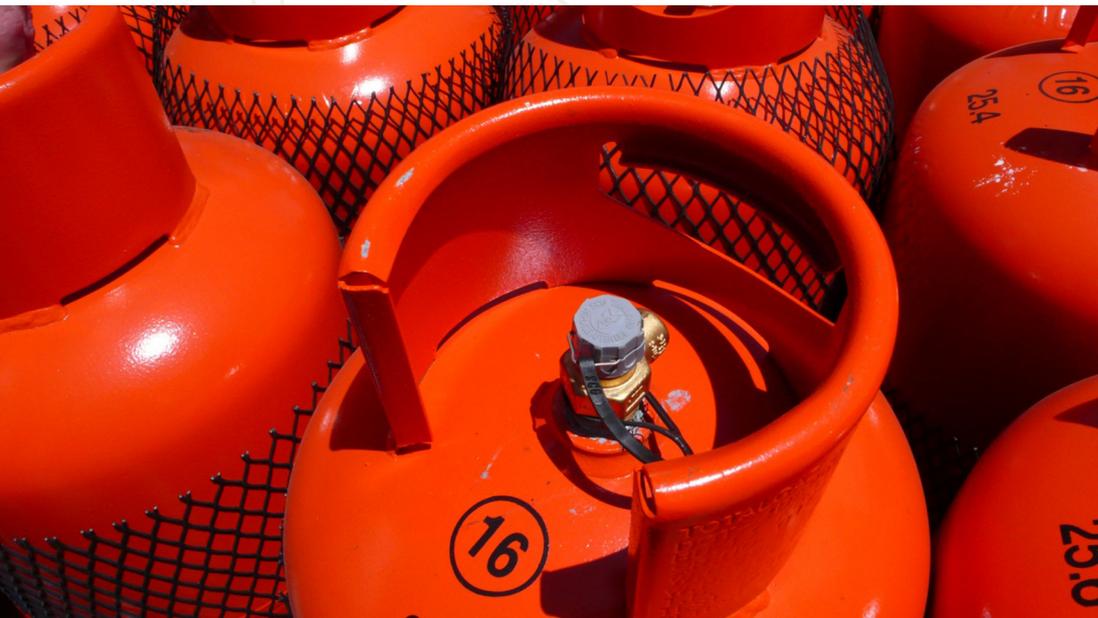


Guidelines for the Development of Sustainable LPG Markets

Transitioning-Stage Markets



GOOD INDUSTRY PRACTICES

The World LP Gas Association

The World LP Gas Association was established in 1987 in Dublin, Ireland, under the initial name of The World LPG Forum.

The World LP Gas Association unites the broad interests of the vast worldwide LP Gas industry in one organisation. It was granted Category II Consultative Status with the United Nations Economic and Social Council (ECOSOC) in 1989.

The World LP Gas Association exists to provide representation of LP Gas use through leadership of the industry worldwide.

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Introduction

Purpose of this Edition

The *Early-Stage Markets Edition* of the *Guidelines for the Development of Sustainable LPG Markets* focuses on countries where LPG use per capita is low: below 10 kg per capita per year, and typically around 2 kg per capita per year.

This *Transitioning-Stage Markets Edition* focuses on countries that have attained LPG consumption of around 15 kg per capita per year, or are approaching that level, and aspire to develop successfully to the advanced stage over time.

This Edition assumes that the recommendations of the *Early-Stage Markets Edition* were implemented and resulted in relatively steady and safe growth of the LPG market and, in particular, of the market's inventory of safely filled and maintained LPG cylinders.

It introduces additional recommendations for:

- Safeguarding and building upon the benefits achieved during a positive early-stage LPG market development experience
- Supporting increased scale and scope of LPG use
- Detecting and preventing market dysfunction

Typically, national goals for LPG in the transitioning stage include:

1. Expanding LPG access to more geographic areas, including especially non-urban areas
2. Expanding LPG access to more of the population, including especially middle and lower income consumers
3. Integrating LPG more directly into national energy planning
4. Strengthening safety and the use of good practices throughout the LPG value chain

As part of energy planning, it is useful for Government to work with an effective and capable national LPG industry association to access both local sector information and information gathered from industry worldwide. That information can guide and inform debate and decision-making about the national LPG sector and about the optimal role of LPG within the national energy mix.

The outcome of effective national debate and decision-making is, ideally, a secure fuel supply situation that provides the right mix of energy sources for all, at affordable prices, and with sufficient choice to meet national needs for efficiency, low emissions and suitability for the intended energy uses.

It is absolutely clear for both early stage and transitioning stage markets that appropriate laws and regulations, adequately enforced, are the single most critical factor in whether widespread access to, and use of, LPG by a country's households and businesses can be achieved in the near and medium term and sustained for the long term, thus progressing these markets into the advanced stage category.

Progressing to an Advanced Stage LPG Market

Advanced-stage markets are not necessarily defined by greater LPG consumption, which may range from around 15 kg per capita per year (for example, France's 18.5 kg) to 40 kg per capita per year or more (for example, the USA's 41.4 kg, Korea's 45.7 kg, Morocco's 48 kg, and Japan's 67 kg). Some advanced LPG markets are actually smaller (for example, the UK's 6.4 kg, Germany's 5.7 kg).

Rather, advanced markets are characterised by:

- The sophistication and diversity of the LPG value chain
- High collaboration between stakeholders (including Government) on common issues of national energy-mix planning, public safety and market structure and function
- An excellent overall safety record

LPG in an advanced market is consumed for a very wide variety of industrial, transport, commercial and residential applications. The volume of LPG consumed is stable year over year, or may be in gradual decline relative to complementary energies like natural gas and low-cost electricity.

However, the LPG market may continue to expand in suburban, peri-urban and rural areas, where complementary energies like natural gas and electricity remain more expensive and/or more time-consuming to deploy than LPG, and in applications where these alternative energies are unsuitable or unfeasible.

Chapter One

Distinct Characteristics of Transitioning Markets

1.1 The Changing LPG Landscape

As an LPG market develops from the early stage to the transitional stage, it will change not only in size but also in scope, structure, complexity, participant capabilities and its developmental issues. These changes create both opportunities and challenges for all LPG stakeholders: end-users, LPG companies, LPG investors, civil society and government.

Wise planners, policy makers and regulators must monitor for trends that may indicate that:

- Market transition is beginning to occur, is occurring, or has occurred
- The transitioning LPG market is operating safely and in an economically sustainable manner, to the benefit of all its legitimate participants—or is not
- LPG is delivering appropriately on national policy goals for energy and development—or is not

Among the characteristics that distinguish a transitioning LPG market from an early stage market are:

1. Significantly increased LPG consumption
2. Diversification of the mix of LPG applications
3. Diversification of customer types and distribution modes
4. Increased LPG sector economic and capacity development
5. Distribution and retail diversification
6. Increased supply chain stability
7. Diversification and expansion of types of facilities in the supply chain
8. Growing confidence in LPG, including the safety of LPG
9. Pressure on government regarding its enforcement role, resources and responsibilities
10. Opportunities to integrate LPG into national energy planning across sectors

Many of these changes are interdependent.

A particular challenge for transitioning-stage LPG markets is that these changes do not necessarily all happen at the same time or at the same pace. Properly nourished and guided by public authorities, these market changes will lead to more, and safer, national benefit from LPG as a reliable and affordable energy choice, and will prepare for a smooth and orderly progression to a large, advanced LPG market over time.

1.2 Advanced LPG Markets

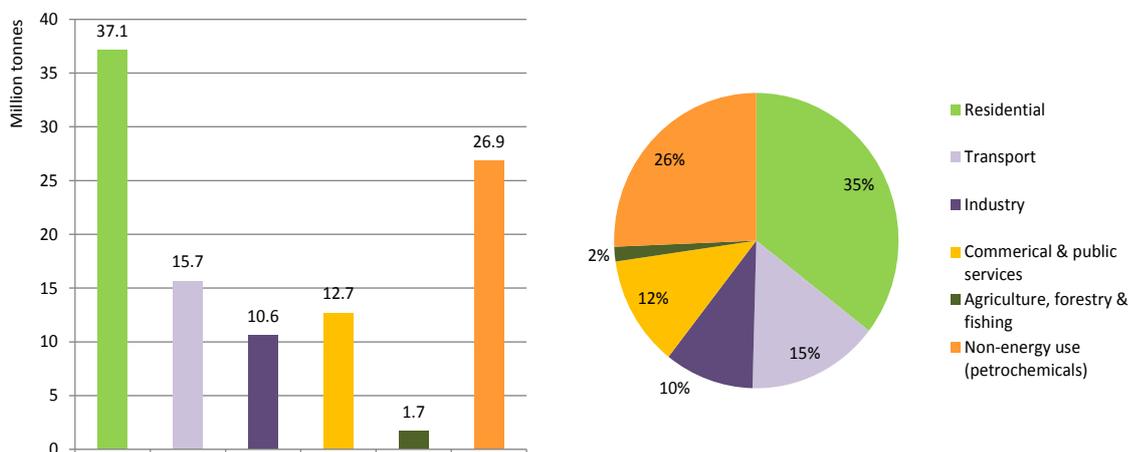
Ultimately, an LPG market with adequate policy and regulatory frameworks, enforcement action, and ongoing private sector investment will evolve into an advanced-stage market. Such a market will be consistently safe, profitable for industry, value-creating for users and other stakeholders, and diverse in its applications.

Per capita consumption is no longer a useful measure of an advanced market's stage. An advanced market may have significantly greater consumption per capita—for example, Japan at 67 kg—or consumption may stay at a transitioning-stage level, around 15 kg per capita—for example, France at 18 kg—or even decline—for example, the

UK at 6.4 kg. The advanced stage market will be characterised by strong institutional capabilities; relatively low fragmentation; vertical integration and possibly horizontal integration in the supply chain; high cooperation on safety and on developing shared scale economies; and high levels of competition on the basis of customer service, branding, price (where unregulated), and application diversity.

As an indication of the application diversity in advanced markets, the chart below shows the LPG consumption mix of the OECD economies in aggregate as of 2012:

Figure 1: Final energy consumption of LPG in OECD countries, 2012



Source: Menecon Consulting analysis; International Energy Agency online databases (data.iea.org).

1.3 Increased LPG Consumption

In a transitioning market, LPG consumption increases significantly over early-stage market levels, typically to around 15 kg per capita per year. This growth in consumption is driven by a number of factors that are described more fully below.

The most important factor remains this:

Appropriate laws and regulations, adequately enforced, are the single most critical factor in whether widespread access to, and use of, LPG by a country's households and businesses can be achieved in the near and medium term and sustained for the long term.

LPG consumption will have increased significantly in both absolute terms and relative to other energies such as charcoal, kerosene, diesel fuel and often electricity.

Typically, the ability of government to measure LPG consumption accurately (whether for taxation or statistical purposes) will have improved. A main reason is that illegal activities like LPG smuggling and unauthorised LPG cylinder filling and decanting decline with effective enforcement by Government of market rules.

The significant increase in LPG consumption in a transitioning-stage market is part of a virtuous cycle of **increased confidence in the LPG sector** to deliver LPG safely, affordably, consistently, reliably and in an economically sustainable manner. The greater the public and institutional confidence in the LPG sector, and in the system of well-enforced market rules that underlie it, the more investment in, and purchase of, LPG and related products will occur. And the more such investment and purchase occur, the greater the confidence in the sector will be—*provided* that the system of well-enforced market rules, described in the *Early-Stage Edition*, continues in full force.

1.4 Diversification of the Mix of LPG Uses

In early-stage markets, LPG is primarily used for cooking and, based on climate, heating. As the market develops, LPG displaces solid fuels such as wood, charcoal, kerosene and animal waste, bringing health benefits and reducing time spent in gathering fuel.

Commercial and Industrial Uses

As the LPG market develops, additional uses of LPG emerge. These may include hotels' and leisure complexes' use of LPG to heat pools, spas and saunas; weed destruction, grain drying and space-heating in rural settings; and industrial use in sectors such as ceramics, glassmaking and food processing.

Further application examples that emerge in transitioning markets include LPG-fuelled forklift trucks for indoor and outdoor warehouses; substitution of LPG for diesel fuel in power generators; and, depending on the local culture, use in crematoria.

The ability for LPG to have such diverse uses is a function of its high energy density, cleanness and portability. These properties of LPG have led to thousands of practical industrial and commercial uses worldwide. For more information about the diverse applications of LPG, please consult www.lpg-apps.org.

Transport Uses

In many transitioning markets, LPG also gains share of the transport fuel market. LPG used for transport is termed **Autogas**.

Internal combustion engines can be retrofit at modest cost to accept LPG as a substitute for petrol (gasoline).

An Autogas sector can emerge informally—for example, as a result of widespread retrofits of taxi fleets of their own volition to take advantage of LPG cost advantages vs. petrol. It can also emerge from the combination of formal governmental planning that adjusts fiscal and tax policy across transport fuels (LPG, petrol, diesel, etc.) and commercial and technical support from transport original equipment manufacturers (OEMs) and transport-fuel distribution companies.

Governments that plan for increased LPG use as a transport fuel are typically motivated by policy goals to reduce pollution in cities and/or to mitigate climate impacts from the national transport sector.

It is beyond the scope of this document, whose main focus is the LPG market for cylinders, to discuss in detail the many policy and regulatory considerations for achieving and sustaining a safe, viable Autogas sector. For more information, the reader may consult www.worldlpgas.com/uploads/Modules/Publications/autogas-incentive-policies-2012-updated-july-2012.pdf.

Additional Residential Uses

With the growth of a more affluent middle-class, residential users may seek to fuel certain leisure activities. Additional cylinders may be employed in homes for heating, barbecues, swimming pools, and other uses.

1.5 Diversification of Customer Types and Distribution Modes

The early-stage market is very much a retail, business-to-consumer market, driven by household-sized LPG cylinders. Depending on the size and characteristics of the country, the distribution chain from producer or importer to end-user may be simple.

As the market grows and diversifies into agricultural, commercial and industrial uses of LPG, it adds a business-to-business market segment.

Business buyers typically have more sophisticated needs, involving energy solutions tailored to specific business requirements. Industrial buyers may also seek ways to stabilise the prices of energy inputs, such as by hedging arrangements with energy suppliers or third parties.

Increased industrial demand for LPG leads to increased need for bulk LPG storage located at the users' premises. However, in many countries, closely-packed factories lack space to permit the installation of bulk LPG vessels. To comply with local LPG safety regulations, alternatives to on-site bulk storage must be found. An example is the use of manifold banks of large cylinders for meeting the gas needs of a factory. This requires the introduction of larger cylinders, typically of 45-50 kg capacity.

The leisure customer may require a more ergonomic cylinder that is lighter and more convenient, resulting in demand for additional small cylinder sizes and/or cylinders made from alternative materials.

The retail customer, particularly as he/she becomes more mobile, may have greater choice among alternative suppliers and may shop around for the best value for his or her gas cylinder and appliances. This leads to increased competition among suppliers and increased consumer switching between suppliers.

In a number of markets, the distribution of LPG cylinders has moved to major supermarket chains and even to automatic pre-filled cylinder vending machines, allowing consumers round-the-clock access to a selection of cylinder choices. It remains essential that the LPG Marketer (owner of the cylinder) retains the obligation, the responsibility and the capability for inspecting, filling, maintaining and (if needed) scrapping the cylinder, coupled with the reward of profit from refilling it over its lifetime.

Saturation of Urban Household Market

In a transitioning market, the urban market segment in major population centres is likely to approach saturation. Penetration levels of urban households may approach 70% or more. This presents both an opportunity and a challenge.

The challenge is that safety of LPG use and distribution becomes even more important as a public issue. Increased LPG use creates more chances for an improperly filled or poorly maintained cylinder to explode. The potential for deaths from such explosions is highest in a densely populated area.

The opportunity is that a strong customer base in urban areas can be leveraged operationally and economically by legitimate LPG Marketers to support deeper penetration of LPG into non-urban areas, provided that the national system of well-enforced market rules, described in the *Early-Stage Edition*, continues in full force in both urban and non-urban areas.

Increased Penetration of Rural Markets

The lower level of household income in most rural markets and the increased logistical cost to distribute LPG there typically cause the rural penetration and use of LPG to be substantially less than in the urban and peri-urban case. This disparity typically persists until the advanced stage of a market, wherein other energies like natural gas may begin to displace LPG in urban centres, and the geographic locus of LPG use shifts outward into suburbs.

However, as the urban LPG sector grows and strengthens, and as rural incomes increase, the natural geographic boundaries within which LPG is viable to distribute commercially will expand. Rural use of LPG can be expected to grow from penetration levels of well below 5% (sometimes under 1%) in many early-stage markets to 20% or more in a transitioning market.

This growth of rural LPG use represents both a benefit and challenge, as described more fully later in this document. The benefit is straightforward: more LPG use in rural areas results in decreased pressure on forest resources for wood fuel and charcoal, and increases the health of rural populations by eliminating harmful cooking smoke.

The challenge is that effective enforcement of necessary market rules, and ensuring good practices and adequate safety for more-remote operations, may be more difficult and resource-intensive to achieve.

1.6 Increased LPG Sector Economic and Capacity Development

As the LPG market transitions, several economic and capacity trends may emerge within the sector:

1. LPG industry profits—and associated government revenues—will rise
2. A number of stronger, pure-LPG companies may emerge
3. LPG companies may vertically integrate across portions of the LPG supply chain (whether guided or organic)
4. Some consolidation of the sector may occur (whether guided or organic), resulting in fewer, larger companies
5. Human capacity and capability in the LPG sector will increase, through experience and formal training

All of these trends are favourable and should be encouraged. They increase the capability of the private sector to serve an expanded base of LPG users.

Government must monitor these trends and should ensure that adequate competition and compliance with regulation continue, balancing the social benefits of increased LPG availability, affordability and safety with the commercial sustainability of the LPG supply chain.

A caution: With rising industry profits comes a rising temptation for a class of non-compliant “entrepreneurs” to attempt to enter the LPG market illegally, without adhering to market rules about fair competition, respect for property rights, safety, and so on. The emergence of this “illegal entrepreneur” class, together with its bad practices, imperils the economic viability of legitimate LPG players, imperils public safety, and undercuts government revenue (as a consequence of their operating outside of the government’s tax regime).

These issues are revisited more fully later in this document.

1.7 Diversification and Expansion of Types of Facilities in the Supply Chain

Granularity in Cylinder Filling and Storage Facilities

As key stakeholders—including Government, LPG Marketers and distributors—evaluate ways to serve a greater portion of the population with LPG, a key consideration is how to extend LPG supply chains safely and viably. There are three main alternatives:

1. Extension of transport logistics: placement of cylinder depots, together with extension of cylinder transport networks, into increasingly remote areas
2. Decentralisation of filling: placement of smaller storage and filling facilities closer to end users located in remote areas
3. Alternative distribution systems: leveraging the distribution systems of other goods and services to provide LPG to remote areas

Each of these involves increased investment in, and use of, smaller-scale facilities of various types along one or more portions of the LPG supply chain.

In the absence of planning and guidance from Government, local industry is likely to experiment with all three to varying degrees. However, this must be undertaken with care, because the consequences to long-term sustainability of the market, including to public safety, can be significant from too-aggressive pursuit of an unsustainable or unsafe mix of alternatives.

These issues are discussed more fully later in this document.

Additional Types of Facilities and Equipment

As mentioned earlier in this document, new applications for LPG mean new types of facilities and equipment. These may include

1. Autogas filling equipment, Autogas retrofit kits for petrol-based vehicles, and OEM-designed Autogas vehicles
2. Increased use of on-site bulk LPG storage tanks for commercial and industrial users
3. Additional types of LPG equipment, such as forklifts, cutting tools, bulk heaters and dryers, and so on

Each has particular safety requirements for operation, refilling, maintenance and storage.

1.8 Growing Confidence in LPG

The single most important aspect of market transition from the early stage to the advanced stage is the growth of confidence in LPG among all key stakeholders—LPG users, companies, investors, civil society and Government. Absent specific surveying about confidence measures, stakeholders (including Government) may monitor a variety of indicators to identify whether confidence is growing. Growth in confidence, combined with adequate safety, translates into growth of the market. Examples of such indicators are:

1. Total economic size of announced LPG sector investments planned in the country (more being good)
2. Incidence of LPG-caused public harm (deaths, injuries, fires, property damage) (fewer being good)
3. Positive vs. negative mentions of LPG in the media
4. Enterprise values of legitimate LPG firms (greater being good)
5. Level of hiring within the LPG sector (if reported) (more being good)
6. Governmental revenues from the LPG sector, assuming rates of taxes and fees are stable (more being good)
7. Number of legitimate applications for new LPG licenses and registrations, assuming stability of licensing requirements (more being good)
8. Level of complaints from the public about LPG issues (fewer being good)
9. Level of complaints from legitimate LPG companies about non-compliance and other forms of dysfunction or bad practice in the LPG market (fewer being good)
10. Geographic extent of demonstrated retail access to LPG (more being good)
11. Other indicators

Additional, qualitative indicators may include reputations of legitimate LPG firms and consumer perceptions about the desirability of LPG (more favourable being good), which may be assessed via survey.

1.9 Pressure on Government Regarding its Enforcement Role, Resources and Responsibilities

As the LPG market develops, its increased size, scope, level of activity, number of participants, and complexity inevitably require-and may strain-governmental resources in the areas of

1. Regulatory enforcement, which must occur across more market players (legitimate and illegitimate), in more locations, further from urban centres
2. Funding for increased obligations for existing governmental subsidy on LPG fuel or equipment (if any)
3. Planning for LPG within the national energy mix

In advanced markets, the demands on Government may actually be reduced, because a strong private LPG sector comprised of competent, professional, larger-scale companies and an effective national LPG association can help Government via an agreed, effective level of self-regulation and other forms of public-private cooperation.

But in transitioning markets, the critical role of Government remains extremely important, and the corresponding workload on Government actually increases.

As stated earlier:

Appropriate laws and regulations, adequately enforced, are the single most critical factor in whether widespread access to, and use of, LPG by a country's households and businesses can be achieved in the near and medium term and sustained for the long term.

These pressures on Government should be viewed as a good thing: they mean that LPG has started to provide much greater benefit to a much larger portion of the population, and to the nation's economic development, than ever before. Government, through its attention and action (or inattention and inaction), will inevitably determine whether that progress is sustained and even accelerated, or whether the market devolves back toward the size and problems of the early stage.

Development of an LPG market is not necessarily always forward. Worldwide experience shows that LPG markets can easily devolve, with corresponding increases in safety incidents, loss of confidence, declining consumption, declining investment, and exits of legitimate LPG companies, if the conditions necessary for a sustainable market are no longer maintained.

1.10 Opportunities to Integrate LPG into National Energy Planning Across Sectors

As LPG becomes a larger portion of a country's energy consumption, it creates an opportunity for Government to include LPG formally in national energy mix planning.

Starting in the transitioning stage of the market—if not before—LPG can and should be a formal component of a country's secondary energy matrix¹. Governmental planning should include what quantity of LPG is required—and desired—in future, in order to satisfy the main sources of national energy demand, such as transport, heating, cooking, lighting, industrial, etc.

Public-private coordination can then focus on planning and implementing the environment and activities that will match LPG supply, infrastructure and distribution to the needs and goals defined in the energy matrix.

This topic is covered more fully in Chapter Four, *Planning for LPG in the National Energy Mix*.

LPG and Alternative Fuels

As the economy of the country develops and per capita energy usage increases, markets for other types of fuel also develop. Which fuels may come to dominate the market depend on a number of factors. For example, if there is abundant geothermal, wind, solar or hydro-electric energy, an increasing level of access to very affordable electricity may shift consumption for some applications toward on-grid electric appliances. If industry demands natural gas for high-energy processes, natural gas suppliers may consider investment in import facilities and local reticulation infrastructure or Compressed Natural Gas (CNG) infrastructure.

The pricing structure for energy in any country will depend very much on the energy strategy of the national government and the taxation structure, pricing policy (if any), and subsidies (if any) the government applies to each type of energy.

In addition to being a very clean energy, LPG has as a major advantage the ability to reach every region of a country in cylinders, wherever passable roads or littoral transport are available. In planning its energy matrices and corresponding energy-related fiscal policies, Government should consider the trade-offs among the fixed and capital costs and variable and operating costs of energy infrastructure and distribution, and of social, health and environmental impacts, across both geography and main energy applications.

¹ The primary energy matrix maps key energy sources that are directly consumed, like oil, natural gas, coal, wood and hydropower, to total energy demand. The secondary matrix maps transformed or derived energy sources, like LPG.

LPG typically performs very favourably with respect to capital cost, scalability, geographic reach, and social and environmental benefit.

Misleading and Incomplete Indicators of LPG Market Progress

Stakeholders, particularly Government, must be alert to false indicators about the progress of the LPG market.

As an example, a certain East African country, as of this writing, had a number of positive indicators about its LPG market that might have suggested it had progressed successfully into the transitional stage:

1. Increased LPG consumption. Particularly in urban areas (although this had levelled off in recent years).
2. Diversification of distribution modes. Example: Experiments in rural distribution using mobile filling systems.
3. Increased LPG sector capacity development. Example: Increased training activity throughout the LPG sector. Effective and dynamic national LPG association.
4. Distribution and retail diversification. Examples: Commercial experiment in peri-urban cylinder retailing using specialised kiosks; leveraged LPG distribution through rural employment cooperatives.
5. Increased supply chain stability. Example: Recently investment in increased import capacity investment to offset unreliable refinery supply of LPG.
6. Growing confidence in LPG. Tens of millions of US dollars of new private sector investment had been announced in the media (although little of this had actually been invested yet).
7. Pressure on government regarding its enforcement role, resources and responsibilities. Indeed, pressure from industry and the LPG association was very high for increased enforcement.

However, a recent audit of the LPG distribution and retail chain revealed that the majority of commercial LPG activity in the country was actually carried out by illegitimate, non-compliant operators. Real confidence in the sector was poor. LPG safety was declining and deadly explosions occurring with greater frequency. Cylinder investment by legitimate companies was occurring primarily to preserve market share against inroads by illegitimate operators, rather than to grow the market.

These contrary indicators had not been reliably measured in the past. They reveal that the country is not yet in the transitioning stage, but is still in the early stage. Thus, the country must concentrate first on enforcing successfully the market rules necessary for good early-stage LPG market development.

Planning for and Managing LPG Market Change

2.1 Inspection and Enforcement Agencies

As the scale of governmental responsibilities in enforcing market rules grows with the growing LPG market, the required tasks may exceed the staff resources of Government.

Government must either plan for expanded internal resources for enforcement, or for engaging one or more independent enforcement agents with suitable powers and authority to identify non-compliant operators and impose penalties and/or seize assets (subject as applicable to court sanction). In some countries, funding for such additional resources is divided between Government and industry.

In both early stage and transitioning markets, self-policing by industry should not be tolerated. Even legitimate market participants in such markets may have certain personnel, or certain activities, that are intentionally non-compliant, despite an overall posture of compliance.

2.2 Uniting LPG Marketers with their Cylinders

One issue that arises as the LPG market expands and more competitors enter it is the ability of customers to switch between more and more LPG suppliers. With the cylinder being the property of the LPG Marketer, one supplier's distribution system may end up in possession of a competitor's cylinder each time a customer switches suppliers. Such cylinders may accumulate at retailers and distributors, or make their way back to the originating filling plant.

A key market objective for both regulators and operators is having a realistic mechanism that ensures that each LPG Marketer's cylinders are returned to it promptly for inspection, maintenance, scrapping (as needed) and refilling. Some countries employ a dedicated organisation to arrange the recovery and return of all such "stranded" cylinders. Others ensure that agreements are in place between the LPG Marketers, so that each LPG Marketer can (and must) collect its own cylinders from the others' inventories.

2.3 Market Entry and Exit of LPG Companies

Even in a robust and growing market, some LPG Marketers will go out of business, voluntarily or involuntarily. It is essential that their branded cylinders do not then become a means and a lure for illegal fillers to expand their illegitimate activities.

A key objective for both regulators and operators is having a practical mechanism that ensures that the entire inventory of an existing company's "stranded" cylinders—whose owner is no longer in the market—is rebranded with a new owner, and that the corresponding customer, distribution and retail relationships are transferred timely.

A bidding, allocation, or other equivalent process among other legitimate LPG Marketers to acquire "stranded" cylinders and distribution and retail contracts, together with a rebranding, testing and recertification requirement, is one proven mechanism for ensuring that all cylinders on the market remain legitimate, properly branded, and safe, and that the customers, distributors and retailers of a failed or exiting LPG Marketer have the maximum opportunity to remain part of the LPG chain with minimum disruption of supply.

2.4 Policy and Regulatory Drift

For domestic reasons, the public authorities in a country with a transitioning LPG market may adjust the market rules which make up and underlie the cylinder distribution and market model described in the *Early-Stage Edition*. This may occur gradually, or abruptly.

First and foremost, successful progress to the transitioning market stage from the early stage, and sustaining the advantages gained from a transitioning-stage market, require stability regarding the market rules.

The private sector cannot plan and commit substantial investment when there is uncertainty about the market rules in future.

This said, rules may be adjusted by Government in ways which improve the conditions for LPG market development or which, as an unintended consequence, impede that development. In fairness to governmental planners, unintended consequences can be difficult to predict.

In general, it is not practical, and often not possible, to make up for a material deviation in one area of the necessary and sufficient set of rules for sustainable LPG market development (as set out in the *Early Stage Edition*) by adjusting some other area of the rules.

As the trade-offs and consequences of trade-offs that may be proposed or made by Government in law-making or rule-setting for LPG are very case-specific and case-sensitive, the following is restated from the *Early-Stage Edition*:

The Role for Well-Qualified Experts

These Guidelines must not be implemented without considering the existing conditions in a given country. Therefore, the WLPGA strongly recommends that these Guidelines be used along with input from professionals in the field of LPG distribution and retail with deep, relevant experience in the transition of LPG markets from early-stage to transitioning-stage. In all cases, a key requirement is that a competent expert in LPG distribution and retail must assess the safety aspects of any national distribution system and its corresponding law and regulation in order to ensure that safety risks are managed to a level that is acceptably low for that country's stakeholders and its people.

2.5 Addressing Supply Chain and User Storage Developments

This section discusses the new infrastructure, equipment and processes that typically arise when markets reach the transitioning stage. Each case discussed below may require a corresponding advancement in regulation and regulatory enforcement capability.

2.5.1 Infrastructure

A typical early-stage market might involve an LPG import terminal supplying one or more cylinder filling plants which, in turn, supply cylinder distributors. The distributors supply retail points where new customers obtain LP equipment and returning customers exchange empty LPG cylinders for full cylinders.

The Import Terminal

At its most basic, the import terminal can comprise a jetty for receiving ISO containers of LPG and transferring them to stands where they are coupled to a pump and thence to co-located cylinder filling systems or to a road or rail tanker filling point for bridging to a distant cylinder filling plant.

At the next level of sophistication and scale, the import terminal will have a jetty or offshore mooring point and pressurised fixed LPG storage (in spheres or bullets) and will receive small pressurised cargoes.

As the scale of the operation increases, large cargoes in the scale of thousands of tonnes may become necessary to receive. The terminal must then be equipped to handle refrigerated LPG.

This implies either the installation of heating facilities to bring the cargo to ambient temperature for immediate transfer to pressurised storage, or refrigerated storage with heating for transfer into pressurised storage later.

An interim stage might be mooring of “floating storage” off shore whilst on-land import terminals are constructed.

There are comparatively few import terminals with refrigerated storage, and as some ships are equipped with heating facilities, it may become the norm to move to large pressurised storage for import facilities as the market grows.

Joint ventures and public utility models to invest in import terminals (and/or cylinder filling and bulk distribution facilities) are feasible solutions to achieving economies of scale and justifying increased investment.

Such projects may be private-sector driven (with appropriate governmental regulation and oversight) or public-private initiatives.

The Cylinder Filling Plant

Cylinder filling facilities using a number of manual filling machines served by manual handling are typical in early stage markets. If these facilities are configured correctly, this method of filling can be efficient. It is scalable up to a point. In a low labour-cost economy where it is desired and justified to support increased employment, this method of cylinder filling may suffice into the transitioning-stage market and beyond.

Simple process planning will ensure that workers are not waiting for cylinders to fill, but are continually engaged in placing or removing cylinders. As volumes increase significantly, it often becomes justifiable to install automated cylinder filling lines or to palletise cylinders to reduce manual handling.

Some LPG Marketers may equip their cylinders with RF chips so that the entire cylinder de-palletising, filling and palletising process can be automated (other than for supervision). A microchip on each cylinder also has the advantage of enabling tracking of the cylinder along much of the distribution chain, providing data on usage rates, requalification due dates, and so on.

Distribution

In an early stage market, cylinder distribution is often performed by distributors with ordinary trucks collecting cylinders from, and returning cylinders to, the filling plant. (A distributor operates under contract to an LPG Marketer.) Empty cylinders are moved manually one by one from the truck to the filling platform, and full cylinders are similarly moved onto the empty truck.

As cylinder volumes increase, the risk of injury—and damage to assets—from manual processes increases. This leads to consideration of other forms of cylinder handling, such as palletisation. Palletisation can be via simple cages loaded by forklift truck, or it can be in pallets designed for automatic palletisation and de-palletisation. Palletisation leads in turn to the need for larger distribution vehicles, and to the need for distributor depots to receive pallets and transfer between pallets and smaller vehicles for local delivery to retail points.

Bulk LPG vehicles in an early stage market may only be required to transfer from an import terminal to a filling plant. These may be very simple bulk road tankers with no pump. The LPG may be transferred from the truck by the use of a compressor or pump at the filling plant. Where demand for bulk LPG arises among end users, decisions must be made on the sizes and capabilities of the truck fleet. Access to end user sites may require only a small truck, but maximising distribution efficiency requires the largest trucks possible. The highest possible pumping capacity for the truck will reduce delivery times but risks overfilling² of customer tanks where such customer tanks are small. In practice, a variety of trucks will be required. Innovations such as rear-steer axles can allow medium sized trucks to access locations that used to be accessible only to small trucks.

² Filling a tank to above its maximum safe pressure level.

Countries with remote industrial installations may benefit from rail wagon bulk distribution. In this case, LPG rail wagons are usually leased from a rail company and moved by the national rail carrier. A loading facility and discharge facility must be built with suitable safeguards and emergency measures.

The safety capability of the rail carrier's tracks, switching, and operations is a critical factor in determining whether to transport LPG by rail. In particular, the possibility of rail car capsizing must be effectively zero.

Pipeline distribution and inland waterway distribution by barge may also be justifiable wherever appropriate. In practice, these methods of transfer are less frequently utilised.

2.5.2 Customer Installations

Cylinder Installations

As the cylinder market develops and demands for larger cylinders arise from commercial and other bulk users, 45-50kg vapour cylinder installation using manifolded cylinders is often the initial solution. The large surface area from a number of large cylinders gives a high evaporation rate for processes that require a large flow rate of gas. Two logical solutions are use of liquid withdrawal cylinders and a small vaporiser, or use of a small bulk LPG tank. Note that effective safety regulations (as described in the *Early-Stage Edition*) will prohibit siting a bulk tank at most factories.

For customer installations at this scale, whether commercial or residential, it is common to have two cylinders manifolded together with an automatic change-over device between them. The change-over device indicates which cylinder is in service and whether a cylinder is empty. This provides continuity of supply; one cylinder can be removed and replaced while LPG is provided from the other cylinder. This type of installation consists of two flexible high-pressure tubes, each with a non-return valve, which connect from the cylinders to the change-over device and thence to a pressure regulator matching the gas pressure to what is required by the gas appliances. The low-pressure gas is piped into the home for cooking and/or space-heating. It is essential that the installation is performed by a qualified, competent person—either an employee or contractor to the LPG distributor—using approved equipment.

There are changeover devices with built-in telemetry to alert the gas supplier that a cylinder is empty and should be replaced.

Bulk Installations

Customer bulk installations can range from storage for a few hundred kilogrammes to a few hundred tonnes of LPG. These normally utilise horizontal cylindrical vessels, which are commonly known as “bullets”. In the residential market, the growing middle classes in any developing country who wish to live away from the city require an energy supply which is clean and convenient, with the minimum of inconvenience in receiving a continuous supply of energy.

Small bulk tanks are the simplest and most effective way of supplying this continuous supply of LPG. The vapour space of the tank is connected to gas regulators and safety devices which reduce the tank pressure to a few millibars of pressure for supply into the home. The tank is filled by a bulk road tanker every few months as required by the customer. Increasingly, tanks are being installed with telemetry systems that transmit the level of the tank contents to the LPG supplier. The supplier arranges to refill the tank before it runs out, based on the telemetry data. This has the advantage that the customer gets a continuous supply of energy without his or her intervention. Additionally, the distributor can plan a delivery when his/her road tanker is in the vicinity, thereby increasing distribution efficiency and reducing distribution cost.

Industrial bulk demand may require large storage; many tonnes of LPG may be used by a single industrial consumer each week. The appropriate size of storage is based on various parameters, including distance from the supply point, supply reliability, maximum gas flowrate required, and regulatory controls which may limit size of storage. Where an intermittent high gas flowrate is required, or where regulations restrict the size of storage, vaporisers are installed to evaporate the liquid into gas. The vaporisers can be heated by LPG (direct fired), electricity or steam. Considerable

expertise is required in designing vaporiser and pressure regulation systems so that gas does not condense in the piping system, and so that no residue enters the system.

Increasingly, luxury residential bulk installations involve the storage tank being buried under the ground. The only visible part is a manhole cover for access to the tank connections, the level gauge and the filling point. The tank is therefore invisible.

Piped Installations

Apartment buildings, gated communities, and rural villages may be supplied with piped LPG from a central bulk tank installation. In this case, a gas meter is fitted at each home so that each homeowner may be billed for the gas used.

Whole cities can be supplied with mixtures of LPG with air on a reticulated grid basis. This gas supply is designed to replicate closely a natural gas supply, with a precisely matched calorific value, so that unmodified natural gas appliances can be used with the LPG-air mixture. In this case, a gas-air mixing plant controls the mixture of gas and air to deliver a constant calorific value per unit volume, identical to that of natural gas. This mixture is piped, usually under the city streets, and metered into each home.

This approach allows easy transition by consumers and the gas utility to natural gas from the LPG-air mix, once natural gas becomes available. After natural gas becomes available, the LPG-air mix can continue to be used to serve peakload gas demand that is uneconomical to serve via natural gas alone. It is normally not economically feasible to build the natural gas supply capacity required to serve 100% of all possible peak loads. Peak-shaving with LPG-air is thus an economical means of meeting peak gas demand.

2.5.3 Transport Installations

The development of LPG installations for forklift trucks (FLT), cars and commercial vehicles involves both cylinders and bulk tanks.

Often the early transport installations in a market involve fitting cylinders to vehicles. In the case of FLT, this involves working with FLT suppliers to provide a suitable liquid withdrawal cylinder for mounting on the back of the forklift truck. When empty, this cylinder is removed and replaced with a full cylinder.

The empty cylinder is returned to the cylinder filling plant for refilling, just like a residential cylinder. However, special cylinders must be used, because they must deliver liquid (not gas) and must not have any internal contamination from rust or residue, because that would block the FLT's fuel filter, thereby stopping the truck and requiring maintenance.

The FLT cylinder has disadvantages: it has to be manually handled to and from the truck, and if it has a level gauge, the gauge is normally not visible to the FLT driver whilst driving. If the truck runs out of LPG while in use, the truck may just stop operating with no warning. The alternative is to have a fixed LPG tank on the FLT and a bulk fuelling point for the FLT. In this case, the FLT operator has a fuel gauge in front of him and can drive up to the fuelling dispenser, connect the filling hose and refill—much like fuelling a car. A common enhancement is card readers for the dispenser, which provide fuel management information by allocating fuel usage to individual FLT. The bulk installation comprises a small bulk tank, pump, pipework with bypass to the tank and a metering dispenser.

The car and commercial vehicle fuelling option (that is, Autogas) is very similar to that of FLT fuelling. A bulk installation is provided with a pump and pipework to a dispenser. In this case, the dispenser is similar in outward appearance to the fuel dispenser associated with petrol stations.

The bulk vessel can be the normal, above-ground bullet tank, or it can be installed underground. In the underground case, a submersible pump is normally used to supply the LPG (as a liquid) to the dispenser. On a car, the LPG tank is often fitted in the spare wheel well and is toroidal in shape (often called “donut-form”). Cylindrical tanks (often called “torpedo form”) may be fitted in vans and larger vehicles.

The installation in a car comprises a filling connection, the LPG tank, an LPG level gauge wired to the car dashboard, a relief valve and a liquid outlet for the liquid LPG to be sent to a vaporiser in the engine compartment. The vaporiser is heated by the engine coolant, turning the liquid into gas, which is injected in turn into the inlet manifold via a control system. An electronic system emulates the engine management system to deliver LPG in proportion to engine demand. The latest and most sophisticated car systems inject liquid LPG directly into the engine using a high pressure pump.

Figure 2. Example of an LPG-fuelled forklift truck in Turkey. Courtesy Aygaz.



Chapter Three

Ensuring Adequate Safety and Business Practices in an Expanding Market

3.1 Issues Arising

LPG is a very safe fuel when it remains within a totally closed system from the point of supply to the point of consumption by the end user, with adequate oversight and enforcement by public authorities. Practices and regulations, detailed in the *Early-Stage Edition*, have been well-developed over many decades for the storage and handling of LPG, resulting in safe equipment and safe use across a wide variety of applications and markets worldwide.

As described in the *Early-Stage Edition*, when LPG markets grow, a class of persons will arise who are attracted by the cash transactions of the LPG business, its growth, and a perception of weak oversight by Government. They will seek to enter the LPG market in order to make “easy money”. “Easy money” means stealing refill business from legitimate LPG companies (sometimes by literally stealing their cylinders from their depots and warehouses) and illegally refilling those cylinders, whilst spending nothing on cylinder maintenance, nothing on safety processes, and nothing on consumer education about safe usage.

The most common and dangerous abuses involve trafficking in stolen or smuggled cylinders and illegally refilling cylinders by decanting from a bulk tank or from a larger cylinder into smaller ones.

This activity “opens” the closed system and, in turn, undermines its benefits for all legitimate participants and stakeholders.

International safety standards require a number of checks on cylinders before, during and after filling, and those checks require calibrated equipment and specific expertise. A defective cylinder, or one that has reached its requalification date, must not be filled. Additionally, without the proper equipment, it is very easy to overfill a cylinder (*i.e.*, above its safe pressure rating). Both situations can contribute to the occurrence of an otherwise preventable gas leak or explosion.

Additionally, cars may be converted to run on LPG with poorly designed, rudimentary and unsafe equipment, or even with standard cooking LPG cylinders, preventing safe vehicle operation.

The abuses noted above may be carried out by individuals without training, expertise, or understanding of safety requirements or good safety practices.

If this class of person captures too large a share of the LPG market, confidence of the stakeholders will erode, cylinder investment by legitimate market participants will slow or cease, public safety and welfare will suffer, and the market may ultimately stall or contract.

It is best if Government creates during the early stage of the market the set of conditions that suppress the activities of this class of person, through effective regulation and enforcement of the cylinder distribution and market model described in the *Early-Stage Edition*. Government must then continue to enforce effectively through the transitioning stage.

Government's oversight and vigilance cannot end with the realisation of a transitioning-stage market. Indeed, governmental oversight and vigilance is more important than ever in the transitioning stage, so that the transitioning stage LPG market does not devolve back into the early stage.

3.2 Solutions

3.2.1 The Role of Government

Appropriate laws and regulations, adequately enforced, are the single most critical factor in whether widespread access to, and use of, LPG by a country's households and businesses can be achieved in the near and medium term and sustained for the long term.

These are described in detail in the *Early-Stage Edition*.

Additional topics for governmental planning consideration are described in Chapter Four, *Planning for LPG in National Energy Strategy*.

3.2.2 The Role of the National LPG Association

Establishing a National LPG Association is an essential measure to ensure the safe growth of the LPG market during all market stages.

The World LP Gas Association (WLPGA) recommends that the National LPG Association be affiliated with the WLPGA to gain access on behalf of local LPG sector participants to:

1. Knowledge of worldwide industry developments
2. Knowledge of good practices in safety and business operations
3. Shared experiences regarding common problems and their solutions from the LPG sector in other countries
4. Forums for influencing the development of common standards related to LPG safety, operations, good business practices, and technology

It is vital for Government to liaise with the local LPG industry to ensure that Government planners and regulators gain access to industry knowledge and concerns about the economic viability of the sector, about customer needs, about illegal and non-compliant activities and actors in the sector, and about how industry and consumers are affected in practice by governmental policies and regulations. Government should also collaborate appropriately with industry to ensure industry achieves and sustains the desired, high level of public safety in LPG operations and use.

Among the best ways to achieve adequate collaboration and exchanges of views and information is for industry to be represented in its dealings with Government by a single, unified National LPG Association.

A National LPG Association should work with the national regulatory bodies to ensure that all necessary and appropriate regulations are in place and are well-enforced, in order that all LPG industry participants operate to high safety and technical standards, with high professionalism and business ethics, and in furtherance (on a commercially sustainable basis) of relevant public policy goals.

The National LPG Association should promulgate codes of practice and guidance regarding safe installations, equipment and procedures. Incidents and deviations from standards should be identified, investigated and acted upon (typically by Government) to prevent recurrences.

Safety campaigns should be created and legal action taken against those who operate illegally in the market. The National LPG Association should be active in creating and proposing localised versions of the best international LPG safety standards and engaging with Government to ensure that they are enacted.

A suite of international equipment standards covering cylinders, tanks, piping, hoses, regulators, valves and most other pressure equipment used in the LPG industry should be adopted and all measures taken to ensure that no equipment is approved for sale in the country unless it bears an approved mark indicating its compliance with the relevant standard.

An approved installer system should be set up for those converting vehicles to run on LPG. Links to insurance companies, vehicle inspection and approval organisations should ensure that all conversions of vehicles to LPG meet the requirements of the relevant codes of practice.

LPG is a unique fuel with many benefits to its users. The National LPG Association should work with Government to ensure that Government understands the benefits of LPG in local context, and that governmental policies enable LPG to fulfil to the maximum justifiable level its role as a clean, environmentally friendly, health-preserving fuel that can bring energy access to all.

Additional guidance on the aforementioned topics is available from the WLPGA. See www.worldlpgas.com for more information, in particular the www.worldlpgas.com/uploads/Modules/Publications/good-business-practices-for-lp-gas-associations.pdf.

3.2.3 The Role of Individual LPG Marketers

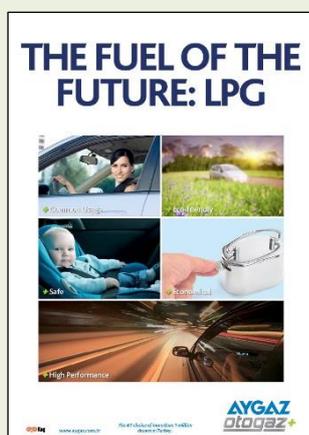
Individual LPG Marketers must comply with law, regulation and standards. They must reinforce through their activities and investments the tenets of the national cylinder distribution model and market model, described in the *Early-Stage Edition*.

They should educate their customers and prospective customers on the safe use of LPG through safety awareness campaigns. Techniques can include informational neck rings on cylinders, hand-outs to bulk customers when filling the tank, and information mailed with invoices.

LPG Marketers should also participate actively in the National LPG Association as their primary liaison with Government. They have a responsibility to help keep Government informed about deviations from the cylinder distribution model and market model, and about the presence and activities of illegitimate market participants, where and when they learn of them.

Ultimately, it is the confidence in the future of the national LPG market among the LPG Marketers, their partners, their investors and their end-customers that will determine whether ongoing investment in the sector will continue, halt or decline.

Example of LPG Marketer Educational Campaigns Applicable to Both Transitioning-Stage and Advanced-Stage Markets: Turkey



Even in Turkey, which has reached an advanced market stage with extensive penetration of LPG and high product awareness throughout the country, market leaders (such as Aygaz) continue to invest in consumer information campaigns. These campaigns emphasize key aspects of LPG, such as safety and environment friendliness. Aygaz brands LPG as the “Fuel of the Future” and utilises a wide range of communication media including leaflets, billboards, online and TV ads to convey its informational and educational messages. Additionally, its experts travel to all regions of the country, from urban centers to the most remote, in customized educational vehicles to educate employees and customers by the thousands about using LPG safely and beneficially.



Planning for LPG in National Energy Strategy

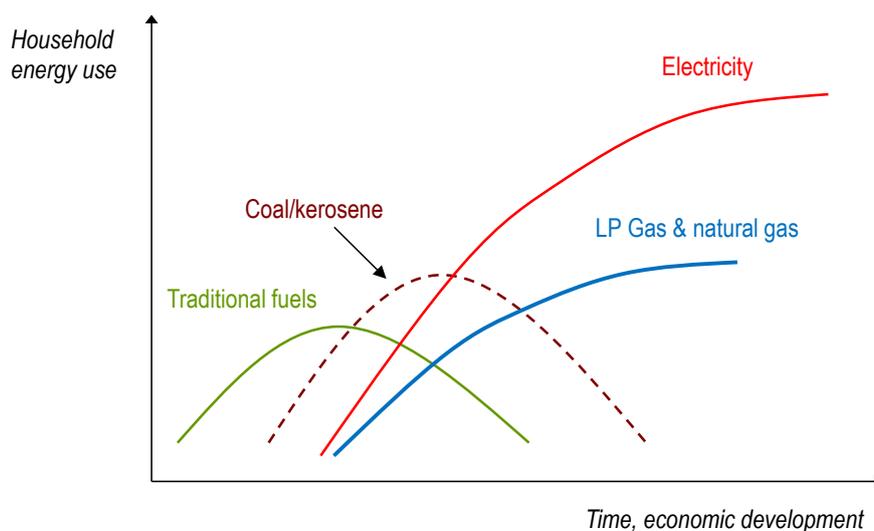
4.1 LPG in the National Energy Mix

In a transitioning LPG market, LPG will be a key energy source for enough people and businesses in the national economy that it must begin to be planned for as an essential component in the national energy mix and the national energy strategy.

Even in very mature markets, LPG remains a vital and economically important complement to energies like electricity and natural gas.

This is reflected conceptually in the below diagram of energy use in developing energy markets over time:

Figure 3. Generalised National Household Energy Use by Fuel Type as a Function of Economic Development



4.2 Natural Gas and LPG

In countries where LPG use has become widespread, natural gas often follows. LPG use typically precedes natural gas use because LPG infrastructure is much less costly and much faster to deploy than natural gas infrastructure. For invest in the natural gas sector in a country to occur, there must be significant concentrated demand, and this is usually achieved through focusing on gas use for power generation, major industrial areas and large, dense urban centres. The natural gas company can thus optimise pipeline installation cost whilst maximising revenues from usage.

This may indirectly help the indigenous LPG sector, through greater awareness of the benefits of gas (whether natural gas or LPG) as a fuel and through a much wider range of gas appliances introduced into the market. In many countries, natural gas is never supplied beyond large cities and major industrial areas, because extending the distribution grid to villages, isolated rural communities, and many suburbs is not commercially viable.

In this case, those who are not connected to the natural gas grid may still desire the benefits of gas and gas appliances. They can obtain those benefits by utilising LPG.

LPG is the solution for areas that natural gas will not serve, and LPG is the transitional (or “gateway”) solution for areas that natural gas is expected to serve in future but does not presently serve. LPG is “the off-grid gas”.

This creates an opportunity for the LPG sector to work with equipment suppliers to provide solutions that provide the benefits of gas on an off-grid basis. As mentioned in Chapter Two, *Planning for and Managing LPG Market Change*, an underground LPG tank with embedded telemetry that triggers just-in-time refilling can perfectly replicate the continuous-service experience of the natural gas network for the customer.

LPG companies that develop piped LPG systems adjacent to growing natural gas infrastructure must plan for transition of their pipe network asset to the natural gas distributor. Government rules should permit a smooth transition that allows for adequate return or cost recovery to the LPG reticulated-network investor in such cases. Where natural gas is implemented, there will continue to be a requirement for LPG injection into the natural gas to improve the energy content of the gas. (This is also the case when biogas is created from refuse sites.) In addition, combining LPG with photovoltaic, wind or solar water-heating energy sources can produce continuous reliable energy with very “green” credentials.

LPG is also a very viable alternative to diesel for power generation applications: LPG is typically less costly than diesel, the LPG engines weigh less than the diesel per watt generated, and LPG, unlike diesel, has near zero emissions.

Changes in government subsidies and fuel duty rates can unintentionally distort the market, often significantly. In some cases, the withdrawal of a subsidy to encourage switching from kerosene to LPG has resulted in an unintended switch back to the original fuel by consumers. Here again, careful liaison between policy makers, the national LPG association, and appropriate qualified experts will help such transitions take place smoothly and with high odds that the desired results will occur without any unintended, counterproductive outcomes.

4.3 Electricity and LPG

Finding ways of holding down electricity costs and ensuring reliable electricity supply has become an urgent priority in many parts of the world amid growing concerns about the impact of rising energy costs and supply disruption on economic and industrial competitiveness and living standards.

LPG can displace electricity use in applications such as cooking and heating, in instances where it is the more economic energy choice. Switching to LPG may be on a permanent basis—aimed at shedding load along the load-duration curve or just at peak—or can occur as part of a demand-reduction programme. In such a programme, LPG is used as a substitute or back-up fuel (for example, for an on-site generator) to replace electricity from the grid. In most countries, there is considerable scope for such switching.

LPG competes against electricity as well as several other fuels (primarily natural gas, distillate/heating oil and coal) in all energy end-use sectors, but mainly in the residential/commercial and industrial sectors. As of this writing, electricity is generally uncompetitive against LPG for transport.

In the residential and commercial sectors, LPG and electricity compete, mainly in the provision of energy for cooking, space heating and water heating. In the industrial sector, they compete mainly for space heating and process heat. LPG also competes against grid-based electricity in the provision of electricity services through use of LPG to co-generate heat and power on-site.

LPG can thus be used to reduce national electricity consumption or reduce its growth rate, and/or to modify electricity customers’ patterns of electricity usage, as a way of lowering the overall cost of providing electricity service and ensuring reliable service.

In many countries, electricity utilities are faced with rising costs of new generating, transmission and distribution capacity, either to replace ageing assets or to meet growth in demand. Building, maintaining and operating adequate capacity to meet peak demand is particularly costly—often between two and four times the cost of base-load electricity supply—because the generating and network capacity dedicated to meeting peak load is used only for limited periods. The capital cost associated with this peak load capacity normally represents a very large proportion of the total cost of supplying electricity at peak.

The use of LPG in place of electricity for applications where LPG is well suited can thus lower the overall national cost of energy, and the national cost to supply that energy.

More information on this topic is available in the document *LPG and Electricity Demand-side Management* published by the WLPGA.

4.4 New LPG Technologies and Standards

As new technologies debut, new standards must be agreed also, to ensure and to promote safe use and handling of the new technologies. Public authorities must therefore monitor technological developments as well as standards developments that may impact their markets. That, in turn, is an area for productive dialogue between the public authorities and the national LPG association.

A major LPG supply innovation that developed demand at the end of the 20th Century and into the 21st is the lightweight cylinder, made from either lightweight steel or from composite materials. In some composite cylinder designs, the gas level can be seen through transparent portions of the cylinder body. Composites also do not experience corrosion and permit more varied aesthetics that can increase the cylinders' appeal to consumers.

“New” technologies in LPG retailing should be evaluated with great care and abundant caution during the early stage and transitioning stage, when their potential for disruption of steady and sustainable market growth is high despite potential or perceived advantages. In particular, a number of “new” technologies being promoted in some countries as of this writing are in fact revivals and variants of very old, and generally discredited, approaches from the distant past. In allowing experimentation with such technologies, it is important to review worldwide experience with them across other countries and contexts, to determine if they are truly new, and to determine if they expose the market to development or safety risks which may outweigh potential benefits during the more fragile early stage and transitioning stage of market development.

4.5 Developing the Rural LPG Market

A common policy goal for developing countries in, or entering, a transitioning-stage LPG market is expanding LPG access and use in rural areas.

There are a variety of strategies for doing so. A full treatment of them is beyond the scope of this document. However, one key issue is what elements of the LPG supply chain to locate where, and with what level of central control.

A common but very high-risk strategy—one whose risks are often not understood well by its proponents—is to place as many small filling plants (“mini-filling plants”) as possible as close as possible to the rural consumers.

The economic hypothesis underlying this approach is that the main operational and cost barrier to serving rural communities is the high cost of transporting the cylinders over long distances. Cylinders' weight is approximately 50% steel heading outbound, and 50% LPG; inbound, it is 100% steel. The hypothesis posits that performing the filling close by to the end user allows the LPG to be transported in bulk for most of the required distance, lowering significantly the logistical costs.

As mentioned in the *Early-Stage Edition*, the overall capital cost for this decentralised approach to filling is actually significantly higher, in aggregate, than the capital cost for a more centralised filling network with fewer, larger plants. This is because there are significant economies of scale related to the size of LPG filling plants and storage facilities.

The operational cost may be superficially lower, but when externalities are considered, it is often not the case.

The more important issue than capital costs and operating costs is **the ability to maintain the integrity of the cylinder distribution and market model in a decentralised system.**

As LPG Marketers become larger and stronger companies, and Government becomes more adept and better funded and staffed to carry out regulatory inspection and enforcement (including in rural areas), the ability to expand cylinder distribution safely and sustainably will become easier, and greater and greater penetration of rural areas will become possible—and will organically occur.

Experimentation with decentralisation can thus be tested, with careful monitoring and evaluation, in the transitioning stage.

The weakness of decentralising too aggressively or too soon is in the human element.

Small, remote filling operations come with the following challenges and risks:

1. It is more difficult to ensure adequate levels of education, training and supervision of staff involved in safety and operations
2. It is more difficult - sometimes impossible - to perform all of the essential safety inspections and maintenance tasks for cylinders in a mini-facility
3. It is far easier for illegitimate actors to infiltrate remote markets and undermine their safety regime and the commercial viability of legitimate market participants (as described in Chapter Three, *Ensuring Adequate Safety and Business Practices in an Expanding Market*)

It is often overlooked that among the most important innovations in the history of LPG worldwide was the centralised filling plant, dating to the 1960s. This innovation made possible the level of consistent safety from professional and rigorous cylinder inspection, filling and maintenance which, in turn, allowed LPG markets to grow to serve millions and millions of households in country after country. Prior to this innovation, LPG was a much less safe, much less manageable and controllable, and far less scalable industry and product.

Pro-rural policies and initiatives must take into careful consideration up front the aforesaid risks and plan for managing and mitigating them, and for providing sufficient economic incentives and resources (whether from the private sector or the public sector or both) to do so.

To penetrate rural areas to a greater degree than is commercially justifiable, a cost transfer mechanism is typically required, such as a cross-subsidy. It is beyond the scope of this document to discuss the relative merits and challenges of designing and implementing effective and sustainable cost transfer schemes.

An Example of Expanding LPG Access to Remote Locations and Lower Income Customers: Turkey

In Turkey, the introduction of 2 kg LPG cylinders with a strong marketing and promotional campaign expanded LPG access effectively in remote (non-urban) areas and provided an affordable energy solution for lower-income consumers.

Smaller size cylinders are easier and less costly to deliver to retail points in remote locations than larger cylinders. Dealers and customers can also handle small cylinders more easily than larger ones. Small cylinders may also be more affordable for lower income customers, who tend to choose alternative fuels like kerosene or biomass because they are unable to save enough between refills to afford the refill cost of a larger cylinder of, for example, 12 kg or 16 kg. Smaller-sized cylinders may also be less attractive to illegal refillers, if larger cylinders are also in the market.

Cylinder sleeves can also be applied to the 2 kg cylinders to increase their appeal to consumers and provide useful information.

Figure 4. Example of 2 kg LPG Cylinder with Sleeve from Turkey. Courtesy Aygaz.



4.6 Developing the LPG Market for the Urban and Peri-Urban Poor

A second policy goal for developing countries in, or entering, a transitioning-stage LPG market is expanding LPG access and use among the urban and peri-urban poor.

The two main approaches for doing so are:

1. Allowing smaller cylinders into the market (e.g., 3 kg, 2.5 kg)
2. Encouraging exchange of filled cylinders for empty cylinders through a dense network of a wide variety of types of retail point, such as food retailers, dry goods retailers, hardware stores, and the like

Mini-filling plants (as described above in the section *Developing the Rural LPG Market*) are sometimes considered, and are somewhat less risky from a human (management control) standpoint in an urban setting than in a rural setting. However, the impact of an explosion due to a safety lapse in an urban setting will be far greater, due to the much higher population density.

Additionally, the presence of mini-filling plants in urban settings may encourage illegal operators (as described in Chapter Three, *Ensuring Adequate Safety and Business Practices in an Expanding Market*) to enter the market more readily than plants in rural settings, due to the higher visibility and high cash transaction volumes associated with urban installations.

Mini-filling plants are a secondary way by which a “closed” national LP system becomes “open”, through dissemination of knowledge to the class of “easy money” entrepreneurs mentioned previously, without correspondingly vigorous enforcement of market rules.

Lastly, a practice from the period up through the 1950s that has seen a resurgence in developing country markets, but which is inherently dangerous to public safety and especially attractive to copy-cat illegal operators, is LPG decanting. In this process, LPG is pumped or drained from a larger cylinder into a small one. A related marketing pitch may be the ability for the consumer to refill a cylinder part way, without having to exchange it. The option for consumers to refill cylinders without the return of the cylinder to a properly staffed and equipped facility for rigorous inspection, maintenance and recertification as required, and scrapping if needed, is directly opposed to the principles upon which an early-stage market may be developed, and a transitioning-stage market sustained and further developed toward the advanced stage.

4.7 Planning the National Energy Matrix

The energy matrix is a planning tool for Government, with input from other stakeholders, to determine the level of primary and secondary energies required to meet the anticipated demand for major uses.

LPG is considered a secondary energy.

Government planners should evaluate the potential demand for major energy-using application areas and sectors applicable to the country. These may include transport, lighting, heating, cooking, industrial uses, agricultural uses, and so on.

Then, the volumes of desired energies to meet those needs should be determined. Relative promotion of, and securing of supply of, each energy type then informs policy formation.

What is critical is that government planners include LPG in the national energy matrix. Without this step, policies affecting LPG risk being formulated in isolation from policies affecting other energies, which may cause unintended consequences for both LPG and for the other energies that comprise the national energy strategy.

Figure 5. Example: A Primary Energy Matrix for Brazil 2010-2020

Energy source	2010 (%)	2020 (%)
Petroleum and byproducts	38.5	31.8
Sugarcane and byproducts	17.7	21.8
Hydropower	14.2	12.5
Natural gas	10.2	14.4
Charcoal and wood	9.5	8.3
Coal and byproducts	5.1	6.1
Other renewable sources	3.4	3.7
Uranium	1.4	1.4

Source: Enterprise for Energy Research

Source: Enterprise for Energy Research, China

LPG is bundled with “Petroleum and byproducts” in this primary energy matrix. In the secondary matrix, LPG should be broken out from the “Petroleum and byproducts” category, and mapped to main applications (that is, to main sources of demand).

Energy mix planning should also include how LPG will be used to offset the peak loads on grid-based energies like electricity and natural gas, where high peaks in demand may trigger very high marginal energy generation costs or may cause disruptions of service.

Additional Macro Factors Affecting LPG Market Growth

5.1 Global Supply

Typically, an LPG market that begins to leave the early stage will grow rapidly for 10-15 years, then slow down and plateau for a number of years before entering a slow decline. During the plateau and slow decline phases, there may be upward ticks in market volume as innovations are introduced or world supply patterns change.

As of this writing, the world is in a period of substantial availability of LPG for many years to come. The recent revolutions in shale gas and shale oil production, and major new discoveries of oil and natural gas (especially offshore), will ensure ample LPG supply on a global basis.

Of course, refined oil products and natural gas compete with LPG as well.

5.2 Governmental Policies Across Fuels

Worldwide experience shows that LPG markets that develop well evolve from main use of LPG for cooking and heating (and sometimes lighting) to use of LPG as a fuel of choice across many applications for reasons of convenience, low emissions, luxury and leisure.

This shift in usage is dominated by the Government's policies and regulations:

- First and foremost by the wise design, effective implementation and enforcement—or lack of wise design, effective implementation and enforcement—of the cylinder distribution and market model described in the *Early Stage Edition*
- Secondly by the way other policies and regulations, including taxes, pricing regulations and/or subsidies are applied—or not applied—to each type of energy or fuel in the country's energy mix, and to the equipment for supplying or using each type of energy

5.3 Public-Private Coordination

It is useful for Government to work with an effective and capable national LPG industry association to access both local sector information and information gathered from industry worldwide to guide debate and decision-making for the national LPG sector and for the optimal role of LPG within the national energy mix.

Ideally, a secure fuel supply situation is created that provides the right mix of energy sources for all at affordable prices with sufficient choice to meet the needs for efficiency, low emissions and suitability for the intended use.

Where multiple LPG associations already exist in a country³, they should attempt to harmonise their positions regarding key drivers of LPG market development, despite representing potentially competing commercial interests.

³ LPG associations may compete vertically—for example, an oil marketing company association and an LPG retail association co-existing—or horizontally, for example, two LPG associations co-existing, each comprising a different group of LPG Marketers, each dominated or led by a different LPG market leader.

Government should not exploit inter-association competition to keep each association weak. Rather, Government should encourage inter-association harmonisation of views on key topics that, if achieved, will help governmental planning, regulation, oversight and enforcement of the LPG sector for achieving national energy policy goals.

5.4 Cross-Sectoral Coordination

Despite being a small part of the national energy matrix by volume, LPG affects huge portions of the populations of low and middle income countries. Next to electricity, it is often the most important fuel, measured by the user population.

As mentioned earlier in this document, LPG has many external benefits that are not priced into the economics of the sector, and which merit good coordination across sectors as development of the LPG market is planned.

This presents an opportunity for coordination among the energy, health, finance sectors, and others, and corresponding governmental ministries, departments and agencies, to ensure that LPG delivers the maximum justifiable benefit to the maximum justifiable population.

Effective cross-sectoral coordination can help accelerate LPG market development leading into, and then beyond, the transitioning stage.

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