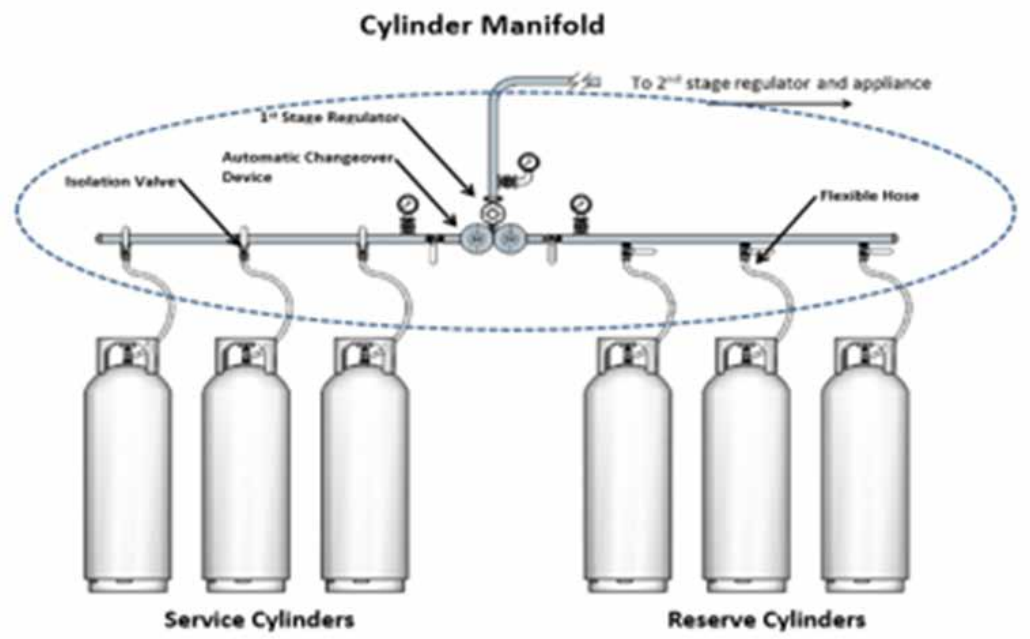
Small bulk tanks are installed when the demand is high, and they are accessible by LPG road tanker.

Important properties of LPG are included in APPENDIX ONE.

Many of the traditional fuels have to be frequently mined, collected or gathered by women and children in often dangerous circumstances.

The mining of coal has a long history of injuries and deaths associated with bringing it to the surface. The subsequent transportation, storage and combustion of coal creates challenges to human health. Especially when used in old and poorly designed equipment.

Traditionally, the collection of wood in the household is done by women and children. It is a dangerous and painstaking task that starts early in the morning and can take several hours. As outlined in the CCA's Statistical Snapshot: *Access to Improved Cookstoves and Fuels and its impact on Women's Safety in Crises* (331-1.pdf), several organisations, including the CCA, have found that women and children spend up to five or six hours a day collecting firewood and are being subject to violence and exposed to danger from wild animals.



Larger LPG cylinder storage facilities with an automatic changeover device (source: LPGas Business)

There are other consequences that impact on the social and economic aspects of the family. Very young children are left at home by their mothers with other family members, often the grandparents. Some parents take their younger children with them to collect wood, impacting their schooling and education.

When these fuels are burnt, they are often used in open stoves that release damaging emissions in the cooking environment. This results in respiratory and cardiovascular related infections and diseases to those in contact with the smoke.

The use of firewood is also a major risk for burns, especially with children, and a possible cause of homes being destroyed by fire.

In addition to this, it is often young trees that are taken, undermining the future of the forests.

Charcoal is very inefficient to manufacture, wasting energy even before it is used. Because it is relatively light and easy to carry, children are frequently asked to collect charcoal, making them vulnerable to assault and theft.

The traditional LPG distribution channel is well established and involves trained and professional people delivering the LPG to the consumer (see Appendix Three).

In the case of a communal kitchen, the demand will be relatively high probably requiring either a small bulk tank or a bank of large cylinders.

LPG is very clean to store and use. A small leak of LPG will disperse, whereas a leak of kerosene emits an odour, and is a safety hazard.

These same properties enable LPG to be used in the aftermath of natural disasters, caused by extreme weather such as earthquakes and cyclones, to reinstate vital services and provide food and fresh water.

Women carrying wood (source: WLGA)

Woman burning wood (source: WLGA)

Children buying charcoal (source: LPGas Business)

LPG is commonly recognised in cylinders but it can also be provided from small bulk tanks (source: LPG as Business)

02

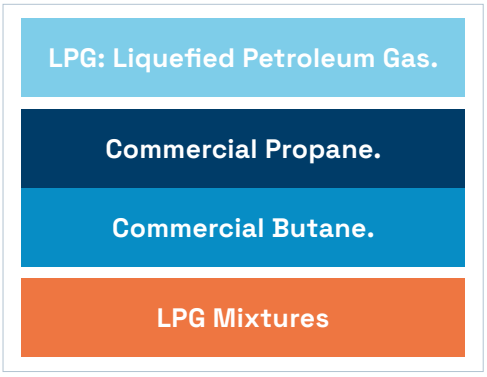
LPG – an Exceptional energy

- LPG is an exceptional energy, providing many benefits when compared to traditional fuels
- All forecasts suggest there will be plentiful supplies for the foreseeable future
- Renewable LPG is also being developed securing a sustainable future for the product
- LPG is available in most of the countries where there are displaced people and disasters
- Countries that have a history of natural disasters have established LPG supply chains

2.1 What is LPG?

Liquefied Petroleum Gas (LPG) is propane, butane or mixtures of the two. Propane and butane are chemically very similar but have different properties, making them suitable for different applications (see Appendix One).

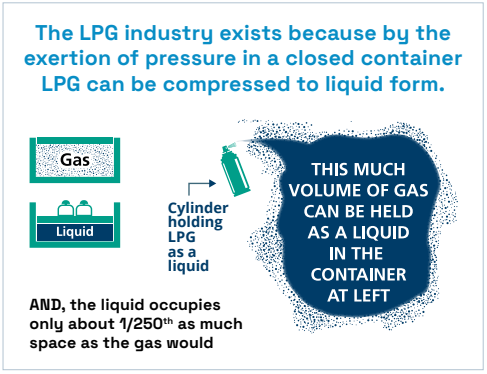
LPG can be easily compressed to a liquid under modest pressure and stored in cylinders. This enables it to be transported and used in remote areas that cannot be reached by natural gas or the electricity grid.



LPG is part of the natural gas family (source: LPGas Business)

When that pressure is released, by operating a cook stove for example, the liquid LPG in the cylinder will boil and produce a vapour or gas. One unit of liquid will produce around 250 units of gas, which illustrates how powerful LPG is in liquid form.

LPG is easy to ignite, and its flame can be controlled across a wide range, which is necessary for cooking. The quality of traditional fuels varies greatly depending on the source, composition and condition but LPG has a very consistent composition and quality.



LPG is an extremely powerful energy (source LPGas Business)

2.2 Where does it come from?

LPG is a by-product of the crude oil refining process and can also be extracted from natural gas production. Today there is an increasing amount of LPG being produced from natural gas which underpins its long-term availability.

North America and the Middle East are the two largest LPG producing regions, but the industry is well equipped with very large gas carriers (VLGCs) to transport LPG to the major demand centres around the world.

The USA is now the world's largest exporter of LPG, larger than any of the Middle Eastern producing countries. This turnaround (the USA was a net importer of LPG just a few years ago) has been driven by the huge discoveries of shale in the USA.

The logistical infrastructure is in place to transport LPG from the major producing countries to the regions where there are opportunities for developing new LPG markets.

VLGC Lycaste Peace was the first LPG vessel through the Panama canal's new locks in July 2016 (source: Panama Canal Authority)

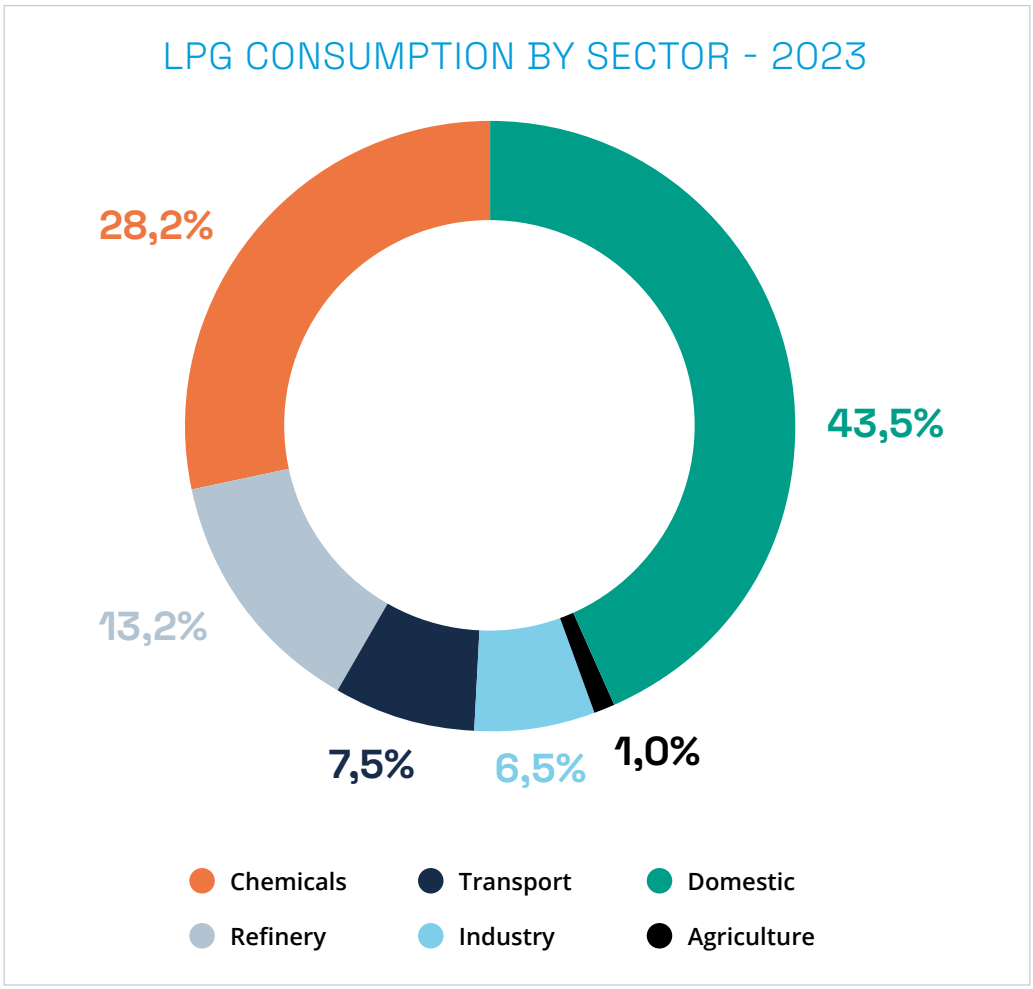
The opening of the new Panama Canal in July 2016, which is large enough to accommodate VLGC's, has opened a gateway from the USA to the large and fast-growing markets of Asia.

The trade flow map in Appendix Two illustrates that availability is no barrier to transporting LPG to the demand centres of the world.

2.3 How does LPG fit into the Global Energy Picture?

Although LPG is technically a by-product, it plays an important role in the world's energy picture.

Around 360 million tonnes (mn t) of LPG were consumed in 2023 with almost half being used in the domestic (residential) sector.



LPG used in domestic (residential) applications, cooking and heating, is the largest sector (source: Global Statistical Review 2024 - Argus Media/WLGA)

The second largest sector is the chemicals industry where LPG is used as a feedstock for manufacturing plastics. Here it competes with naphtha, one of the derivatives of crude oil. It is this link with crude oil that has historically driven a correlation between world crude oil and LPG prices.

There are hundreds of other applications for LPG in the commercial, industrial, agricultural and transport (automotive) sectors. LPG is used for transport because it is a very good engine fuel, with an octane rating higher than gasoline (petrol). About 8% of all the LPG consumed in the world is used in road vehicles, as an alternative to diesel and gasoline.

In the context of other energy forms, total LPG consumption is equivalent to 10% of global coal consumption, 11% of natural gas consumption, 42% of nuclear energy consumption, 42% of the world's hydroelectricity consumption and 140% of the world's liquefied natural gas consumption.

2.4 Where is it used?

It is estimated that over two billion people use LPG globally, in one application or another. From cigarette lighters to cook stoves. The ease in which LPG can be stored, handled and distributed enables the infrastructure to be installed relatively quickly and efficiently.

LPG is already used in most countries of the world where LPG infrastructures exist. This enables quick and easy access to LPG in most countries following a humanitarian crisis.

One of the main drivers of LPG demand is Gross Domestic Product (GDP) and there is a close correlation between GDP per capita and LPG consumption per capita.

The charts in 9.2 show where LPG is being used in the world and the per capita consumption by country. These heat maps provide a good indication of where the infrastructure exists for storing and distributing LPG and where the opportunities are for further development of LPG demand.

LPG is produced in refineries and natural gas production facilities. Where local production is unable to meet country demand, imports supplement the remaining or total supplies needed.

Sea fed LPG imports require land-based storage together with facilities to fill cylinders and move the product in bulk. A list of primary storage facilities by country provides another illustration of the scope of LPG penetration. This is shown in Appendix Four.

03

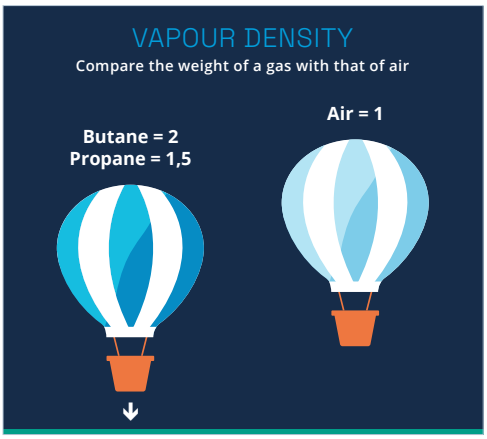
Key Properties of LPG

- LPG is ideally suited for use in refugee camps and areas hit by civil conflict and natural disasters
- Apart from cooking it can also be used for heating, transport, power generation and pumping water
- LPG is easy to use, although first time users will need some education and basic training
- Involvement of all stakeholders in the change process is important

3.1 Description of Key Properties and Characteristics

LPG becomes liquid at room temperature if moderately compressed and reverts to a gaseous form when the pressure is sufficiently reduced. This gives it a considerable advantage over other fuels because it can be easily transported and stored in the liquid state. Some general properties of LPG are included in Appendix One.

One important property of LPG is that in its vapour form it is heavier than air. If LPG leaks, it will always fall towards the ground rather than dissipate into the air. LPG should therefore never be stored below ground and always be kept in a well-ventilated area.



LPG vapour is heavier than air

LPG is portable, enabling it to reach the most inaccessible areas. LPG has a high calorific value enabling it to provide energy to a number of households at the same time.

In liquid form LPG is lighter than water. A full domestic LPG cylinder, weighing typically 30kg, will float. This was most evident during the Tsunami in Japan where storage tanks, road tankers and cylinders were seen floating amongst the debris after the tsunami had struck.

Storage tanks containing other forms of energy such as gasoline (petrol) and diesel were rendered useless after the tsunami in Japan. The distribution channel, including storage tanks and road tankers, became contaminated with water and created an environmental danger as the fuel spilled out.

Because LPG is stored under pressure, any leak will disperse without creating an environmental mess. In Japan, after the tsunami, LPG was one of the only forms of energy that was available and useable.

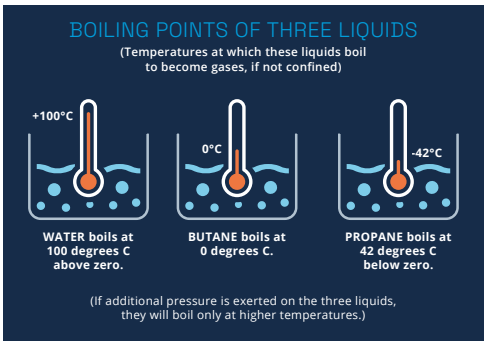
LPG has a much higher calorific (heat) value than traditional fuels such as firewood, charcoal, biomass, kerosene etc. It is also clean burning, creating no particulate matter, has a very low sulphur content and burns very efficiently.

Because LPG is lighter than water the cylinders floated after the tsunami in Japan (source: LP Gas Association of Japan)

Propane boils at around minus 42 degrees centigrade which makes it more suitable than butane for cold climates. Butane boils at zero degrees.

The flame temperature of LPG is very high, making it an ideal cooking fuel. Because it burns within a narrow range, the risk of unintended ignition is reduced.

Liquid LPG has a high co-efficient of volumetric expansion which is why cylinders should never be completely filled. An ullage, or space, around 20% if the container's total volume, is left in the container to allow the liquid LPG to expand when the temperature rises. This is especially important in the event of a fire.



Propane can be used in circumstances where there are very low temperatures

Unlike natural gas (methane), which does not liquefy unless compressed at high pressures, or is chilled, LPG can be easily delivered in small quantities by road tanker at ambient temperature.

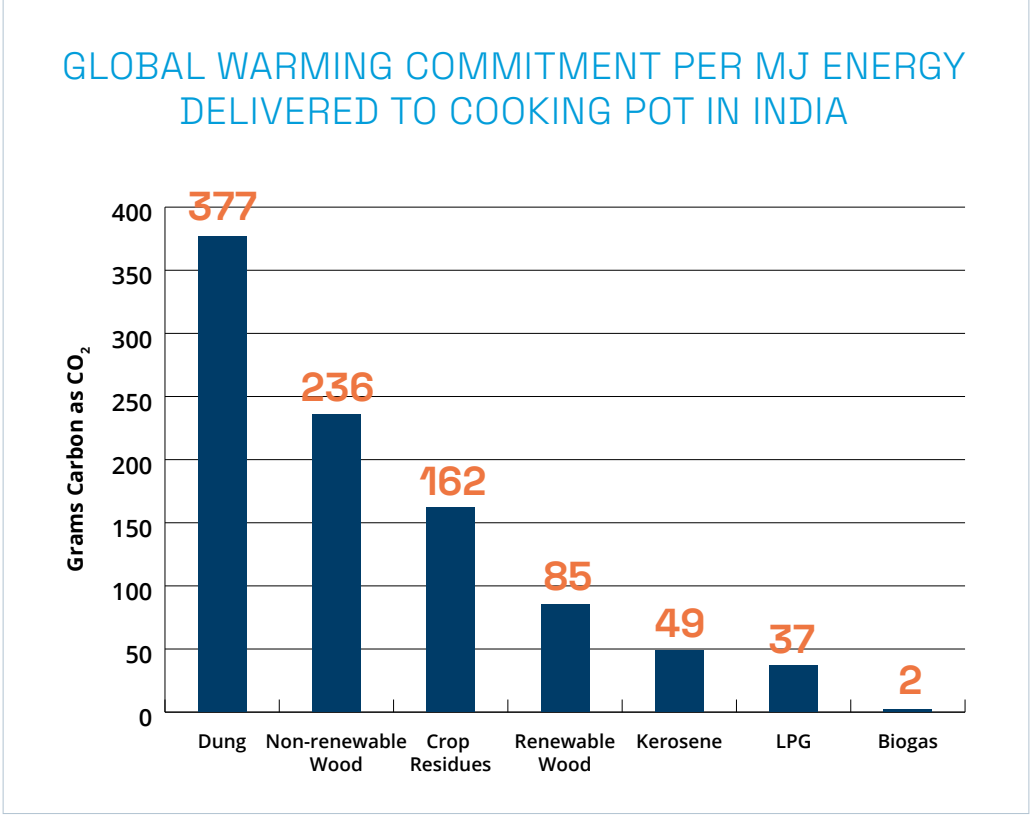
The global warming commitment per mega joule (MJ) of LPG is significantly less than other fuels according to Dr. Kirk Smith et al (see the illustration on the left).

Unlike traditional fuels, which are very visible, LPG is a gas. Consumers see a pile of logs deplete but they cannot see the contents of a steel LPG cylinder deplete.

This can be managed with education, but it has to be considered when transitioning away from traditional fuels.

The introduction of composite cylinders has allowed consumers to see the level of the contents through the translucent body.

LPG is non-toxic, environmentally friendly and very safe when used properly.



Global warming commitment of different fuels (source: K Smith et al 2000)

3.2 How these Key Properties and Characteristics Impact on the Use of LPG

Everyone involved in handling and using LPG needs to be trained on basic LPG product knowledge and safe handling to increase safety awareness and avoid malpractices, which can result in accidents. Below are some safety tips to be aware of.

LPG containers (cylinders and tanks) should never be overfilled. It can lead to the container being subjected to hydraulic pressure resulting in the pressure relief valve lifting to relieve LPG. This is a hazardous situation that should be avoided.

The maximum fill level is dependent on climatic conditions of the location. Typical figures would be 85% for small bulk tanks and 80% for LPG cylinders.

LPG is stored under pressure meaning that any small gaps or pinholes can cause LPG to leak out. Pipes must never be stepped on, or used to hang kitchen equipment and other objects that may create undue force on.

LPG can be detected by means of its 'rotten egg' odour. It is odorised in such a concentration that even the presence of a small amount of LPG is discernible by smell. Gas valves should be closed immediately once LPG is detected by smell and all ignition sources should be put out.

Soapy water should be used to check for leaks in the piping system. It should be applied on all joints and hoses. The presence of bubbles indicates a source of leak. Naked flames should never be used to search for leaks.

When appliances are disconnected for servicing or removed to clean the area, the connection should be checked for vapour tightness when those appliances are reconnected.

The design and shape of cooking utensils should match the burners used. A burner where the flame exceeds the base of a pan wastes heat and energy.

Appliance gas valves should always be closed when the appliance is not being used and when LPG is not used for an extended period of time.

When using an appliance without a spark igniter, the lighter or match must be lit before opening the appliance gas valve to avoid an accumulation of LPG vapour which could cause a flash fire.

Never leave the cooking appliance unattended with the flame on.

Keep the cooking area well-ventilated to dispose of products of combustion. Ensure there is a sufficient supply of air for combustion. Some kitchens may be equipped with an exhaust fan which needs to be turned on before cooking begins.

Cylinders should always be used in the upright position. Never shake the cylinder or turn it upside down in an attempt to draw out residual LPG.

When converting from traditional fuels to LPG a suitable space should be allocated for the LPG installation. The location must comply with safety standards so as not to pose a hazard to people in the building as well as the surrounding community.

LPG installations should preferably be outdoors. The space required will depend on the size of the installation. Cylinder installations will typically require a smaller footprint than bulk tank installations.

Where cylinder installations are allowed by law to be indoors, they must be in an isolated section of the building and ventilated to outside air. The installation must comply with all safety requirements.

The location of the LPG installation should be accessible to delivery trucks, particularly bulk storage facilities. Deliveries can take a few minutes to an hour depending on the quantity of LPG to be unloaded. This should be considered when selecting a site to avoid inconvenience to occupants of the building and to minimise any risks during delivery. When designing the storage facilities, the need to reverse the vehicle should be avoided.

The installer is usually the person qualified to assess the suitability of a space for the LPG installation and to give recommendations to meet the safety requirements.

LPG appliances do not emit smoke or other toxic fumes that can be hazardous to individual health. They must, however, be placed in a location with sufficient ventilation to disperse the elements of combustion. Such elements consist mainly of carbon dioxide and water vapour. This minimises any risk of the build-up of carbon monoxide and asphyxiating (oxygen deficient) conditions.

There are many types of LPG appliances available that can meet the different needs of the consumer i.e. cook stoves, ovens, water heaters etc. The right appliance should be chosen for consumers to optimise the benefits of switching to LPG.

Only appliances that are certified, and/or meet applicable standards or regulations, should be used. Uncertified appliances may pose a risk.

The LPG appliance chosen must be compatible with the grade of LPG used. The installer must be consulted regarding any adjustments to be made on the appliance.

LPG appliances should preferably have an automatic igniter and a flame failure device. The latter is a safety feature that cuts off the flow of LPG to the burner in the event the flame is extinguished for some reason (i.e. blown out by weather) to avoid the discharge of unburnt gas.

Insufficient air will result in yellow tipping of the flame. Too much air will cause the flame to lift. It is the appliance installer's responsibility to ensure there is adequate supply of air for combustion and for the comfort and safety of the occupant.

It is recommended to get the LPG appliances installed and serviced by an approved installer.

04

A Global Energy

- LPG supplies are growing by 3-4% a year, with its growth rate expected to continue
- Nearly half the global demand for LPG is in the domestic (residential) sector
- Many countries still have very low usage levels on a per capita basis
- International LPG prices have been relatively stable during the past 18 months

4.1 Overall Supply and Demand Picture

Some of the questions often asked by governments when discussing LPG as an option to their energy policy are ‘is there going to be much LPG available in the future?’, ‘will it be affordable?’ and ‘is LPG sustainable?’.

This chapter tries to address those questions in the context of the opportunity for displacing traditional fuels with LPG into a potential market the size of Japan.

LPG is a by-product, and global demand is driven by supply. Historically, LPG supplies have grown consistently at around 3% to 4% a year. With 2024 volumes at around 360 m metric tonnes (mn t), this adds around 15 mn t of new LPG supplies to the global market every year.

LPG production occurs across the world, but the USA and the Middle East are the largest producing regions. The ease at which LPG can be transported allows the product to flow to the markets where the demand lies. The map shown in Appendix Two illustrates this.

4.2 Future Outlook for LPG

With the increasing discoveries of shale related gas in the USA, together with the new natural gas fields continually being discovered around the world, the outlook for LPG supplies is good.

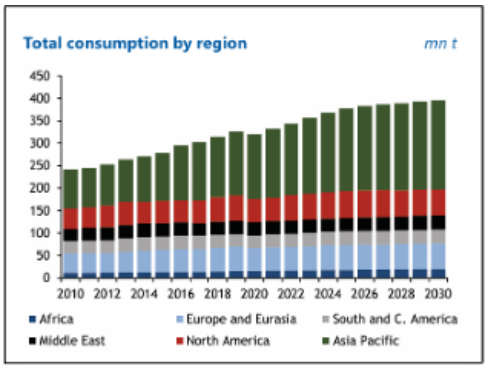
Historically supplies have grown by 3-4% per year and most forecasts are predicting similar growth over the foreseeable future. There is likely to be more LPG produced from natural gas than crude oil in the future.

This is leading governments to confidently plan LPG into their future energy strategy. Controversies over the use of diesel – with the WHO in 2012 confirming that diesel emissions are a proven group one carcinogen to humans, coupled with the VW emissions scandal – has led governments to act against the use of diesel in urban areas.

This has not only opened up opportunities for LPG as a replacement for diesel, but it is also confirming governments' views that LPG is clean.

Against this background of plentiful supplies, coupled with government endorsement, the future for LPG as a clean alternative to traditional fuels looks positive.

Most of this forecast of increased production is expected to come from the USA, the Middle East and Asia/Pacific regions with the USA likely to remain the world's largest exporting country.



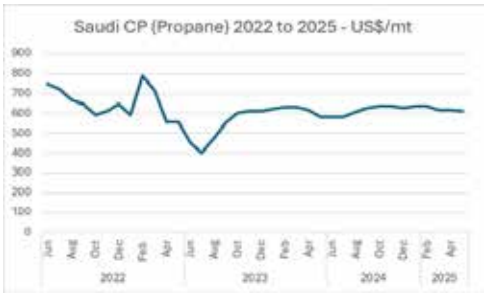
LPG consumption grew at around 4% in 2023 across all regions to reach around 360mn t (source: Statistical Review of Global LPG 2024 – WLGA/Argus Media)

4.3 What Drives the Price of LPG?

The international price of LPG is set on a monthly basis and one of the most common methods has been to use the Saudi Arabia Contract Price (CP). CP is announced at the beginning of each month in US$/t. The CP is a 'free on board' (FOB) price, meaning that freight, insurance and other costs will be added to determine the final price at the LPG cylinder filling plant.

There are other pricing mechanisms, but all have been trending downwards and stable over the last couple of years to levels not seen since 2000.

This chart illustrates how the CP for propane has changed over the last three years. Three years ago the international price of LPG was around US$1,000/metric tonne (t), but during the last 18 months prices have fallen to around US$600/t and remained steady.



Recent CP trends (source - GEA)

Predicting prices is very difficult but the hope is, with the assumption of continued plentiful supplies and stable conditions, that these prices could continue into the foreseeable future.

Cost has been a barrier for the challenge of transitioning people from traditional fuels to LPG, but the possible continuity of low prices for LPG is good news for the industry and consumers.

4.4 How can LPG compete with other Forms of Energy?

Despite the falling, and stable, price trends, one of the challenges for LPG is that traditional fuels are often purchased in very small quantities for little outlay, or they may even be obtained at no cost.

Another challenge for LPG is that when consumers purchase it for the first time there is also the initial cost of the equipment – cylinder, hose, regulator and appliance (cook stove). This can be over US$40 depending on the size of the cylinder.

Compare this to a primitive wood stove that might consist of three rocks, and a free supply of wood.

The initial cost of the various energy options hides the actual cost of cooking a meal. LPG burns very efficiently and can be turned on, turned down or turned off, very easily. Wood fires are often sustained during the day in order to cook later meals, wasting energy when not being used.

If the wood or charcoal is wet, traditional fuel stoves are not easy to light, and keep alight, but LPG stoves can be easily ignited and turned off. Also, the efficiency of an LPG stove compared to a traditional stove is much higher.

Despite these advantages, the cost of transitioning from traditional fuels to LPG for most people is beyond their reach. This is due, not only to the upfront cost of the initial equipment, but the ongoing refill cost.

There have been several initiatives to break down this entry barrier and two of those, the Community Kitchen and the Darfur project, have been included in Chapter Eight.

Following a pilot programme in Southern China in the 1980's when consumers switched from using coal briquettes to LPG, they were reluctant to revert to coal. Instead, they would continue to use LPG, albeit sparingly, by supplementing with other fuels. This is called 'fuel stacking'.

Firewood is sometimes obtained at no cost (source: LPGas Business)

05

Humanitarian situations

- There are over 120 million displaced people in the world
- The UNHCR has a mandate to support refugees
- Organisations like the Clean Cooking Alliance (Home | Clean Cooking Alliance) also provide support
- Over 85% of refugees are in low- and middle-income countries that are close to situations of conflict
- Many use traditional fuels as their primary energy
- Transitioning them away from traditional fuels would alleviate their situation

UNHCR mid-year report – 2024 (Document - UNHCR - 2024 Mid-Year Trends report - October 2024)

UNHCR's 2024 Mid-Year Trends report reflects on the first six months of the year, and covers the main displacement, statelessness and durable solutions figures covering the first half of 2024.

The report shows that at the end of June 2024, UNHCR estimates that 122.6 million people remained forcibly displaced worldwide due to war, persecution, violence and human rights violations. As a result, one in 67 people worldwide remained forcibly displaced, 71% of them in low- and middle-income countries.

The main drivers of forced displacement in the first half of 2024 were the conflicts in Sudan, the Democratic Republic of the Congo and Myanmar, the war in Ukraine and worsening gang violence in Haiti.

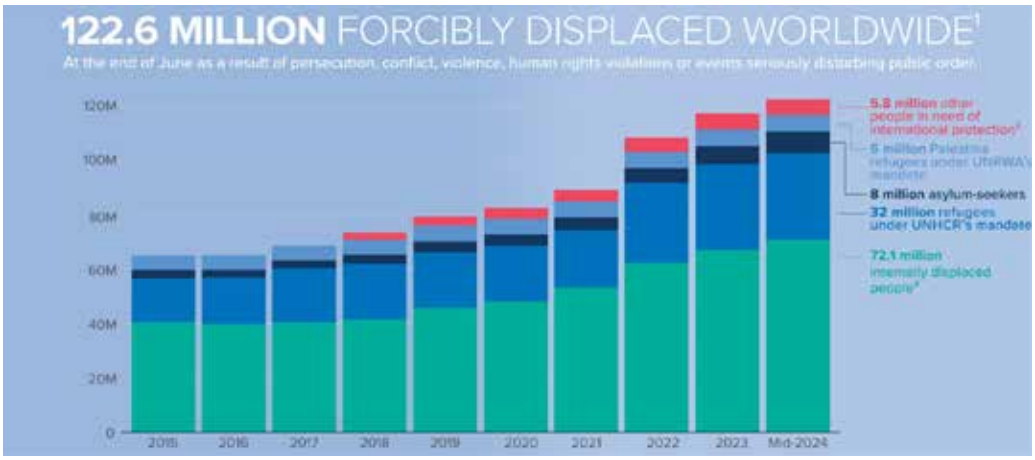
The UN High Commissioner for Refugees, Filippo Grandi, said *"…more people are being displaced by war and persecution, and that's worrying in itself, but the factors that endanger refugees are multiplying too…"*; *"…at sea, a frightening number of refugees and migrants are dying each year; on land, people fleeing war are finding their way blocked by closed borders…"*

The report said that forced displacement has been on the rise since at least the mid-1990s in most regions, but over the past five years the rate has increased.

For more than 12 years, the number of people remaining forcibly displaced by persecution, conflict, violence, human rights violations and events seriously disturbing public order has continued to grow, reaching an estimated 122.6 million by the end of June 2024. This represents an increase of 5%, or 5.3 million, compared to the end of 2023, primarily reflecting rising internal displacement in several countries and the growing backlog of asylum applications.

UNHCR estimates that forced displacement has increased further since June 2024, and barring rapid positive developments in one or more large displacement situations, will continue to rise.

While the spotlight in 2024 was on Europe's challenge to manage more than one million refugees and migrants who arrived via the



Forcibly displaced people 2015-2024 (source: UNHCR)

Areas of conflict over the last 15 years that have been driving the refugee problem (source: UNHCR)

Mediterranean, the report shows that the vast majority of the world's refugees were in developing countries in the southern hemisphere.

Secretary - General António Guterres said *"…we are witnessing a paradigm change, an unchecked slide into an era in which the scale of global forced displacement as well as the response required is now clearly dwarfing anything seen before…"*

The UNHCR report details how, in region after region, the number of refugees and internally displaced people is on the rise. In the past five years, at least 15 conflicts have erupted or reignited: eight in Africa (Ivory Coast, Central African Republic, Libya, Mali, northeastern Nigeria, Democratic Republic of Congo, South Sudan and Burundi); three in the Middle East (Syria, Iraq, and Yemen [see Appendix Four]); one in Europe (Ukraine) and three in Asia (Kyrgyzstan, Myanmar and Pakistan).

The report notes *"…few of these crises have been resolved and most still generate new displacement…".*

In the EU, the biggest volume of asylum applications was in Germany and Sweden. Overall, forced displacement numbers in Europe totalled 6.7 million at the end of the year, compared to 4.4 million at the end of 2013, and with the largest proportion of this being Syrians in Turkey and Ukrainians in the Russian Federation.

Africa's numerous conflicts, including those in the Central African Republic, South Sudan, Somalia, Nigeria, Democratic Republic of Congo and elsewhere, together produced immense forced displacement totals in 2014.

In all, sub-Saharan Africa saw 3.7 million refugees and 11.4 million internally displaced people, 4.5 million of whom were newly displaced in 2014. Ethiopia replaced Kenya as the largest refugee-hosting country in Africa and the fifth largest worldwide.

Asia has been one of the world's major displacement producing regions. Continuing displacement was seen in, and from, Myanmar. Iran and Pakistan remained two of the world's top four refugee hosting countries.

The Americas also saw a rise in forced displacement. The full Global Trends report with this information and more, and including data on individual countries, demographics, numbers of people returning to their countries, and available estimates of stateless population is available at (Document - UNHCR - 2024 Mid-Year Trends report - October 2024)

5.1 Types of Humanitarian Settings

One of the focuses of this document is on the plight of refugees in camps. However, there are similar challenging situations to be found with populations living in the peri-urban slum areas of major cities in developing countries and those that suffer from natural disasters.

According to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) nearly 100 million people have been affected by natural disasters (source: OCHA).

The common denominator with all these situations is that the people affected by these humanitarian settings all need to cook food to survive. The fuel available to most of them is traditional fuel such as wood, charcoal and kerosene. This might be because of cost, or it might be that traditional fuels are the only form of energy available in the circumstances they are in.

The effects of tsunamis can be even more challenging than the situations faced by refugees, with unchecked diseases and wrecked infrastructure. Tsunamis strike with little warning and the consequences can be devastating when power lines and gas mains are severed. The situation is probably not dissimilar to a war zone. Survivors need assistance very quickly and there is little time to plan.

The peri-urban areas of some major cities present their own challenges which are on-going. A lack of proper sanitation due to poor water supplies and no sewage brings health risks to the communities. Illegal power lines create a constant fear of electrocution and fire, with poor housing that exposes the residents to such hazardous elements. In addition to this, there is the need for food and fuel to cook meals.

Night brings darkness and the absence of electrical power limits any activities unless some other form of artificial light is available. Primitive kerosene lamps might be the only option, but these pose their own threat with the risk of fire from spillages.

The impact of the tsunami in Japan caused massive devastation (source: Japan LP Gas Association)

Some refugee camps have been supplied with solar lanterns which are not only safer but provide light at no cost.

Natural disasters such as tsunamis are fortunately relatively uncommon events but wreak havoc when they do occur.

Recent events around the world have shone a spotlight on the refugee crisis with so many people suffering the trauma of being forcibly displaced from their homes, especially in Africa and the Middle East.

But the tsunamis that hit Asia on 26th December 2004 and Japan on 11th March 2011, highlight that not all the humanitarian situations are caused by man, and no region is safe. Nature too can devastate a community anywhere.

Conditions in some of the world's slum's create immense challenges too (source: LPGas Business)

In slum areas the only fuel is sometimes waste newspapers (source: LPGas Business)

Conditions are challenging with small children to look after (source: WLGA)

The impact on the estimated 120 million population having to be forcibly removed from their homes is massive. One of the fundamental objectives for families in this situation is to make sure they can find a way to feed themselves and their families. Finding food, and a means to cook that food, can be a daily challenge.

In tsunami-stricken areas this can be an almost impossible task, with lines of communications down and energy supplies severely interrupted or simply washed away.

Unlike refugee numbers it is difficult to obtain accurate data on the slum areas of cities. The challenge of dealing with these people and providing them with the basics of life remain huge in some countries.

The apparent ever-growing plight of refugees has been well documented and the scale of the problem appears daunting.

Lighting from a kerosene lamp made from string and an old beer can (source: LPGas Business)

The UNHCR has very good data available on refugee camps and although the information might be disheartening, it presents the opportunity for change. Refugee camps are by nature temporary structures, although some have been in existence for many years, and many have also grown with demand. The changing boundaries of dispute might also mean moving populations.

Host governments are clearly not willing to encourage longevity with the camps which makes the supply of sustainable services more of a challenge.

This document is focusing on the supply of energy but there are many additional needs that must be met.

5.2 What Essentials are needed in these Situations (Water, Food, Clothing, Light, Heat Etc.)

The UNHCR list a number of needs for the refugee camps that they are administering, and providing energy is just one item on the long list. This document is focused on the opportunities for LPG, but they stretch far beyond cooking.

Apart from providing the opportunity for a clean and efficient cooking fuel, the versatility of LPG can also make a big difference to a facility with no heating or main source of electricity.

Electric power also provides light and the opportunity to use refrigeration to improve food hygiene. Gas hot water systems also bring improvements in personal hygiene and in the kitchen.

Removing traditional fuel from the kitchen might be one of the biggest challenges but it will create the largest benefits. The kitchen may be part of the living quarters in a single dwelling or in a central facility. Emissions from traditional fuel in this situation also impacts the living quarters.

USAID (Food Security Interventions among Refugees around the Globe: A Scoping Review - PubMed) reported in 2022 that more than 80% of refugees may have missed their meals several times, even when food exists, because of the lack of fuel to cook with.

The dynamics of supply and demand for energy services to displaced people are diverse and complex. The situation varies between rural and urban settings. UN agencies and those leading humanitarian responses share differing levels of responsibility with governments and implementing partners depending on the context.

It is difficult to compare services available in upper-middle-income countries such as Jordan, Lebanon or Iran with those in low-income countries such as Burkina Faso or Uganda. The country of origin and former standard of living of the displaced people in question also make a difference. For example, Syrian refugees will use energy equipment differently from that of internally displaced people (IDP's) in the Central African Republic.

Also, the method of payment will differ. The UNHCR encourages a market economy in camps where refugees can buy what they need. The introduction of vouchers within refugee camps has encouraged this market concept.

In Chad, the roofs of refugee huts are traditionally made of straw. Since the closure of the Chad/Central African Republic (CAR) border, commerce has collapsed, and refugees struggle to find enough straw for their cattle on the local market, and resort to feeding their animals with the straw from their roofs. The UNHCR distributes plastic sheets to enable a temporary solution.

Although water can be drawn from the ground using hand pumps, in some countries, like Bangladesh for example, the water can be contaminated. By drawing water from deeper sources, it is possible to go below the contaminated levels. Hand pumps are unable to recover water at these depths and so electric pumps are used. Pumps driven by LPG power generators can make this achievable.

LPG can be supplied to a dwelling either independently or as part of a reticulated system. The fundamentals of providing LPG to a kitchen are set out in the WLGA Guide for LPG in Commercial Kitchens.

Refugees in camps can be supplied with LPG in each home through the use of cylinders, or if the circumstances allow, it can be reticulated through a piped network. LPG cylinders can be swapped or exchanged when empty but reticulated supplies will require some form of metering in order to measure the amount used per family.

Reticulated systems might be an option if the facilities and refugee camps appear to be semi-permanent.

LPG generators, powering electric water pumps can assist with sourcing deeper fresh water supplies (source: UNHCR)

5.3 The Role of LPG in Humanitarian Settings - INFOGRAPHIC

The following infographic describes the key role of LPG in a humanitarian setting and can be accessed here: [WLGA - The Role of LPG in Humanitarian Settings]

THE ROLE OF LPG IN HUMANITARIAN SETTINGS

AS AN EFFICIENT, PORTABLE, SAFE AND RELIABLE FUEL, LIQUID GAS, INCLUDING LPG, PLAYS A KEY ROLE IN HUMANITARIAN AID, BOTH IN THE SHORT AND LONG TERM. IT IS USED FOR A WIDE VARIETY OF LIFE SAVING APPLICATIONS AND AS A PORTABLE COOKING FUEL IT ENABLES IMMEDIATE FOOD PROVISION WHICH IS A KEY PRIORITY IN THE AFTERMATH OF A HUMANITARIAN EVENT.

FOOD
LPG is one of the most used cooking fuels in the world. Following a crisis, it is used for large scale food provision or by families in temporary accommodation

HEATING
LPG can be used to provide heating in common or individual spaces using large scale heating systems or individual heaters

POWER GENERATION
When power networks are down, LPG-powered generators can provide power for lighting, communications or medical services

EMERGENCY EQUIPMENT
LPG is used to power a variety of equipment utilised by first responders including emergency lighting, water pumps, blow torches, pressure washers, hammer post drivers and burners

SANITATION
One of the major risks following disasters is the outbreak of diseases or epidemics. LPG can be used to boil water and mobile LPG-powered units provide on-site incineration to mitigate this risk

WATER PUMPS
LPG-powered water pumps provide access to and distribute water following disasters

TRANSPORTATION
Autogas (LPG as a fuel for vehicles) can quickly provide transportation fuel in affected areas where the supply of traditional transport fuels has been interrupted

ECONOMIC RECOVERY
In the medium to long term, LPG provides efficient off-grid energy that can help kick-start economic recovery

FORKLIFTS
LPG forklifts provide vital lifting capacity that is crucial for getting aid to where it most needed

WHY LPG?

PORTABILITY
LPG can be transported in cylinders or in bulk supplies. The type of vessel can be selected depending on the specific needs of the crisis

SPEED
LPG can be transported quickly by rail, road, waterways, and air, or even carried by people, pack animals, carts and bicycles

SAFETY
When used correctly, LPG is safe, and its applications are simple and easy to use

VERSATILITY
LPG can be used for a range of applications. The same cylinder can be used to provide energy for cooking, power generation, water pumps and lighting

AVAILABILITY
LPG is globally available in large volumes and can be sourced from large port terminals to local distributors

EFFICIENT
LPG is efficient and due to its energy density, packs a big punch in a small volume

SCALE
The supply of LPG can be scaled up quickly and is not limited by the capacity of existing energy infrastructure

STORAGE
LPG can be stored on-site for extended periods, which can be critical if road access is impacted by seasonal climate conditions

CONSERVATION
The availability of LPG for cooking and heating can avoid short term deforestation caused by the collection of firewood

FAMILIARITY
Both first responders and those impacted by crises tend to be familiar with LPG and in most cases no additional awareness or training is required

CLEAN
In disaster-stricken areas, where the air quality is already compromised, using LPG helps in minimising further pollution to maintain a healthy work environment for survivors, rescue, and relief workers. Using LPG also eliminates the risk of ground pollution

INFRASTRUCTURE INDEPENDENT
Natural disasters or conflicts can result in the destruction of energy infrastructure, such as electricity and natural gas networks. LPG provides locally stored energy that can be used until infrastructure is restored

RENEWABLE OR PARTNER FOR RENEWABLE ENERGY
The production of renewable Liquid Gas is increasing globally, and LPG can also be used as back up in hybrid applications for renewable energy, for example in power generation

06

Why LPG is a Good Option

- LPG is a proven clean energy for billions of users
- It can easily displace traditional fuels and bring significant benefits
- It can be rapidly mobilised in an emergency
- It reduces indoor air pollution, alleviates the need to collect wood and reduce deforestation
- LPG can also enable electricity and water to be provided through small generators and pumps

6.1 Why LPG is such an Exceptional Form of Energy

The properties of LPG described in Chapter Three enable it to be used in many different applications in the most remote locations, making it a truly exceptional energy.

The WLGA has launched a dedicated web-based library showcasing the different applications that LPG can be used (http://lpg-apps.org/).

Residential applications, especially domestic cooking, water and room heating, are the most popular applications for LPG. Its portability, high flame temperature, ease of control and cleanliness – both in storage and in use – make it very suitable for humanitarian setting applications.

Propane can be used in very cold climates and elevated regions (source: LPGas Business)

An added benefit is the use of LPG as an engine fuel enabling it to be used in gas engines for power generation.

As one of the cleanest conventional fuels available, LPG complements renewable energy sources and technologies, which depend on variable weather conditions. LPG is a natural partner for renewable energy in hybrid applications.

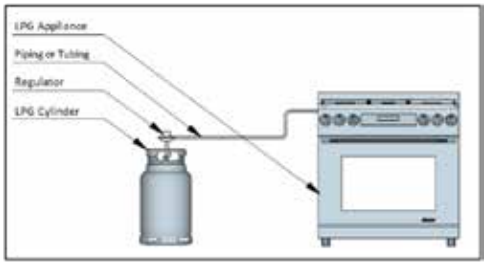
Where butane cylinders can only be used where temperatures are above freezing, propane boils at minus 42 degrees Centigrade making it very suitable for use in cold climates.

6.2 LPG use as a Cooking Fuel, Space and Water Heating and Power Generation

A basic LPG system for domestic cooking consists of the LPG container (cylinder or tank) and valve connector, a regulator, piping or tubing, and an appliance.

The container can be a cylinder(s) or bulk tank(s) depending on the demands of the consumer. The piping or tubing conveys the vapour from the container, through the regulator – which reduces the gas pressure to the appliance – where it is ignited to create the flame for cooking.

LPG vapour pressure inside the container fluctuates with changes in temperature – an increase in temperature increases the vapour pressure – which can affect combustion. The purpose of the regulator is to control these fluctuations to ensure a constant pressure at the appliance.



A simple LPG system (source: LPGas Business)

To reduce the cost of the LPG system it is possible to fit the appliance or cook stove directly onto the top of the cylinder. It is important to make sure the base of the cylinder is large enough to ensure stability in use.

LPG lights and small room heaters can also be fitted directly to the cylinder creating a useful and portable package for use in humanitarian settings.

LPG also enables highly efficient decentralised power generation through small self-containing generators and micro-combined heat and power units. For these types of localised power generation units, LPG's carbon footprint is lower than that of diesel and significantly lower than gasoline.

Its versatility, easy handling, high efficiency, low carbon and clean combustion make it an attractive option for LPG hybrids where LPG exists alongside renewable energy options such as solar and wind.

This is especially true for energy-intensive activities which can be located off the gas-grid such as heating, cooling and power generation.

These potential hybrid appliances include heat pumps, solar energy systems and photovoltaic power generators.

LPG power units can range between the small portable units generating 1kw of electricity to very large 300MW units.

An LPG cook stove and light fitted directly to a 4.5kg cylinder being demonstrated in Southern China (source: LPGas Business)

LPG power generation units sit well alongside grid-based systems where they can be used for standby operations in the event of unscheduled power cuts.

Even small LPG cylinders have the capability of producing significant amounts of heat for a period of time and so portable room heaters are often used as stand by units.

LPG has a much higher calorific value than natural gas and so it cannot be used in natural gas systems or appliances. By blending LPG with air however, to dilute the calorific value, a synthetic natural gas (SNG) can be created. SNG is a gas that resembles all the characteristics of natural gas, with the ability to be used in natural gas appliances.

A small portable LPG generator, the type that can be used to provide power to a family (source: Elgas)

LPG powered water pumps can be used to extract fresh water where there is no power (source: Cavagna)

This allows SNG to be used alongside natural gas networks as a back-up, or a stand-by system in the event of high natural gas tariffs or interruptions in supply. SNG is often used to create demand in an area for natural gas before the natural gas system has entered the area.

In cases where cylinders do not have capacity to generate sufficient vapour for the appliances connected, a vapouriser is used. The vapouriser withdraws liquid LPG from the container and vapourises it by means of heat from electrical power or circulating hot water supplied from a boiler or water heater. This is a common method where there are a large number of consumers. For example, in a piped LPG system supplying many thousands of households.

A simple synthetic natural (SNG) gas system (source: Japan LPGas Association)

6.3 Key Benefits as a Domestic/Commercial Energy

Portability, cleanliness and flexibility are the three key words to sum up LPG as a domestic or commercial energy. The portability of LPG enables it to reach the most remote areas where modern energy would, otherwise, not be possible. Whether that be in areas hit by natural disasters or refugee camps located away from grid and piped energy.

A single burning cook stove supplied from a 3kg cylinder (source: LPGas Business)

LPG is clean to store and burn. Small leaks of LPG will disperse without leaving unwanted stains and when burnt it produces low emissions compared to traditional fuels.

LPG is flexible enough to supply a single dwelling using a small cylinder, up to a multi dwelling community where there are thousands of consumers. The latter would probably be best served using a central storage facility and a piped distribution network.

LPG is stored under pressure in containers that range from cigarette lighters containing just a few grams of product, to domestic and commercial cylinders with capacities between 1kg and 50kg.

LPG can also be stored in bulk storage tanks containing several tonnes, as well as sea fed storage vessels and ships containing tens of thousands of tonnes (see 2.2).

Underground storage facility supplying over 7,000 apartments through a piped network (source: LPGas Business)

07

Typical LPG Distribution Channel

- LPG infrastructure is already in place to deliver to all areas
- The portability of LPG makes is extremely accessible even in the most remote locations
- LPG has a very long shelf life and can be stored for years without deteriorating
- Emergency supplies can be quickly introduced

7.1 How LPG works

LPG is easily stored as a liquid under moderate pressure. Once that pressure is released, for example when the valve on an appliance such as a cook stove is opened, the LPG liquid boils releasing the vapour.

The amount of vapour released is equivalent to 250 times the equivalent volume as a liquid. This makes it a very powerful fuel and one where large amounts of energy can be transported easily.

LPG is invisible as a vapour and people using it for the first time need to be trained properly. Unlike some of the fossil fuel alternatives, LPG has a very long shelf life enabling it to be stored for years without fear of degradation.

7.2 Training

Training is an essential element of ensuring safety when handling and using LPG. It helps create awareness for the hazards and risks associated with LPG and minimises bad practices that may lead to an incident with serious consequences.

It is the responsibility of the people in charge to ensure all personnel involved with handling LPG undergo training by a competent person before they are allowed to carry on with their normal activities. The personnel who should be trained include managers, kitchen staff, administrative staff, maintenance workers, and security guards.

The LPG supplier should be responsible for training their drivers and delivery personnel. Training should cover topics such as LPG product knowledge, relevant procedures, and emergency actions.

In particular, the following topics should be covered:

- Basic characteristics and properties of LPG
- Cylinder handling procedures
- Bulk LPG delivery procedures
- Proper use and maintenance of LPG appliances
- Basic principles of combustion
- Actions in case of emergency
- First aid

The amount of training for each person will depend on his/her level of involvement with LPG. Training should be done on a periodic basis and whenever there are new personnel involved. Training should include regular emergency exercises. Finally, food safety and sanitation training are vital components of healthy and safe meal preparation. These are preventative practices that are designed to reduce the spread of disease and food borne illnesses.

Details of these training procedures can be found in the various other Guides produced by the WLGA (Simply Safety - World Liquid Gas (WLGA)).

7.3 Basic Components (Supply, Storage, Handling, Distribution, Use)

The basic components needed to supply LPG are very simple and easy to use. In the simplest case, all that is required is the cylinder, valve, regulator, pipework and appliance described earlier. A typical distribution channel is shown in Appendix Three.

In each case, the cylinders can be transported readily from the centres of supply to the various markets.

The way LPG is transported can be very innovative. Smaller cylinders can be carried home by the consumer. A 4.5kg cylinder when full weighs under 10kg allowing it to be hand carried.

Larger cylinders are often delivered to the consumer by the retailer using bicycles or rickshaws.

Where LPG is supplied in bulk, road tankers are used to bring product to a bulk storage facility.

Refugee camps are by nature densely populated areas and suitable to be supplied by LPG through a piped network fed from a central bulk storage facility. This type of installation requires significant upfront investment which is generally only justified with a long-term supply contract.

15 kg cylinders being delivered in Ecuador (source: WLGA)

Smaller LPG cylinders can be carried home by the consumer (source: LPGas Business)

Because refugee camps are likely to be temporary structures, a piped supply is probably not going to be justified. Similarly, with an LPG supply to an area hit by a natural disaster. It is hoped that both are temporary arrangements, but if a justification exists, then a piped supply might be an option.

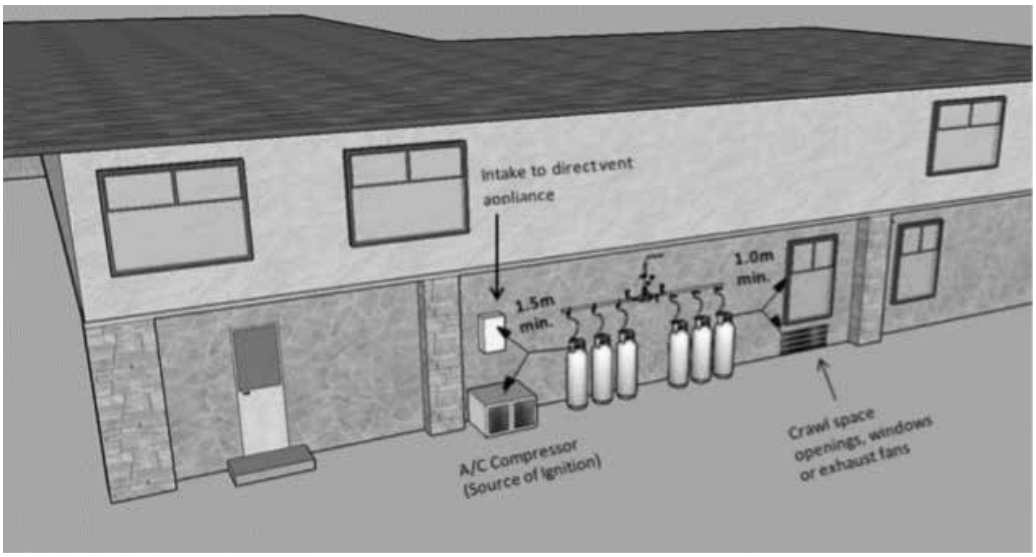
There may be cases where it is justified to have a small community facility such as those found in parts of India where villages share a community kitchen (refer Chapter Eight).

Road tankers are a common method of transporting LPG from terminals to depots, or consumers, even in very cold weather as shown here (source: WLGA)

A community arrangement like this removes the entry barrier cost of buying or putting a deposit on LPG equipment, such as the cylinder and cook stove package.

The LPG supply could be from a few large cylinders or a small bulk tank.

The choice of supply will often be determined by access conditions. It may be difficult for a vehicle to access some of the areas where the centre of demand is. In cases like this, alternative methods exist to distribute the LPG, such as horse-drawn carts or boats.



LPG cylinder installation location supplying a number of consumers (source: LPGas Business)

08

Examples and Case Studies

- LPG played a major role in Japan in providing vital energy immediately after the 2011 tsunami
- LPG has already been introduced successfully in refugee camps in South Sudan and Bangladesh
- Poland used LPG to supply food to Ukrainian refugees
- Poland also recently had to tackle floods in the southern part of the country
- The World Central Kitchen (WCK) responds to global emergencies with their giant LPG cookstoves
- Bush fires and floods in the USA used propane to respond to emergency situations
- In New Zealand, LPG was mobilised quickly to provide energy after the earthquakes of 2010
- Community kitchens in India using LPG can be a model for their potential use in refugee camps

The following examples illustrate how LPG has been used successfully in humanitarian settings where extreme weather and conflicts have severely disrupted peoples' lives, and where access to any form of relief has been curtailed.

8.1 Poland – (Examples Provided by the Polish LPG Association, www.pogp.pl)

Poland provided two recent examples of how LPG supported populations in humanitarian need with severe flooding in the south of the country last year which followed the sudden influx of refugees from Ukraine as a result of the Russian invasion in February 2022.

8.1.1 FLOODS

Intense rainfall caused the rivers of southwestern Poland to swell beyond their banks, flooding residential areas and farmlands. The heavy downpours devastated numerous communities, especially in mountainous valleys where runoffs surged quickly. Many roads were washed out, and large numbers of people were forced to leave their homes or shelter in place without basic utilities.

Local authorities and humanitarian organisations mobilised to deliver relief, but conditions were challenging. Damaged infrastructure made it difficult to transport large equipment or reconnect the standard power grid, and urgent assistance was required for heating, cooking, and lighting. Here, LPG played a particularly significant role in sustaining those cut off from mainstream services.

LPG and LPG equipment being loaded for delivery to populations in need (source: POGP)

As soon as the severity of the flood became clear, residents turned to portable energy solutions. Where LPG was available, gas stoves and portable heaters allowed families in temporary shelters to prepare hot meals and stay warm. Unlike electricity, which depends on functioning lines and substations, LPG can be quickly moved into hard-to-reach locations. Cylinders and stoves were delivered on small trucks and private vehicles, ensuring that isolated individuals could cook food and

The aftermath of flooding in Poland (source: POGP)

heat living areas while waiting for full-scale aid efforts. Several non-governmental groups coordinated closely with civic authorities to set up relief points. In those makeshift centres, trained personnel demonstrated how to handle LPG devices safely and advised newcomers on the proper installation of portable stoves. This approach not only helped people meet immediate needs but also reduced the likelihood of accidents in difficult conditions.

The ability to prepare meals and warm living quarters gave communities a stronger sense of security and reassurance that they had not been abandoned.

After the initial rescue phase concluded, attention turned to clearing debris and planning reconstruction. Construction crews relied heavily on portable power sources during repair work. In certain locations, LPG-fuelled equipment facilitated the removal of mud and flood-damaged materials. The presence of a reliable, on-site energy supply meant that rebuilding efforts advanced without waiting for standard utilities to be fully restored. It also helped local contractors meet pressing deadlines, ensuring that people could move back home or resume work faster. Over time, spontaneous networks of citizens, local companies, and relief workers formed to maintain supplies of LPG for those still displaced. Public communication campaigns encouraged cautious usage of any portable fuel source, and safety regulations were explained in practical, accessible terms to reduce risk. Many lessons emerged about the flexibility of LPG as an emergency resource, proving its value for keeping people safe, fed, and warm under severe conditions.

The 2024 floods demonstrated that disaster response depends on cohesive teamwork among public institutions, private entities, and local communities. LPG was one of the factors that enabled a quicker return to ordinary life for thousands of families. By combining an accessible fuel with a coordinated relief strategy, southwestern Poland managed to cope with a natural disaster of significant scale, setting an example for other regions that may face similar challenges in the future.

8.1.2 UKRAINE

The Russian Federation's military invasion against Ukraine, which began on 24th February 2022 has led to one of the largest refugee displacements in Europe since World War II. According to official data, during the first eight months of the conflict, more than seven million people crossed the border from Ukraine to Poland.

Among the refugees, women and children represented the largest group. This demographic required immediate assistance, including medical care and safe accommodation. From the onset of the crisis, it was necessary to provide essential goods for mothers, children, and the elderly, many of whom had nothing beyond hand luggage.

At the peak of the refugee influx, all Polish-Ukrainian border crossings operated 24 hours a day with approximately one million cars crossing the border. The increased traffic from Ukraine significantly boosted demand for automotive fuels in Poland.

Polish volunteers provided immediate assistance, offering food, warm clothing, and logistical support. Many companies in the LPG sector contributed at the border by providing transport, supplying LPG for heating, and supporting food distribution efforts.

Providing food was one of the most fundamental forms of aid. Humanitarian organisations and volunteers prepared meals for those in need, many LPG companies contributed by supplying LPG for heating and cooking. LPG companies were also supporting people in Ukraine by partnering with the World Central Kitchen (WCK) to help reach their goal of serving 100,000 hot meals a day to Ukrainian refugees.

WCK also worked closely with the Polish Liquid Gas Organisation (POGP) which assumed a co-ordination role for member companies, responding to requests from the WCK on a daily basis. This left the WCK to focus on managing their core business of providing efficient relief operations. POGP assistance in understanding the Polish standards and safety regulations relevant for the LPG industry was also valuable.

POGP activities in supporting WCK were focused on the WCK mobile kitchen site in Przemyśl, a major city, and railway hub located close to the border crossing in Medyka. As the crisis unfolded, the site became the first safe haven for refugees where they could get warm and eat a hot meal.

Refugees often arrived exhausted from long waits at border crossings, which sometimes lasted up to three days. Staying warm and finding shelter became an urgent priority. The Polish LPG industry further contributed by supplying free LPG for gas heaters at the

Polish LPG cylinders supplying one of the WCK giant cookstoves (source: POGP)

temporary refugee shelters, hotels, and other facilities especially during the initial surge when supplies were scarce.

Poland, due to its geographic and cultural proximity to Ukraine, became a key hub for relief coordination. Charitable organisations leveraged their networks to facilitate aid distribution, assist refugees in settling, and raise international awareness about the humanitarian situation. Close partnerships between the Polish LPG industry and international NGOs allowed for more efficient charity operations.

During this humanitarian crisis, LPG proved to be a crucial energy source, enabling quick and effective relief efforts. It provided heating and warm meals to refugees, demonstrating its value as an easily deployable energy carrier in emergency situations. The key advantage is that LPG can be quickly deployed wherever it is needed, even without any pre-existing energy infrastructure.

[Photos and narrative all provided by POGP]

8.2 Japan – Earthquake and Tsunami

On Friday, 11th March 2011, at 2:46pm, a powerful earthquake struck the east coast of Japan some 130km off Miyagi Prefecture in the Pacific Ocean. The earthquake set off a devastating tsunami that sent walls of water washing the coastal area of this northeast part of Japan.

Waves up to ten meters rushed onto the shore, engulfing houses, cars and carrying fishing boats and debris away. Even in Tokyo, far from the epicentre, the earthquake struck hard causing the city's skyscrapers to sway.

Despite the fact that Japan is exceptionally well prepared for disaster situations, and that cities are constructed with high level construction codes, almost 16,000 people perished and over 3,000 people are still missing. Over 270,000 homes were destroyed, the roads were rendered impassable, public transportation was utterly devastated and electricity supplies were cut off across a widespread area. Even in Tokyo, the mobile telephone system floundered.

The gas pipeline networks were significantly damaged by the earthquake and tsunami. Refineries and LPG import terminals were also heavily damaged. The petroleum product terminals and LPG terminals on the coast were also hit.

The disaster affected about 160,000 households using LPG. Many cylinders were washed away and local LPG distributors suffered damage to their filling facilities. Subsequently, the supply chain suffered.

In Japan LPG importers import and store at their terminals, distribute mostly by using transporters and sell LPG to end users, wholesalers and retailers via their sales networks.

LPG is an extremely efficiently distributed source of energy in Japan. Typically, LPG residential users have two LPG cylinders, one full and one spare. When the full one is empty retailers replace the empty cylinder with a full one.

The situation was bleak after the Japanese tsunami but LPG played a major role in providing immediate relief in the way of energy for cooking food (source: Japan LPGas Association)

As a reliable, portable energy, unlike grid-based energy services, LPG played an important role in the historical disaster relief effort in Japan. The tsunami destroyed everything in the affected area, particularly the northeast coast. Even outside of the directly affected area by earthquake, infrastructure was damaged.

The electricity supply was cut off in many areas and modern city life, so dependent on electricity, was effectively suspended. Transport suffered enormously; train services were cancelled, petrol stations closed, and gasoline (petrol) was in seriously short supply.

Supplies of LPG were affected but recovery was swift. Despite many LPG road tank trucks being lost in the tsunami, with a plentiful stock of LPG at terminals, the industry united to ensure the affected areas had the supplies they needed.

LPG distributors in the area brought in emergency kitchen kits comprising LPG cylinders and cook stoves for food centres that were rapidly set up in temporary shelters, providing life-saving space for evacuees to come together, cook meals and stay warm.

LPG was used to generate electricity by fuelling stand-by gas fired generators at the temporary shelters, to provide lighting and communication services, while the electricity grid system was disrupted.

The city gas companies in the area supplied substitute natural gas (SNG), manufactured by an LPG and air mixture, to their customers who had lost access to the piped gas network. They maintained the portable gas manufacturing facilities using LPG as the disaster prevention equipment.

Refineries that had been hit had sufficient stock of crude oil, but critically not of petrol. Petrol stations suffered short supplies and motorists often had to queue for hours. Autogas (LPG as a transport fuel) drivers, on the other hand, could refuel with no difficulties as LPG facilities continued to operate. Taxis, which in Japan run largely on Autogas, were also available to provide public transport, and transport relief supplies to the temporary shelters.

Over 52,000 temporary evacuee housing units were constructed in the affected region in northern Japan. Approximately 50% of these units were equipped with LPG facilities including heaters, cook stoves and hot water facilities.

In light of the March 2011 disaster, LPG was proven to be resistant to disaster circumstances. There were three key elements of immediate reaction:

(i) A Mutual Assistance Agreement was put in place between Japanese LPG importers to lessen the risks for importers caused by shortage of LPG supply during an emergency. Under this agreement, LPG importers may initiate interaction and discussion with each other to 'borrow' LPG under reasonable conditions and take delivery of LPG at their agreed terminals. Consequently, LPG stock will be kept at each terminal throughout Japan, effectively maintaining a joint, available stock among the Japanese importer community.

(ii) Each local LPG association, whose members are the local retailers, located in the 47 Japanese prefectures (administrative divisions), including the capital of Tokyo, entered a cooperation agreement with their local government administration to secure supply.

(iii) The Japanese government agreed to release LPG from the national stockpile to cover any shortage of LPG importation caused by the closure of the LPG import terminal which had been blocked by a 91,000GT cargo ship grounded by the power of the tsunami.

The main lesson learned was that to be more effective during great disasters, regional LPG filling plants must be made stronger, and communications must be improved. The Japanese government is now nominating around ten LPG filling plants in each prefecture to function as primary facilities to ensure a fully maintained LPG supply to the local population. These filling plants will be equipped with stand-by generators and Autogas vehicles with sufficient fuel to transport LPG cylinders and satellite communication systems to affected areas. These equipped filling plants will serve to further strengthen the LPG supply chain.

The government has also decided to provide four transportable power generation systems, which will be transported to the LPG import terminals to maintain LPG supply, even in the case of ruptured electricity supply to the affected terminals.

Centralised energy distribution networks are more prone to failure during natural disasters. As a decentralised, off grid energy source, LPG is a peerless fuel in times of hardship. LPG can be moved easily to the suffering areas, it effectively and completely supports primary needs of the affected population and fully supports emergency and recovery backup activities and systems. It does so by fuelling temporary kitchens and refugee centres with cooking, boiling water and refrigeration appliances; establishes electric power generators; introduces mobile LPG-Air systems to replace damaged natural gas networks in vital buildings such as hospitals and schools; and provides the opportunities for heating and power systems (combined heat/power systems mCHP). In addition to this, automotive fuel for Autogas vehicles or dual fuelled Autogas vehicles running on LPG, allows to keep them running when other vehicles are forced to stop due to a shortage of fuel.

[Photographs and narrative provided by Makoto Arahata, Japan LPG Association]

8.3 USA – Hurricanes and Wildfires

Map showing areas hit by Hurricane Helene (source: PERC)

Map showing wildfire outbreak in Southern California (source: PERC)

During September and October 2024, two major hurricanes, Helene and Milton, levelled parts of Florida, Georgia, North Carolina, and Tennessee. Then in January 2025, a series of wildfires brought devastation to Southern California. In January 2025 there was a wildfire outbreak in the Los Angeles area. In response, propane (LPG) demonstrated its unique capabilities in supporting recovery and resilience. From small local marketers to regional and national powerhouse companies, the LPG industry supported communities when they needed help most.

Here are just a few examples of how the industry provided essential energy that helped disaster-stricken communities survive and thrive again:

8.3.1 STRINGER OIL & LPG (ANDERSON, SC) – HURRICANE HELENE

Stringer is a small operation with six employees in total. After Hurricane Helene had struck, they organised LPG cylinders, parts, and other supplies and delivered them to several locations in western North Carolina, including Bakersville, Burnsville, and Newland. The company delivered 50 LPG cylinders and 200 LPG regulators to Youngs Fuel Service, another small family-owned company that had suffered severe losses in the storm. Stringer owner Reagan Bonnette returned to western North Carolina several times to offer support as rebuilding efforts continued. 'This recovery is a marathon, not a sprint,' said Bonnette.

Truck loaded with LPG cylinders and regulators (source: PERC)

8.3.2 BLOSSMAN GAS (OCEAN SPRINGS, MS)

Blossman Gas was able to mobilise 36 LPG Autogas-fuelled delivery trucks into service one day after Helene struck in North Carolina, South Carolina, Tennessee, and Georgia, despite the difficulty in accessing retail locations in affected areas and some employees having lost their homes.

Truck loaded with LPG cylinders and regulators (source: PERC)

Thanks to onsite LPG-powered generators, the company was able to fill more than 4,000 LPG cylinders in the first eight days after the storm at its Asheville, NC, branch and a further 1,600 at its Hendersonville, NC branch. Blossman's planning and mobilisation allowed the company to support local, state, and federal agencies responding to the disaster by providing vital LPG cylinders early on in the disaster.

For many western North Carolina residents, a battery-powered radio was the only way to get information from the outside world. A Blossman LPG delivery truck was able to get through and deliver LPG to the broadcast tower of Blue Ridge Public Radio in Asheville, NC. The LPG-powered generator kept the station on air for days after the storm.

8.3.3 PARACO GAS (RYE BROOK, NY)

In the aftermath of Hurricane Helene, Paraco deployed nine tractor trailers filled with more than 12,000 propane cylinders for communities across Georgia, North Carolina and South Carolina. The cylinders were used to provide power to appliances for lighting, cooking and power generators.

8.3.4 SOUTHEAST PROPANE ALLIANCE (SEPATEC)

The technical team of the Southeast Propane Alliance (SEPATEC), with support from Rinnai, Gardner Marsh, and LG Jordan Oil & Gas (Apex, NC), designed and assembled a portable hot water shower system capable of supplying water for laundry and eight shower units.

The unit was assembled at Blossman's staging area in Asheville, NC for use by the community and first responders after Hurricane Helene.

SEPATEC's mobile shower and laundry facility is shown here ready for use at Blossman's post-Helene staging area in Asheville, NC.

Mobile shower and laundry facility (source: John Jessup (SEPATEC)

8.3.5 FOSTER FUELS, INC. (BROOKNEAL, VA)

Foster Fuels, under a contract with the Federal Emergency Management Agency (FEMA), sent 150 LPG trucks and 200 personnel to areas affected by Hurricanes Helene and Milton, dispatching more than 500,000 gallons of LPG (1kt) and other fuels to power critical relief operations.

Members of Foster Fuels' emergency response team prepare to deliver fuel and water to areas affected by Hurricane Helene (image from Foster Fuels Facebook page).

Foster Fuels personnel prepare to deliver LPG and water (source PERC)

8.3.6 AMERIGAS (KING OF PRUSSIA, PA)

AmeriGas partnered with two non-profit organisations, Operation Air Drop and Ground Force Humanitarian Aid, to coordinate the delivery of more than 1,300 LPG cylinders via pack mule and ATV to Spruce Pine, NC, and other areas nearby where families and businesses were stranded without power or resources after Hurricane Helene.

8.3.7 PROPANE AND POWER RELIEF FUND

The Propane and Power Relief Fund, a 501(c)(3)* nonprofit organisation, was created by an alliance of LPG marketers and energy companies led by Elite Power and Energy Corp. President Kelly (K.D.) Tidwell. The fund is used to collect donations that can be used to buy LPG for residents, allowing them to maintain heat in their tents, campers, makeshift (shed) homes or tiny homes as they continue the long road to recovery.

Kelly Tidwell created the fund after encountering staggering devastation and need on his first trip to drop off generators and supplies to communities in western North Carolina in the wake of Hurricane Helene. Within about a month after the storm, the fund's supporters had accumulated more than $300,000 worth of monetary donations, fuel, and equipment, going directly to assist recovery and rebuilding efforts.

(*A 501 organisation is a United States corporation, trust, unincorporated association or other type of organisation exempt from federal income tax under section 501 of Title 26 of the United States Code. It is one of the 29 types of 501(c) nonprofit organisations in the US).

Kelly (K.D.) Tidwell, delivering donated LPG cylinders to a community in western North Carolina (source: PERC)

8.3.8 OPERATION BBQ RELIEF/FERRELLGAS (OVERLAND PARK KS)

Operation BBQ Relief, with Ferrellgas as its key LPG partner, provided nearly 1.4 million meals to families and first responders during a 34-day deployment in response to Hurricanes Helene and Milton in Florida, Georgia, North Caolina, and Tennessee.

Operation BBQ Relief also provided nearly 22,000 meals to people in need during a 17-day deployment in January 2025 to Malibu, CA in response to the devastating series of wildfires in the Los Angeles area.

Operation BBQ Relief delivering hot meals to a family in Sarasota, FL after Hurricane Milton (source: www.operationbbqrelief.org)

8.3.9 TED JOHNSON PROPANE (BALDWIN PARK, CA)

Ted Johnson Propane supported first responders battling the Los Angeles-area wildfires by supplying LPG to the Cal Fire mobile kitchen unit set up at the Zuma Beach Incident command centre in Malibu.

The command centre served as the main staging area for efforts to fight the Palisades, Eaton, and Hughes fires during the January 2025 wildfire outbreak in the Los Angeles area.

Mobile kitchen with LPG during the fires (source:Julie Johnson/Ted Johnson Propane)

8.4 North Darfur, Sudan (Source: GACC)

Between 2002 and 2007, Practical Action (www.practicalaction.org) successfully facilitated a shift from wood and charcoal to LPG in 1,500 households in Kassala State, East Sudan.

Traditional fuels comprise over 80% of the total primary energy supply in Sudan. The majority of this is consumed by households, inefficiently burned over three-stone fires or traditional metal cookstoves. Dependency on charcoal and firewood has caused widespread deforestation throughout Sudan, which has lost over 11% of its forests between 1990 and 2005.

The Clean Cooking Alliance (CCA) (**Home | Clean Cooking Alliance**), formally The Global Alliance for Clean Cookstoves (GACC), is a public-private partnership that seeks to save lives, improve livelihoods, empower women, and protect the environment by creating a thriving global market for clean and efficient household cooking solutions. CCA states that '…refugees, internally displaced people, and other crisis-affected populations lack access to clean cookstoves and fuels for cooking. Clean and efficient cooking solutions can help reduce the need for long and often dangerous trips in search of fuel, and improve outcomes in humanitarian settings…by developing a sustainable clean cooking industry, we can save lives, empower women, reduce air pollution, and improve livelihoods…'

In 2005, Human Rights Watch reported that 82% of the rapes treated by Médecins Sans Frontières (MSF) in West and South Darfur occurred when women left the towns and internally displaced people (IDP's) camps in search of firewood and other supplies.

A 2006 study showed that 80% of IDPs interviewed in North Darfur reported selling food from their World Food Programme rations to buy firewood – negatively impacting their nutritional intake. On average they missed three meals a week when they had food but lacked cooking fuel.

Without a clean fuel alternative, health, protection, and environmental impacts, Sudan's reliance on biomass fuel will only worsen. Addressing this issue in the long term, however, requires an intervention that is both financially and environmentally sustainable.

Drawing on the lessons learned in Kassala, Practical Action partnered with Carbon Clear (http://carbon-clear.com/uk/) in 2008 to apply the project model in El Fashir – the urban capital of North Darfur. As of 2010, the population of El Fashir included 198,391 local residents and 29,645 (IDPs), with a low household income, seldom reaching US$30 per month.

With start-up financing from Carbon Clear, Practical Action established a revolving loan fund that is managed by the Women's Development Association Network (WDAN). Local women who participate in the project receive a loan that covers the upfront costs of the LPG fuel and cooking equipment, which they then pay back in instalments over time.

WDAN's representatives are local community members, which enables them to develop flexible payment plans that meet the specific circumstances of each grantee. As the loans are repaid, the money is invested back into the fund and can be loaned to another woman. The loan fund has "revolved" 20 times in this manner since 2008, enabling long term benefits.

The three burner table top LPG stove used in the project (source: Practical Action)

In humanitarian settings, free distribution of products without sufficient training often results in the products being improperly used, broken, or sold – negating their intended benefits.

Recognising this, Practical Action hosts training sessions to educate women about the health and environmental benefits of switching to LPG, to introduce the concept of revolving loans, and to give women the opportunity to provide feedback on their needs.

Those who are interested can then receive further information and are trained in how to safely handle LPG equipment. These activities ensure that the women are fully engaged and willing to invest their own resources in the loan program.

The LPG equipment distributed to each loan recipient consists of a stove, a gas-filled bottle, and a Kisra (local sorghum chapatti) plate. The majority of the stoves are three-burner tabletop cookers which are manufactured and assembled in Khartoum. These stoves burn two to five times more efficiently than the three stone fires, mud stoves, and metal stoves that families previously used with firewood and charcoal. This results in substantial savings on fuel costs.

On average, women in El-Fashir purchase one sack of charcoal per month at 130 Sudanese Pounds (SDG). Refilling their LPG cylinders once a month costs about 70 SDG. The savings assist the women in paying back their loans on the initial equipment.

8.5 Indonesia and the World Central Kitchen (WCK) – Earthquake, Volcanoes and a Tsunami

Map of Indonesia showing the epicentre of the earthquake (source: CIA)

A 7.4 magnitude earthquake struck the Indonesian island of Sulawesi on Friday 28th September 2018, triggering a three-metre-high tsunami and reducing the city of Palu to rubble.

A few days later a volcano in northern Sulawesi erupted, spewing ash up to 4,000 metres into the air.

Subsequent aftershocks, liquefactions and landslides severely affected Donggala, Palu municipality, Sigi and Parigi Mountong Central Sulawesi. Many areas were difficult to reach.

According to the World Health Organisation (WHO) there were over 2,000 deaths and thousands of injured and missing people following the disaster. There are also nearly 100,000 displaced people in over 100 camp sites.

The earthquake left a trail of death and destruction (source: Pertamina)

Cooking facilities on site (source: Pertamina/WCK)

Shortly after the disaster struck, the WCK (www.worldcentralkitchen.org) mobilised some of their chefs to Sulawesi to provide assistance with meals to those affected.

WCK quickly set up emergency kitchens in the Merry Glow Hotel and Resto Jl. Patimura in Palu Selatan in Central Sulawesi. There was an urgent need for commercial cookstoves and supplies of LPG and WCK contacted the WLGA for assistance.

WLGA liaised with Pertamina who provided six 50kg cylinders of LPG and 16 high pressure LPG cookstoves. The facility provided around 10,000 meals a day in Palu.

Chef José Andrés founded WCK after the devastating 2010 earthquake in Haiti with the belief that food can be an agent of change. They have expanded globally and have developed into a group of chefs creating smart solutions to hunger and poverty that has served over 4.6 million meals, over the past year alone, to victims of natural disasters around the world.

In the aftermath of this event the WCK, supported by the WLGA, developed the world's largest deployable cookstove. The cookstove was to be almost two metres in diameter and it had to be constructed, like the rest of the kitchen, in such a manner so as to be packed in standard pallets. The other criteria for the cookstove were that it had be easily setup on arrival, and disassembled and packed away after use without the need for special tools.

The WCK's giant cookstove that can be dismantled and sent to countries in need (source: WCK)

8.6 India – an Example of Communal Facilities

Community kitchen in a rural part of India (source: Hindustan Petroleum, India)

An initiative that has been used to provide LPG into a rural community where traditional fuels have been used is the community kitchen in India. Although this doesn't describe a humanitarian setting is does provide an example of how to penetrate into a community and displace traditional fuels.

The circumstances surrounding this type of community is not dissimilar to that found in humanitarian settings. There is no modern energy available (the community is off the mains electric grid), there is heavy dependence on traditional fuels, especially firewood, and the disposable income is limited.

The concept of the Community Kitchen was introduced into India 25 years ago. It was a scheme to enable rural village folk, who had no access to modern energy, to use a central village community facility where LPG was available.

The kitchen had modern facilities (hot water, gas stoves) which were fed from a small LPG facility, which was managed by one of the village heads. Villagers were allowed access to the kitchen in return for a few rupiahs/hr which covered the cost of running the facility and financed any microfinance loans.

The facility allowed woman to dispense with the chore of collecting wood every day and brought significant environmental (deforestation and climate change) benefits, as well as social, health and economic advantages.

The basis for selection of a village uses the following parameters:

- The population of the village must be must be dependent on wood as a cooking fuel.
- The Oil Marketing Company (OMC) liaises with the head of the village who has expressed interest in installing the facility, and agrees for the following:
  - To provide a suitable building (covered shed) for housing the facility so that at least 5 people can cook at the same time
  - The size of the building should preferably be a minimum of 5m x 2m
  - To take overall responsibility for the day-to-day operations of the facility including fixing and collection of usage charges, maintenance of the kitchen, and safe custody of the equipment provided by the OMCs, etc.

Alternatively, the facility may be operated by the OMC through their Distributor.

The role of the OMC is to provide the necessary LPG facilities such as cylinder manifold, cylinders, stoves and related accessories (pressure regulators, hoses) free of cost, including the cost of the first refill of LPG and the installation charges.

The on-going periodic LPG refills are borne by the operator (head of the village) or the person nominated by him. The head of the village also recovers the usage cost from the consumers (seen here using the facility) on an actual usage basis.

The example of the community kitchen is included in this report because of the scalability into humanitarian settings such as refugee camps and post tsunami conditions.

8.7 New Zealand - Earthquake

Christchurch is the largest city on the South Island of New Zealand and the second largest city in New Zealand. On 4th September 2010, a 7.1 magnitude earthquake hit the city at 4:35am local time. The epicentre was some 40km west of Christchurch, near the town of Darfield at a depth of 10km. The initial quake lasted about 40 seconds and was felt not only widely across the South Island but also in parts of the North Island.

Whilst the earthquake caused significant damage to infrastructure and buildings, there were no direct fatalities, aided by the quake occurring during the night.

There followed a series of aftershocks, the most severe being of a 6.3 magnitude aftershock a few months later on 22nd February of 2011. This second quake struck at a depth of 5km, just 10km south of central Christchurch, and caused the loss of life of 185 people, not to mention massive damage to property and infrastructure that had already been weakened by the initial earthquake.

The overall impact to the LPG industry was minor compared to other utilities, and the network was fully operating within ten days.

All of the LPG distributors took immediate action to restore deliveries as quickly as possible. As soon as the news of the scale of the disaster became clear, LPG staff started mobilising to deliver extra supplies of domestic cylinders to the stricken areas.

People were relying on LPG to keep warm, cook food and heat water on their barbeques. Suppliers were overwhelmed with demand and to ensure supply for the first five to ten days was very challenging. In some cases, people could not access cash, so the gas was supplied at no charge.

One key lesson learned was that normal communication methods cannot be relied on. In times of disaster, traditional communications often fail. One supplier was coordinating neighbourhood deliveries by announcing it on the local radio stations. Residents were waiting for the trucks when they arrived in the devastated areas.

Access to LPG became critical, as most other infrastructure had been destroyed, severely hampering delivery. Some of the LPG infrastructure was also damaged, including a wharf used for ship unloading. However, LPG can be easily stored. In addition, infrastructure was moved by bringing in extra cylinders, trucks and staff from other areas.

LPG equipment at both the supplier depots and the customer installations were monitored to ensure safety. LPG staff and drivers were kept out of undue risky situations, including entry into unsafe areas.

Suppliers made a special effort to ensure that emergency services in the devastated parts were kept supplied with LPG, to make sure they could feed their teams who were operating around the clock. It was also important to keep in touch with the authorities to assess needs from their perspective.

The continuity of LPG supply to Christchurch and the surrounding areas made a bad situation a little easier. The ability to store LPG, combined with the flexible nature of the LPG infrastructure, made LPG an important form of energy during these emergencies.

8.8 Australia - Floods

Coopers Creek (source: Elgas)

In early February 2013, ex-tropical cyclone Oswald caused a landslip that cut off the only road into Coopers Creek, a small town in the Northern Rivers region in the state of New South Wales, Australia. Coopers Creek was completely cut off from the rest of the country by a landslide across the only access road.

After two weeks of isolation, the 140 residents of the area were getting desperate for essentials. The NSW State Emergency Service (SES) helicopter was delivering food and medicine but the residents also needed LPG for their homes.

An SES Huey helicopter was utilised to airlift ten 45kg cylinders into the community. A second Bell Jet Ranger helicopter was used to transport personnel from the Elgas team, as they were needed to supervise the airlift safety procedures and the installation of the cylinders.

On 18th February, the Elgas personnel took an LPG cylinder truck, with stock on-board, to Repentance Creek Hall, the helicopter loading site. The site was chosen as it was as close as they could safely get helicopters to the drop zone. The flight time was still about 15-20 minutes each way. Using advice and close consultation with the safety manager, they stacked and strapped the load together, as one bundle, into a cargo net. The load was then flown and the lowered to Coopers Creek very carefully. The cylinders were stood upright and checked promptly after the landing.

Loading 45kg LPG cylinders in a sling ready to be lifted by the helicopter (source: Elgas)

The 45kg cylinders on their way to Coopers Creek (source: Elgas)

The Elgas personnel arrived at Coopers Creek School, which had been closed due to the landslide and met with local residents who were grateful to see them, and waiting for their LPG. Elgas delivered cylinder handling and connection training to four of the townspeople who would oversee all the connections. Once trained on the school's cylinders, they were supplied with Personal Protective Equipment (PPE), MSDS documentation and all the appropriate signage, with which they erected an emergency depot.

The combination of the exceptional benefits of LPG make it an essential fuel in emergency situations.

- Easily transportable – even by helicopter
- An available source of energy when off-grid systems collapse
- Can be stored anywhere
- Extremely portable in smaller cylinder quantities
- Efficient and easy distribution when other sources fail
- Offers a swift life-saving solution
- Multiple uses to fuel temporary kitchens, power generators, heating and cooking

This case study was developed from a WLGA report to the response by Elgas, Australia, to the floods in Coopers Creek in 2013 (The-Role-of-LPG-in-Disaster-Recovery2-2.pdf)

During the updating of this guide in March 2025, Australia was hit by tropical storm Alfred which caused severe flooding in the same area of northern New South Wales.

09

Sourcing LPG in an Emergency

- Emergency LPG kits are available and can be mobilised quickly
- There is scope for improving some of the emergency kits that exist
- LPG supplies can be easily and quickly mobilised

9.1 Typical Emergency LPG Kits

A Shelter Box provided by Rotary International (source: Rotary International

There are several international charity organisations that provide support to people who suffer as a result of humanitarian situations such as refugees and natural disasters. Rotary International provide Shelter Boxes (https://www.shelterbox.org/), which contain some essential components to assist people who have suffered and require immediate support. The contents of these Shelter Boxes differ depending on the disaster and the climate, but include items such as solar lights, water storage and purification equipment, thermal blankets and cooking utensils. The addition of a small LPG cylinder and stove would provide a valuable supplement.

Inspired by the role that LPG played in the recovery operations during recent humanitarian emergencies, Repsol LPG and the Repsol Foundation (Repsol Foundation) have launched a project to provide LPG Emergency Kits to assist in future crises.

Over 3,000 such kits, which include an LPG stove and eight LPG cartridges, a basic kitchen set and a lamp, have been produced for the express purpose of providing basic cooking, lighting and heating in the immediate aftermath of a natural disaster.

LPG, with its versatile and portable properties is particularly well-suited to providing for such needs when electricity and gas lines have been destroyed, or when displaced persons are unable to return to their homes.

LPG is especially useful in temporary shelters, which require an energy source that can be delivered quickly and efficiently to many people in one location.

Over 1,000 of the kits have already been donated to Spain's Emergency Military Unit (UME), which is responsible for assistance in the event of emergencies such as floods, earthquakes, forest fires, and other disasters. The remaining 2,000 kits will be stored at Pinto, an LPG Repsol filling plant, and are available to a variety of organisations including the Red Cross and the Spanish Agency for International Cooperation and Development.

Immediately after the tsunami in Japan in 2011 there was a desperate need for food and energy.

It was possible to mobilise some LPG cylinders and cook stoves and bring them to the affected areas by road very quickly.

The Japanese government has now recognised the importance of LPG, and its role in alleviating the suffering in the aftermath of a natural disaster. This type of emergency kit is very much part of future planning in the event of a recurring disaster.

Repsol's emergency LPG kit (source: Repsol)

LPG cylinders and cook stoves being loaded off a truck to bring much needed energy to the affected areas of Japan after the tsunami (source: Japan LP Gas Association)

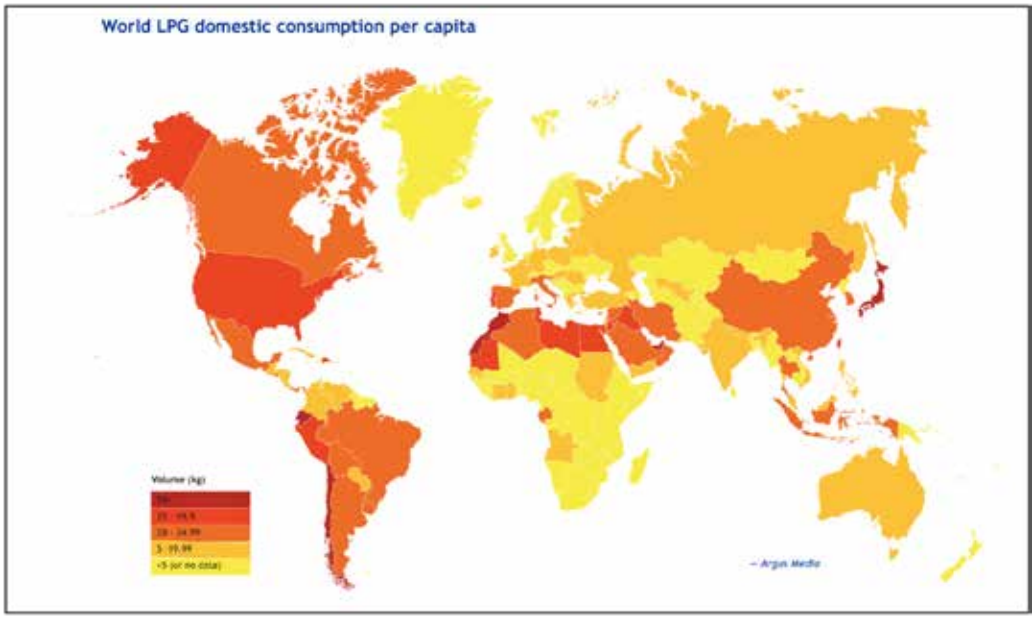
9.2 Map with LPG Usage Worldwide

The WLGA has over 300 members across the world, with many operating in areas of natural disasters, conflict and in countries that are hosting refugee camps. They can all be accessed and contacted through this link (Membership - World Liquid Gas (WLGA)).

There are also many other companies that operate in the LPG business and are able to provide facilities and access to supplies of LPG.

The map below shows where LPG is being used worldwide from a per capita perspective, it highlights where the obvious opportunities are for LPG conversion. Many of the refugee camps are also located in these countries. This also mirrors where there are large consumption levels of traditional fuels.

There are exceptions, with countries such as Türkiye and Jordan, where there is very good LPG infrastructure and an ability to rapidly access camps in those countries. With other countries, access to LPG in remote areas is not difficult but will need managing. This illustrates the need for cooperation between the LPG industry, the UNHCR, and other stakeholders if successful access to LPG into the refugee camps in these areas is to happen.



Map shows where there are low levels of LPG consumption per capita indicating opportunities for development. The areas mirror where most of the refugee camps are located [map courtesy - www.argusmedia.com]

10

How to use LPG Safely

- LPG has a very safe track record
- Users who are new to LPG require education and training
- There is a wealth of material available to enable education and training

10.1 Key Safety Messages

Field training being conducted in India (source: IOC)

Training is an essential component to ensure the safe handling and use of LPG. It helps create awareness for the hazards and risk associated with LPG and minimises bad practices that may lead to an incident. All personnel involved with handling LPG should undergo training, including operators and maintenance people, kitchen staff and security guards. Training should be the responsibility of the LPG supplier. Training should cover topics such as LPG product knowledge, relevant procedures and emergency actions. People involved in the supply of LPG should cover the following topics:

- Basic characteristics and properties of LPG
- Cylinder handling procedures
- Bulk LPG delivery procedures (if applicable)
- Proper use and maintenance of LPG appliances
- Basic principles of combustion
- Actions in case of emergency
- First aid

The amount of training for each person will depend on his/her level of involvement with LPG. Consumers using LPG for the first time should also be briefed on how to use LPG safely. The use of simple safety leaflets using pictures can overcome any issue of literacy. Organisations such as the HSE in the UK have publications that focus on the safe use of LPG. (http://www.hse.gov.uk/gas/lpg/index.htm). Liquid Gas UK also has information available (Liquid Gas UK : Clean, Efficient Energy from the UK Liquid Petroleum Gas Association).

Other organisations with information of the safe use of LPG include the include Gas New Zealand (Gas New Zealand - Renewable Gases are part of our future), and the LPG Association of South Africa (LPGSA – lpgsa).

Examples of an LPG consumer leaflet in Sri Lanka

10.2 Emergency Response

Mention is made here of some basic points to consider in preparing for an emergency.

The primary objective in emergency response is to prevent harm to people. Being prepared on how to handle emergency situations can minimise the risk of minor incidents becoming major incidents.

For a refugee camp where there might be LPG storage areas, an emergency team should be organised and the roles and responsibilities of everyone should be clearly defined. Any emergency procedures should be documented in clear and concise languages with a copy posted near the LPG storage site, where it is easy to read. Diagrams are useful for these procedures.

In an emergency the situation should be assessed and the appropriate response taken.

If a serious incident occurs everyone should be evacuated and made safe. Fire and emergency services should be called for assistance.

When handling a leak of LPG without a fire, personnel should be kept upwind of the leak. Remove any ignition sources downwind of the leak. Do not switch on or off any electrical switch which might cause a spark.

If the leak is indoors, open windows and doors to increase ventilation.

If the leak is on a cylinder, remove and position it in a well-ventilated location with the leak uppermost if it is safe to do so. Clearly mark the cylinder as defective and alert the supplier.

Regular emergency exercises should be conducted to test the preparedness of the local response team in handling emergencies.

Learnings from each exercise should be discussed with the team during the de-briefing session and practiced in the succeeding exercise. Emergency exercises should involve the local fire service.

APPENDIX 1

General Properties of LPG

The following is a summary of some of the important properties of LPG.

LPG - Comprises Commercial Propane and Commercial Butane, and mixtures thereof. They are hydrocarbon gases that can be changed into a liquid and changed back into a gas by the simple application and release of pressure

Density – LPG vapour is heavier than air and tends to gather at low areas such as drains, pits, cellars and other depressions. As a colourless liquid, LPG occupies around 0.4% of its vapour volume, but is about half the density of water and will float on water before vapourising.

Cooling effect – LPG liquid vapourises and cools rapidly; it can therefore inflict severe cold burns if it comes in contact with bare skin.

Non-toxic – LPG is not toxic. However, it has an anaesthetic effect when mixed in high concentrations with air. The greater the concentration (i.e. as available oxygen declines), the greater the risk of asphyxiation.

Smell - What people know and recognise as the 'LPG smell' is usually added to LPG before distribution. This smell can be detected if the LPG content of air is as little as 0.4% (or just 20% of the lower limit of flammability). However, odour is not the only means of detection. Large leaks will also be obvious through hissing or condensation or frosting around the leak; small leaks will show up as bubbles if detergent mixed with water is applied to the suspected leak area. **NEVER try to detect leaks with a naked flame or other kinds of ignition!**

Flammability – LPG can ignite when it forms between 2 and 10% of a vapour/air mixture, so the risks associated with poor handling, storage or usage should be obvious. Uncontrolled ignition of LPG can cause serious fires or explosions (i.e. if ignited within a confined space). A fire started some distance from an LPG leak can very quickly travel back to the source of the leak itself. An LPG cylinder involved in a fire may overheat and rupture violently. The power and intensity of an LPG fire or explosion should never be underestimated.

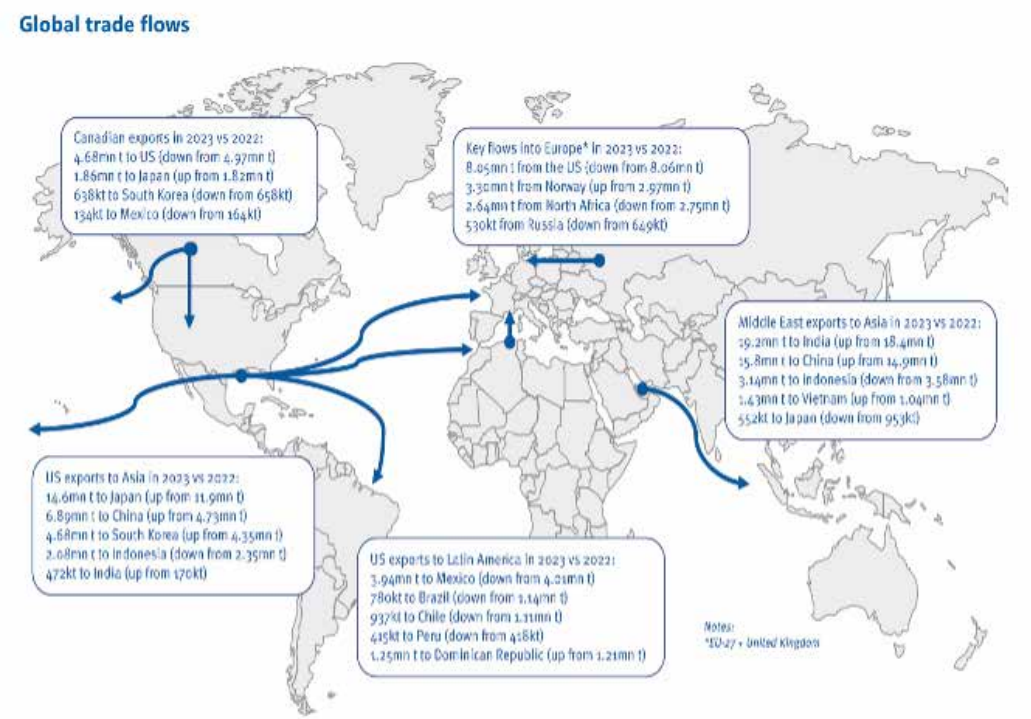
Liquid Expansion – LPG liquid has a high coefficient of expansion. Tanks, cylinders, pipelines and equipment must be protected against the high pressure resulting from liquid expansion with temperature rise.
This is why LPG cylinders and tanks are never completely filled. Typically they are filled to around 80% of their capacity.The table overleaf shows some typical physical properties of LPG. As LPG is a by-product, these values are approximate and indicative only.

Typical Characteristics of Propane and Butane **PHYSICAL PROPERTY**		**COMMERCIAL PROPANE**	**COMMERCIAL BUTANE**
Litres/tonne of liquid at 15 degrees C		1,965 – 2,019	1,723 – 1,760
Litres/tonne of liquid		1,996 – 2,051	1,750 - 1788
Litres/kg of liquid		1.96 - 2.02	1.72 - 1.76
US barrels/tonne		12.4 – 12.7	10.8 – 11.1
Relative density (to water) of liquid at 15 degrees C		0.50 - 0.51	0.57 - 0.58
Ratio of gas to liquid volume at 15 degrees C and 1015.9 mbar		274	233
Relative density (to air) of vapour at 15 degrees C and 1013.25 mbar		1.40 - 1.55	1.90 - 2.10
Boiling point °C		Minus 42	Zero
Vapour pressure at 0°C	barg	4.5	0.9
Vapour pressure at 15°C	barg	6.9	1.93
Vapour pressure at 38°C	barg	14.5	4.83
Vapour pressure at 45°C	barg	17.6	5.86
Upper limit of flammability,	% v/v	10.0	9.0
Lower limit of flammability,	% v/v	2.2	1.8
Gross calorific value	MJ/m³ dry	93.1	121.8
	BTU/ft³ dry	2,500	3,270
	MJ/kg	50.0	49.3
	BTU/lb	21 500	21 200
Net calorific value	MJ/m³ dry	86.1	112.9
	BTUu/ft³ dry	2,310	3,030
	MJ/kg	46.3	45.8
	BTU/lb	19,900	19,700
Latent heat of vapourisation	kJ/kg at 15 °C	358.2	372.7
Latent heat of vapourisation	BTU/lb at 60 °F	154	160

APPENDIX 2

LPG Trade Flow Map

LPG GLOBAL TRADE FLOW MAP (COURTESY ARGUS MEDIA)

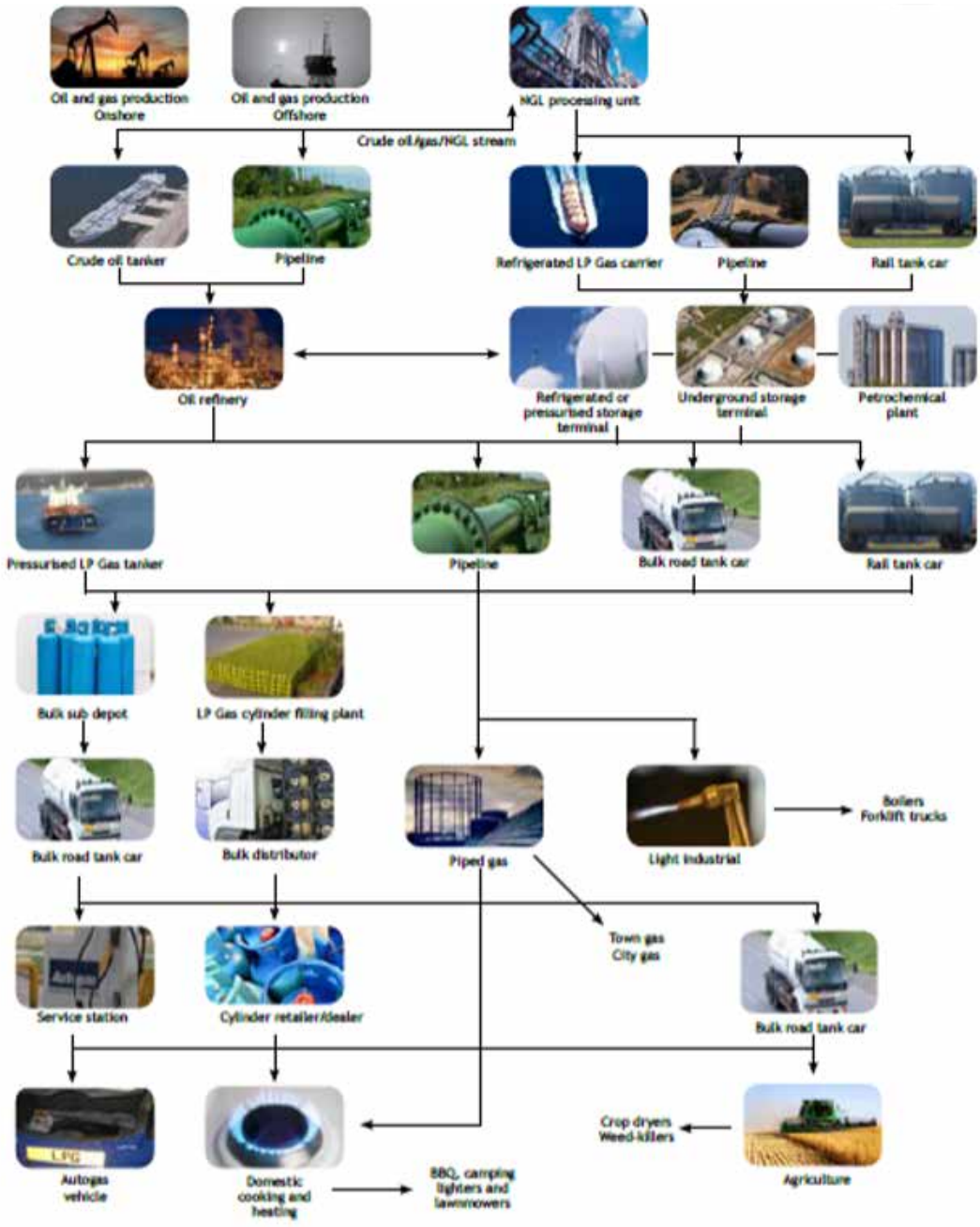


The arrows show the general direction of trade flows, from the producing countries to the centres of demand, by sea and land, with year on year movement (2022-2023) (source: Argus Media)

APPENDIX 3

Typical LPG Distribution Channel

(COURTESY ARGUS MEDIA – WWW.ARGUSMEDIA.COM)



APPENDIX 4

LPG STORAGE BY COUNTRY
(SOURCE: WLGA STATISTICAL REVIEW OF GLOBAL LPG 2024)

Total LPG storage by country	'000t
Country	**Total storage**
North America	
United States	25,458
Canada	3,750
South and Central America	
Argentina	374
Brazil	1,683
Chile	405
Colombia	13
Costa Rica	28
Dominican Republic	126
Ecuador	109
El Salvador	23
Jamaica	4
Mexico	1,298
Peru	121
Trinidad and Tobago	57
US Virgin Islands	6
Europe and Eurasia	
Austria	2
Belarus	10
Belgium	277
Bulgaria	17
Czech Republic	3
Denmark	10
Finland	315
France	558
Germany	153
Greece	10
Hungary	14
Ireland	21
Italy	85
Kazakhstan	61
Lithuania	10
Netherlands	194
Norway	400
Poland	72
Portugal	150
Romania	10
Russia	264
Serbia	11
Spain	204
Sweden	594
Switzerland	1
Turkey	361
Turkmenistan	9
Ukraine	53

Total LPG storage by country	'000t
Country	**Total storage**
UK	740
Uzbekistan	9
Middle East	
Bahrain	40
Iran	327
Iraq	243
Israel	17
Jordan	89
Kuwait	1,280
Lebanon	20
Qatar	533
Saudi Arabia	1,222
UAE	708
Africa	
Algeria	418
Cameroon	6
Egypt	463
Ghana	27
Ivory Coast	6
Kenya	34
Libya	86
Morocco	244
Nigeria	242
Senegal	5
South Africa	34
Tunisia	20
Asia-Pacific	
Australia	556
Bangladesh	93
China	6,746
India	964
Indonesia*	1,758
Japan	4,163
Malaysia	202
New Zealand	11
Pakistan	15
Philippines	143
Singapore	50
South Korea	1,389
Sri Lanka	41
Taiwan	301
Thailand	160
Vietnam	371

Notes: LPG storage of over 1,000t is included but some volumes are unconfirmed and totals may not be comprehensive

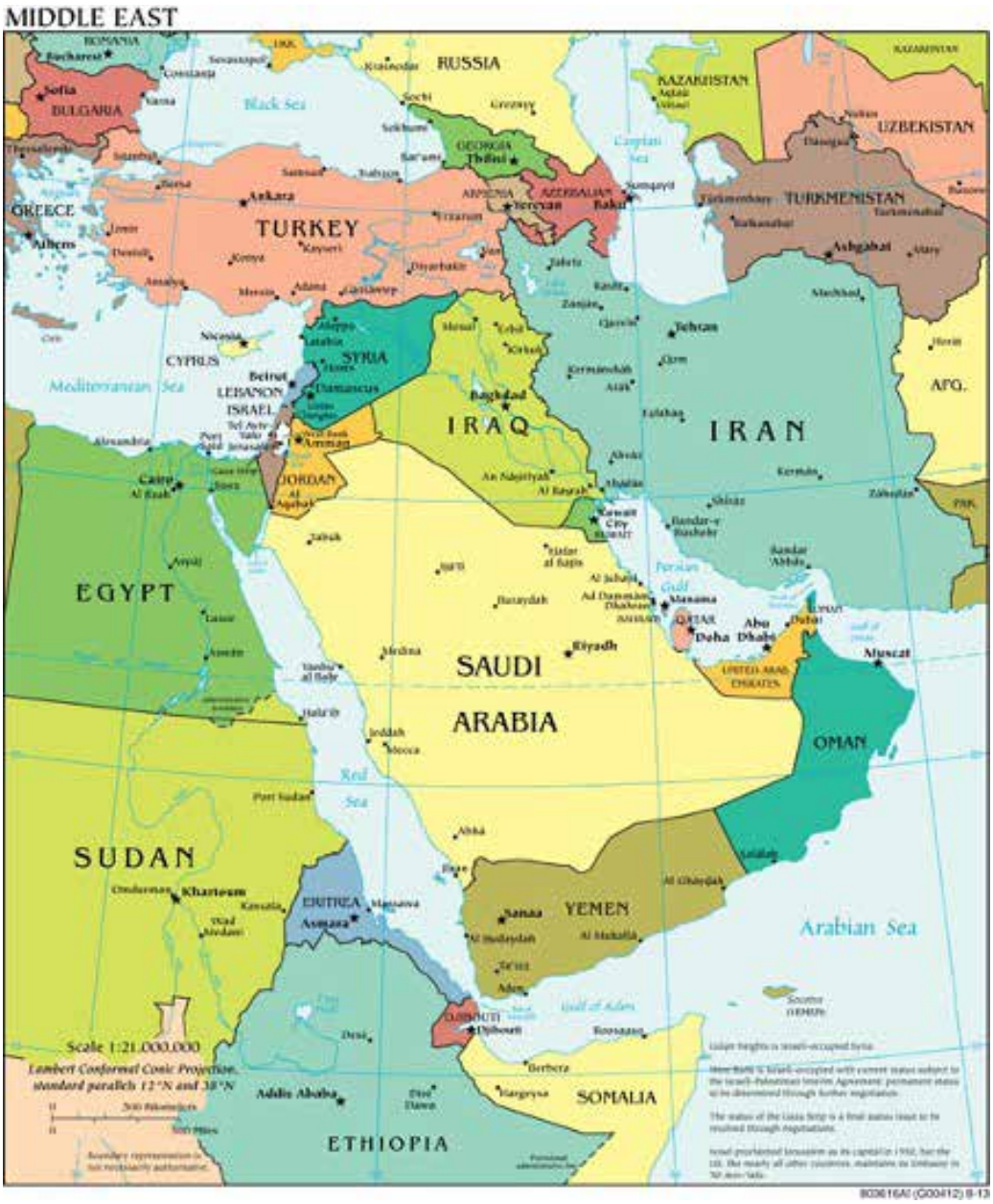
*** Indonesia - includes floating storage**

– LPG Storage Survey from Argus LPG World

APPENDIX 5 –

Refugee Flows from Yemen

The following map has been included to illustrate the impact of one crisis in one country and the neighbouring countries that are affected by it.
Additional maps could be included for many other countries and a similar pattern would emerge. Events causing forced displacement of populations in one country impact not only on its neighbours, but on surrounding countries within in the region.

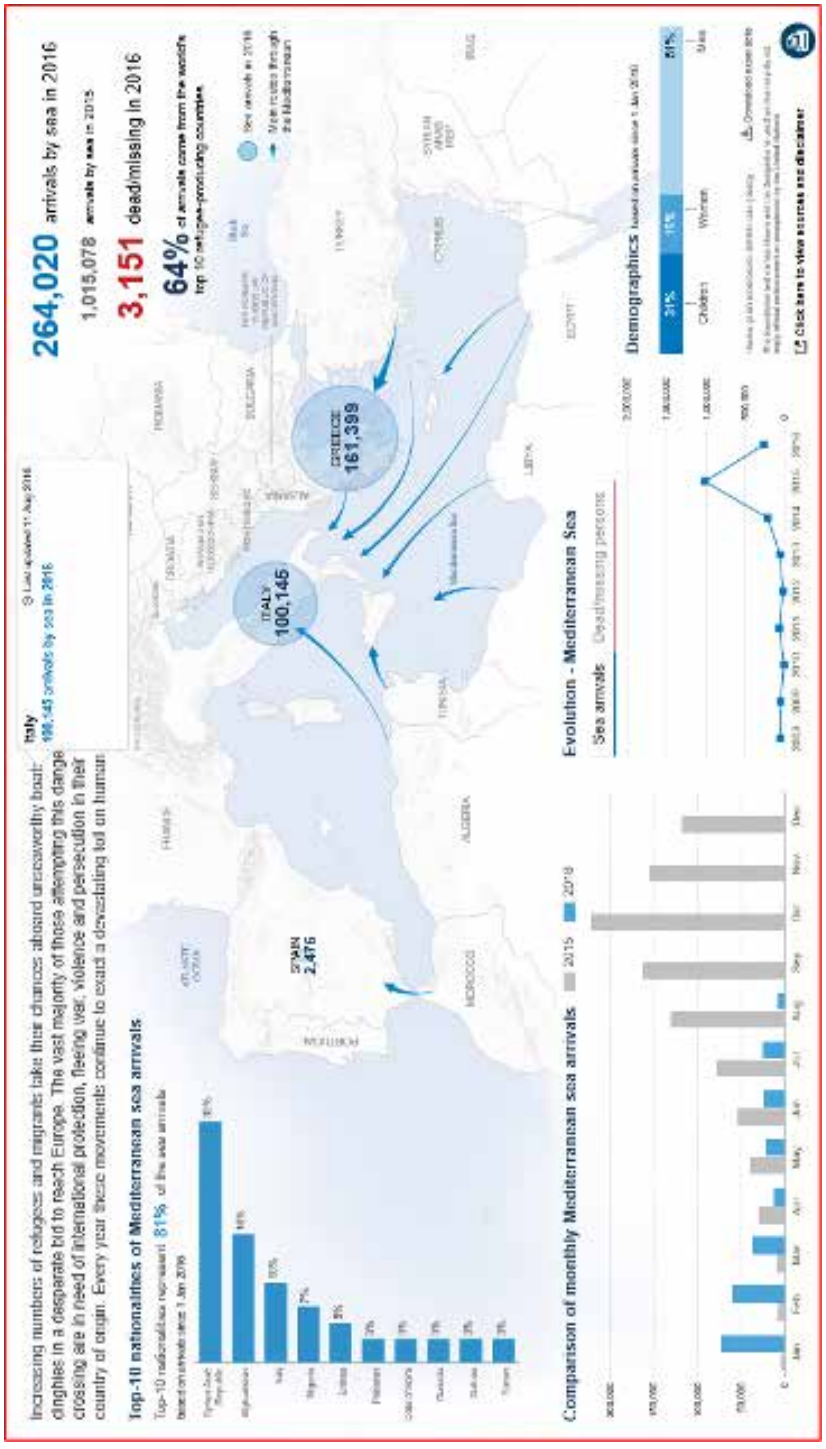


An illustrative map showing typical refugee movements from a conflict area. In this case refuges from Yemen seek refuge in several neighbouring countries, many of which are already struggling to cope with their own populations (source: UNHCR)

APPENDIX 6 –

Refugee Flows in the Mediterranean

The following chart has been provided by UNHCR and demonstrates the refugee flows, and the scale of numbers, in the Mediterranean (2016). It is shown here to illustrate the enormity of the situation and the impact on the receiving countries.



REFERENCES

http://actu.epfl.ch/news/smart-energy-to-power-refugee-camps/

http://www.unhcr.org/4a1d2f422.html

https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/2016-05-19-mei-energy-situation-dadaab-refugee-camps-okello-final.pdf

https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/20151117heatlightpowerrefugeesmeilahngrafham.pdf

https://www.euractiv.com/section/global-europe/news/refugee-camps-energy-bills-over-2bn-due-to-neglected-energy-efficiency/

http://www.theguardian.com/world/2015/ nov/02/winter-is-coming-the-new-crisis-for-refugees-in-europe

http://www.wolframalpha.com/input/?i=refugees

http://www.wlga.org/

http://www.cleancookstoves.org/

http://www.safefuelandenergy.org/

http://caritas.ge/

http://www.unocha.org/

http://www.practicalaction.org/

http://carbon-clear.com/uk/

https://www.chathamhouse.org/

http://www.energy4impact.org/

http://www.who.int

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