



Diesel

Captive fuel supply  
high cost  
highly emitting



LPG

Flexible energy sources  
manageable costs  
environmentally friendly

# Liquid Petroleum Gas

## A Lower-Cost, Cleaner-Burning Alternative to Diesel Fuel for Power Generation



Throughout the developing world, electric utilities are pursuing greater energy independence – in power generation and fuel type. Not widely leveraged, however, are refinery byproducts such as liquid petroleum gas (LPG). This lower-cost fossil fuel is typically unaffected by wild swings in crude oil prices, and LPG can ensure the reliable power generation that intermittent renewables can't.

Just as important, new technologies provide the flexibility to seamlessly switch between LPG and other fuels, allowing power generators to easily adjust fuel supply based on cost and availability. These technologies also offer greater energy efficiency, lower emissions and a smaller footprint than old-school power generation.

### Benefits of Mobile Fast-Track Power

This turnkey distributed power solution, using state-of-the-art gas turbine technology and reciprocating generators, offers myriad benefits as a bridge to a better quality of life and economic growth while permanent power stations are progressing along the long path to reality.

Among the advantages of mobile fast-track power:

- Gas turbines and reciprocating generators are easily transportable by land, sea and air
- Installation and commissioning are rapid due to minimal construction and set up required for this modular solution
- Rapid installation means reliable power in weeks not years – for as long as the need exists
- Generating capacity can be located near demand, reducing the need for transmission and distribution infrastructure,

while also cutting the power loss that occurs as electricity travels long distances across the grid

- Advanced turbine technology offers flexibility to burn alternative fuels such as LPG, naphtha and kerosene
- Minimal up-front investment, as customers simply provide the site and fuel, avoiding long-term financing and credit issues
- Customers begin to pay only once the electricity is flowing

### Environmental Advantages

As utilities throughout the developing world invest in power infrastructure, they are under increasing pressure to consider the environmental costs associated with the use of

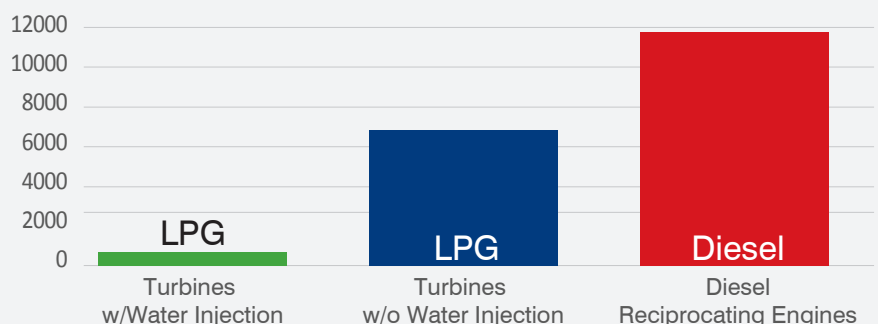
higher-polluting fuels such as diesel, coal and heavy fuel oil. With advancements in technology, there no longer needs to be a trade-off between the advantages of mobile fast-track power and the environmental impact.

Power generation using advanced mobile gas turbines derived from jet engines switch seamlessly between natural gas and other cleaner-burning fuels such as LPG, producing 38-94% less nitrogen oxide (depending upon use of water injection) and 20% less noise than diesel power modules – a great fit for environmentally conscious customers with stringent regulatory controls.

A modular plant using compact, power-dense turbines is an ideal solution for customers with space constraints. The

### NOx Avoidance w/LPG: 4,172 to 11,060 metric tons\*

\*Over 24 months for a 50MW turbine plant operating at 95% availability



1.4-acre footprint required for 50MW of turbine power is approximately one-third of the space needed for the same electricity output produced by reciprocating generators, depending on whether on-site LPG fuel storage is required.

For utilities weighing the emissions advantages of renewable energy, an important consideration – beyond the intermittent nature of sunshine and wind – is the significant amount of land required. A 50MW solar farm would cover approximately 430-500 acres, while 50MW of wind turbines could require from 100 acres if installed on a ridgeline in hilly terrain to 2,500 acres across open, flat terrain. Unlike wind and solar, gas turbines can generate reliable power, 24 hours a day, 365 days a year.

### Cost Factors for Fast-Track Power

The primary cost factor for fossil-powered generation is fuel.

With global crude oil prices rapidly declining from \$100 a barrel in 2014 to less than \$30 in early 2016, petroleum derivatives such as diesel fuel and HFO have become increasingly cost-competitive for fast-track power generation.

However, economic forecasts widely agree that global petroleum prices are rebounding after a significant two-year decline. At the same time, with the growing availability of natural gas worldwide, prices for gas liquids such as LPG are expected to remain flat through at least 2018, resulting in an anticipated cost differential of approximately 20-50% compared with HFO and diesel.

Based on these assumptions, an electric utility could save nearly \$60 million over two years while operating 50MW of turbine-powered generation on LPG\*.

### Conclusion

Fast-track power generation tends to rely on diesel, heavy fuel oil or natural gas. However, APR Energy's mobile gas turbine technology is capable of burning a range of alternative fuels such as LPG, which is forecast to be as much as 20-50% cheaper than HFO and diesel fuel by 2018. Moreover, the ability of the turbines to switch seamlessly between LPG, natural gas and other fuels provides electric utilities with unprecedented flexibility to manage costs by optimizing fuel pricing and availability.

The advantages of switching from diesel-powered reciprocating engines to

## Superior Fast-Track Technology: Mobile Gas Turbines

Aero-derivative turbines – the aviation industry's technology of choice for decades – have a proven record of successfully providing electric generating capacity in both developed and developing markets. Mobile gas turbines serve a wide range of applications that includes seasonal peaking power, base-load operation, industrial generation, back-up power, distributed generation, and bridging solutions while permanent power comes online.

### Scale to Fit Your Needs

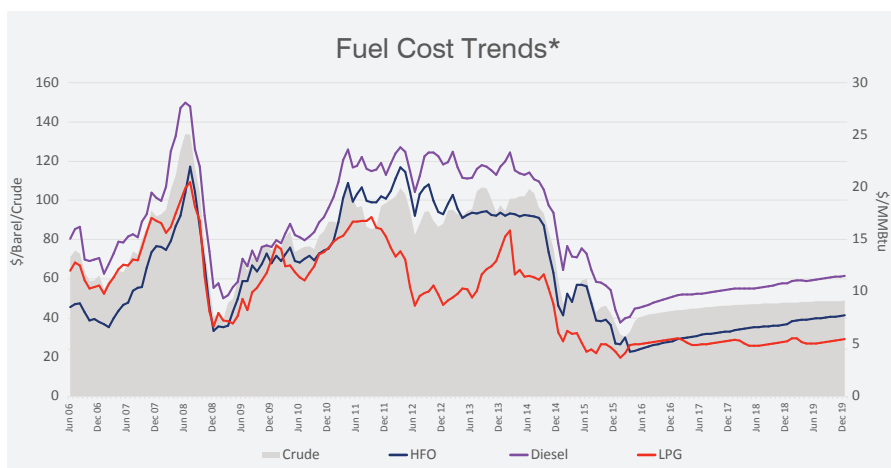
With an ISO power rating of 20-30MW per unit, modular turbine solutions can be scaled to meet capacity requirements ranging from 15MW to 500MW or more – enough to power entire cities.

### Stabilize Your Grid

Mobile gas turbines offer significant grid stability advantages over reciprocating engines, while providing ancillary services such as spinning reserves, positive frequency control and power system stabilization.

### Flexible Operation

Unlike reciprocating engine technology, fuel-flexible turbines can switch quickly and seamlessly between liquid distillates and widely available refinery by-products such as LPG, kerosene and naphtha. They also offer dual frequency, with the ability to easily convert from 50 to 60Hz, and can be grid connected or operated island mode. Once in operation, the turbines can reach full power in less than 10 minutes.



mobile turbines running on LPG are further magnified when one accounts for the significant emissions and noise benefits. Similarly, the higher power density of mobile turbines means they can generate the same amount of electricity on a fraction of the land as reciprocating engines or renewable sources such as solar and wind power – making turbines an ideal fit in areas with space constraints and markets where local economic drivers such as tourism require power generation to be unobtrusive.

At the same time, with APR Energy's mobile gas turbines, customers get more than

just proven technology that offers cost and environmental benefits. The company's turnkey solutions include a complete balance of plant, as well as a full-service package that includes plant design, installation and commissioning, operation and maintenance, fuel management and more.

Given the numerous and significant advantages of mobile gas turbines over diesel-power reciprocating engines, the next three years appear to be an ideal opportunity for electric utilities and energy-intensive industries using fast-track power to switch to LPG-fueled generation.

