

Mobile Distributed Energy Resources

1011465

Transportable Distributed Energy Resources Options

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Technical Update, March 2005

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This report was prepared by

Resource Dynamics Corporation
8605 Westwood Center Drive
Vienna, VA 22182

This report describes research sponsored by EPRI.

The report is a corporate document that should be cited in the literature in the following manner:

Mobile Distributed Energy Resources, EPRI, Palo Alto, CA, 2005. 1011465.

REPORT SUMMARY

Background

Transportable, or movable, distributed energy resources (DER) are used throughout the United States to provide electricity for a variety of needs, usually on a short-term basis as rental packages. Transportable DER units are usually trailer-mounted, have sound-attenuated enclosures, and on-board fuel storage. Most use diesel-fueled reciprocating engines in the 30 to 2,000 kW size range. Electric utilities are interested in using transportable systems for transmission and distribution support applications and for emergency preparedness.

Objectives

This report provides information on transportable DER products currently available in the United States for commercial sale as new, used or available in the rental market.

Approach

A number of manufacturers currently make transportable DER units. Transportable units are those designed for easy transportation and require minimal on-site assembly and construction. Transportable DER units are used for applications such as power at construction sites, for rentals units, and for emergency use. This report researches products from vendors of transportable DER systems (both reciprocating engines and combustion turbines) in the 500 to 20,000 kW size range. The following information was collected by contacting leading manufacturers and distributors:

- Electrical output (continuous/prime and standby)
- Fuel consumption/efficiency
- Fuel properties and pressure requirements
- Typical interconnection packages the vendor recommends for use with the unit
- Physical size – footprint, weight
- Sound attenuation
- Emissions
- Packaged cost

Because transportable DER devices are closely associated with the rental and used DER markets, additional qualitative information was developed for these markets. Rental and used equipment distributors were contacted to obtain this marketplace information.

An EPRI project sponsor is interested in the use of domestic-source liquefied natural gas (LNG) in transportable DER units, so additional information was gathered on this fuel option for use in transportable distributed generators.

Results

The transportable DER market has seen some growth in recent years, mainly due to the rise of the rental power market. Manufacturers like Caterpillar and Cummins sell packaged reciprocating engines and combustion turbines in sound-attenuated, trailer-mounted containers for rental power, and to a lesser extent, for sales to end users. These companies also sell used rental units. Third party packagers like MQ Power have recently emerged to provide a stronger market for new transportable equipment purchases, primarily to rental companies. These new companies take engines, generators, controls, and other equipment from various manufacturers and package them as new transportable DER units for sale. The used equipment market for transportable DER has also grown recently due to the growth of the rental market and the proliferation of online vendors and auction sites.

EPRI Perspective

Transportable DER units are mature DER devices, readily available, and inexpensive compared to stationary DER products of similar rating. Their packaged nature allows these units to be sited quickly and with minimal site preparation. However, their high operational costs, rental fees, and emissions act to limit their market to short term power needs applications. Transportable LNG options appear to be viable and, in conjunction with transportable DER devices, may act open or broaden markets. There are a variety of options available in the 0.5 to 7 MW scale that can be used for electric utility T&D support.

Keywords

Distributed Energy Resources
Diesel Engines
Combustion Turbines
Backup Power
Emergency Power
LNG

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INTRODUCTION

Mobile distributed energy resources (DER) are used throughout the United States to provide electricity for a variety of needs, such as providing temporary power to a construction site. Mobile DER units are usually trailer-mounted, have sound-attenuated enclosures, and on-board fuel storage. Most use diesel-fueled reciprocating engines in the 30 to 2,000 kW size range. Many mobile DER units are owned by the rental equipment industry and are rented to end-users for short-term power needs.

Objective

This project will develop information on mobile DER products currently available in the United States and gather information on the rental and used equipment mobile DER market. The use of domestic-source LNG in mobile DER is also examined.

Approach and Methodology

A number of manufacturers currently make mobile DER units. Mobile units are those designed for easy transportation and require minimal on-site assembly and construction. Mobile DER units are used for applications like power at construction sites, for rentals units, special events like county fairs and sporting events, and for emergency use. This report researches products from vendors of mobile DER systems (both reciprocating engines and combustion turbines) in the 500 to 10,000 kW size range. The following information was collected by contacting leading manufacturers and distributors:

- Output (continuous/prime and standby)
- Fuel consumption/efficiency
- Fuel properties and pressure requirements
- Typical interconnection packages the vendor recommends for use with the unit
- Physical size – footprint, weight
- Sound attenuation
- Emissions
- Packaged cost

The search for this information began with equipment manufacturers that package mobile genset units for rental power and sales to end users. Sources including the Diesel and Gas Turbine Worldwide were used to identify companies. Many large DER manufacturers such as Cummins,

Caterpillar, Kohler, GE and Alstom have divisions dedicated to mobile/rental power applications, and offer a wide range of gensets. Online brochures provided some product specifications, and the companies were contacted by e-mail and phone to obtain additional information about their units.

Through contacting the large engine and turbine manufacturers, it became apparent that many rely on third parties and local distributors to package, sell, rent or lease mobile gensets. Aggreko, MQ Power and Stewart & Stevenson were the most notable of these companies. These companies were contacted to elicit further information about their mobile generation products.

Because mobile DER and the rental and used DER market are closely associated, more qualitative information on the rental DER market and used mobile DER equipment market was also developed. Rental and used equipment distributors were contacted to obtain this marketplace information.

All of the relevant information was consolidated into tables, which show unit specifications. Development of this information and contacting the manufacturers and distributors showed how the mobile DER market is structured, and the importance of the used and rental markets.

The California BUGS (Back-Up Generators) database¹ was also analyzed. It contains a separate section on portable backup generators, which provides information on the engine manufacturer, size, location, and the end-user that utilizes the genset. The database showed that most of the portable gensets were rental units, and that diesel reciprocating engines from Caterpillar, Cummins, and Detroit Diesel dominate the California market. The companies utilizing or renting out gensets were examined and contacted in some cases, to give a better picture of how the rental market works. The market for used mobile DER was examined by contacting vendors who sell such equipment.

Finally, this investigation evaluated what role, if any, liquefied natural gas (LNG) could play in the mobile genset market. Through trade journals, reports from the Energy Information Administration and other organizations, the use of LNG in mobile DER was examined, and future opportunities and hurdles were identified.

¹ CEC's BUG's database is available at <http://www.energy.ca.gov/database/>

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OVERVIEW OF TRANSPORTABLE GENERATORS

Transportable generators in the 500 to 20,000 kW size range consist of reciprocating engines and combustion turbines. While microturbines are oftentimes transportable, and 500 kW units are being developed, most commercial units are currently less than 100 kW, so they are not considered an option for this size range.

Reciprocating Engines

History and Status

Reciprocating engines, developed more than 100 years ago, were the first of the fossil fuel-driven DER technologies. Both Otto (spark ignition) and Diesel cycle (compression ignition) mobile gensets have gained widespread acceptance in almost every sector of the economy, in applications ranging from gasoline powered portable gensets of less than 1 kW up to 2,000+ kW diesel units. Reciprocating engines are a subset of internal combustion engines, which also include rotary engines. With reciprocating engines, pistons move back and forth in cylinders. Smaller engines are primarily designed for transportation applications but can be converted to power generation with little modification. Larger engines are usually designed for power generation, mechanical drive, or marine propulsion. Most of the engines used in the mobile and rental power market were originally designed for the transportation market. Reciprocating engines are available from a number of manufacturers in all DER size ranges, and they currently dominate the market for small mobile DER. In general, reciprocating engines offer low costs and good efficiency, and they are ideal for mobile units, but maintenance requirements can be high, and diesel-fueled units have high emissions.

Operation

Almost all engines used for mobile power generation are four-stroke and operate in four cycles (intake, compression, combustion, and exhaust). The process begins with fuel and air being mixed. Some engines are *turbocharged* or *supercharged* to increase engine output, meaning that the air is first compressed in the intake system. The fuel/air mixture is introduced into the combustion cylinder, and compressed as the piston moves toward the top of the cylinder. In diesel units, the air and fuel are introduced separately, with fuel injected after the piston compresses the air. As the piston nears the top of its movement, a spark is produced that ignites the mixture (in diesel engines, the mixture is ignited by the compression alone). Dual fuel engines use a small amount of diesel pilot fuel in lieu of a spark to initiate combustion of the primarily natural gas fuel. The pressure of the hot, combusted gases drives the piston down the cylinder. Energy in the moving piston is translated into rotational energy by a crankshaft. As the

piston reaches the bottom of its stroke, the exhaust valve opens and the exhaust is expelled from the cylinder by the rising piston.

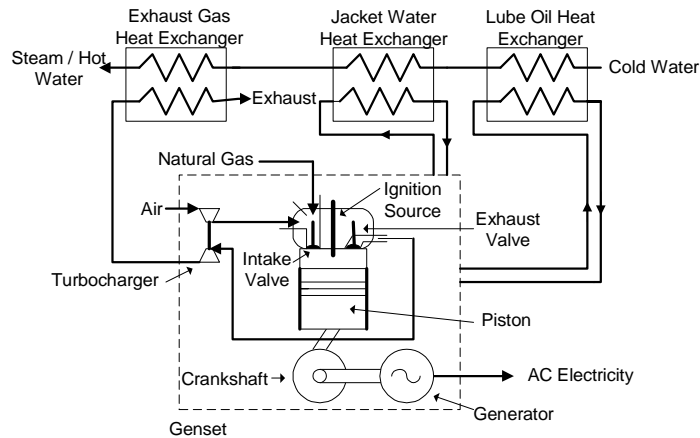


Figure 2-1
Reciprocating Engine

Although reciprocating engines (both compression and spark-ignited) can create considerable noise while operating, mobile units usually come in sound-attenuated containers that minimize this problem. Most of the reciprocating engine models available for mobile power are diesel-fueled units under 2,000 kW in size. Efficiencies for these units are typically 33-38% electrical.

Emission Control Technologies

The combustion process produces NO_x and, as a result of improper fuel/air mixtures and excessive cylinder cooling, carbon monoxide, hydrocarbon, and particulates are emitted. While diesel engines are widely used, tightening emission regulations have made it increasingly difficult to site stationary diesel generators, especially in non-attainment areas. Control technologies like selective catalytic reduction (SCR) are expensive and, as a result, diesels are primarily being used for emergency, standby and mobile/rental applications. Most emergency and standby units are not required to meet emissions regulations because of low hours of operation. Emissions control technologies may be required for some mobile applications in non-attainment areas. Control technologies like selective catalytic reduction (SCR) are usually used for diesel engines. Emissions from typical uncontrolled diesel engines range from 7 to 12 g/bhp-hr.

Newer natural gas units use lean-burn technologies that use a higher ratio of air-to-fuel than traditional units. The lean-burn engines have higher efficiencies and lower NO_x emissions than rich-burn engines, but at a lower power output. Natural gas transportable DER can usually be sited without emissions control equipment.

Reciprocating Engines for Transportable DER Applications

For the most part, the reciprocating engines used in transportable DER packages were originally designed for transportation applications. These engines, however, are easily converted into electric power producers. Most reciprocating engines produced for transportable applications are under 2,000 kW in size. The engines are typically packaged with a generator, controls, and a fuel storage/delivery system, and placed inside of a sound-attenuated enclosure that can be trailer-mounted. Most engines use diesel fuel, but some use natural gas. Dual-fuel engines are rare for transportable applications. Figure 2-2 shows a Caterpillar trailer-mounted transportable genset package



Figure 2-2.
Caterpillar Transportable Reciprocating Engine Genset

This container, typically 8 feet wide, 9-10 feet high, and 20-40 feet long, houses the engine, generator, engine cooling system, fuel storage/delivery system, interconnection equipment, and the controls. In order to truly be considered a mobile genset, all of this equipment must be part of the package. Most reciprocating engine manufacturers have outdoor enclosures as an option, and most reciprocating engine gensets are skid-mounted, but to be considered a mobile genset for the purposes of this report, the package must have all of the options stated above. The transportable reciprocating engine packages on the market are shown in the tables in Section 3 and Appendix B. Most companies are primarily in the business of renting these units or selling to rental companies, and are generally not willing to quote a price for purchase until a size, application, and options are chosen.

Combustion Turbines

History and Status

Combustion turbines (CT) have been used for power generation for decades and range in size from simple cycle units starting at about 1,000 kW to over a hundred MW. Units from 1,000 to 15,000 kW are generally referred to as industrial turbines, a term which differentiates them from larger utility grade turbines and smaller microturbines. These industrial turbines are the units typically used for transportable genset applications. Combustion turbines have relatively low installation costs, low emissions, heat recovery, and infrequent maintenance requirements.

However, they have lower electric efficiency compared to a reciprocating engine of the same rating. With these traits, CTs are typically used for cogeneration applications when a continuous supply of steam or hot water and power is desired, as peaking units by electric utility companies, and in combined cycle configurations. They have also found their way into transportable genset applications. While reciprocating engines dominate the transportable market for units less than 2,000 kW in size, the market for transportable units greater than 2,000 kW is dominated by combustion turbines.

Operation

Historically, industrial turbine DER were developed as derivatives from jet propulsion turbines. Some, however, have been designed specifically for stationary power generation or for compression applications in the oil and gas industries. In a combustion turbine, air is compressed and a gaseous or liquid fuel is ignited. The combustion products are expanded directly through the blades in a turbine to drive an electric generator. The compressor and turbine usually have multiple stages and axial blading. This differentiates them from smaller microturbines (i.e. microturbines) which can have radial blades and/or single stages. The intercooler shown in the figure is generally reserved for larger units that can economically incorporate this improvement (i.e. in non-mobile applications). For most mobile applications (2,000 to 10,000 kW), combustion turbines are typically 30-33% electrically efficient.

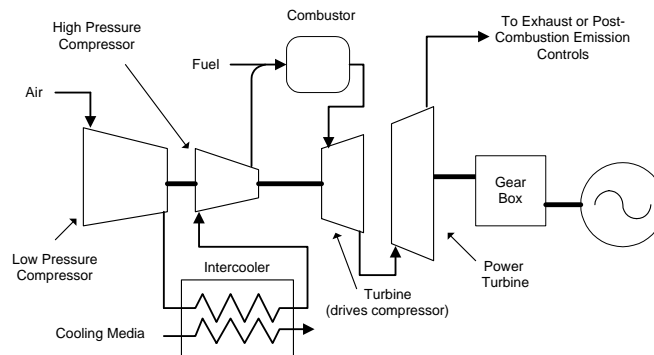


Figure 2-3
Combustion Turbine

Emission Control Technologies

Because combustion takes place outside of the turbine area (unlike reciprocating engines, where combustion takes place inside the cylinder), turbines have more flexibility in reducing NO_x emissions. NO_x emissions from uncontrolled turbines range from 75 to over 150 ppm, normally increasing with higher combustion temperatures. Emissions controls technologies may be required for some transportable applications in non-attainment areas.

Emissions control of combustion turbines is typically accomplished by water or steam injection to reduce the combustion temperature and reduce NO_x levels down to 25-45 ppm. In addition,

these methods increase power production but can reduce system efficiency. While these means have been proven effective in limiting NO_x emissions, the need for water supply and space for storage tanks are constraints for some applications; especially transportable DER.

Dry low NO_x (DLN), conceptually similar to lean burn technology for reciprocating engines, creates a lean, homogeneous mixture of air and fuel that then enters the combustor. This minimizes hot spots and reduces the combustion temperature, which leads to lower NO_x levels. DLN has become the standard for NO_x control in combustion turbines, and may be required for transportable applications in non-attainment areas.

Combustion Turbines in Transportable Applications

The combustion turbines used in most transportable applications are industrial turbines ranging from 2,000 to 20,000 kW in size. Like reciprocating engines, transportable turbine gensets come packaged with an engine, a generator, controls, interconnection equipment, and a fuel storage/delivery system. If a unit does not include all of these features, it is not a true transportable genset for the purposes of this report. Figure 2-4 shows a picture of a trailer-mounted turbine genset – they are typically larger than their reciprocating engine counterparts of a similar rating, and may not fit in a standardized rectangular container, as shown in Figure 2-4. Larger combustion turbine packages, such as GE’s TM2500, are packed into four trailerable modules which can be site assembled in one to two days.

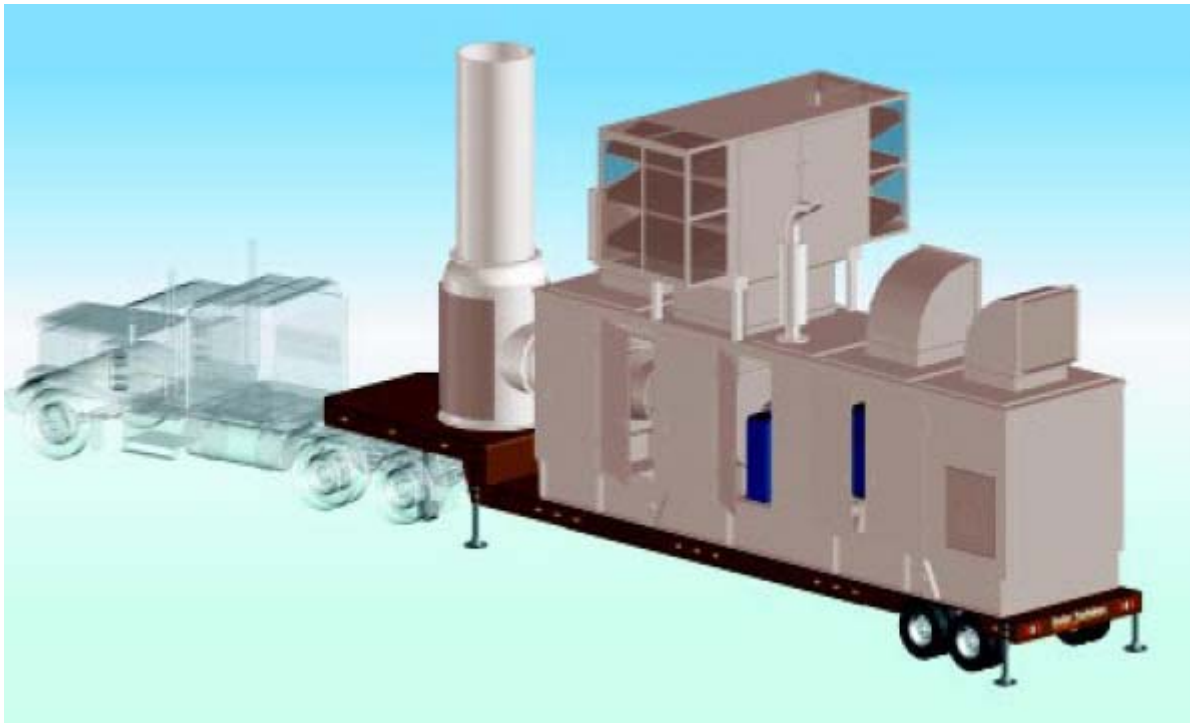


Figure 2-4
Trailer-Mounted Transportable Turbine Genset (Solar Turbines Taurus 60 Model)

Several transportable turbine gensets are being produced. Solar Turbines produces a number of small industrial turbines that are ideal for mobile applications. Their Centaur and Taurus models have been used extensively in transportable turbine gensets across the United States. Rolls Royce's small Proteus and larger Avon models have also been successfully installed in transportable applications. GE and Allison produce transportable turbine gensets for rental applications that can also be purchased as new packages. Although there are fewer transportable turbine gensets compared with reciprocating engines, there is still a market, and they can be the best choice for applications larger than 2,000 kW in size (although sometimes multiple reciprocating engines are used).

3

COMMERCIAL TRANSPORTABLE PRODUCTS

This section catalogues all of the commercial transportable products 500 to 10,000 kW in size currently available on the market. For reciprocating engines, a number of different manufacturers produce units for rental and sales. Each manufacturer is looked at individually, with a brief company description, and their equipment information listed in tabular form. Price quotes are very difficult to obtain for new units, since most of them are manufactured for rental purposes. In some cases, not all of the desired information (such as emissions specifications and efficiency) is readily available. For combustion turbines, there are fewer manufacturers and fewer models available, so the equipment for all companies is listed in a single table.

Appendix B contains a table listing all available transportable DER units, sorted by size range.

Reciprocating Engines

Aggreko

Aggreko is one of the largest transportable DER rental firms in the world, and manufactures their own equipment, using prime movers and other equipment from various manufacturers. The packages are usually rented out by Aggreko, but Aggreko also has a purchase options and will sell equipment to end-users as well. Packages are custom-made, so it is difficult to obtain general price quotes or specifications – prices and specifications are only given to customers who know exactly what options and equipment they want². Aggreko offers four different types of genset packages in the size ranges covered in this report, with different size ranges and features, which are listed in Table 3-1.

² See www.aggreko.com for more details

**Table 3-1
Aggreko Diesel Transportable Reciprocating Engine Gensets**

Model	Prime Output (kW) ¹	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
TwinPack Uninterruptible Generator	~450 to ~730	< 500 to 800	varies with engine make and model used	designed for 8 hour operation	Variety of plug and connection configurations	varies with genset size	160	48-55 dBA at 50 feet	varies with genset size
SuperHush Container Generator	~ 450 to ~1,130	< 500 to 1,250	varies with engine make and model used	designed for 8 hour operation	Output connections are mounted in a dedicated compartment	varies with genset size	160 to 320	48-55 dBA at 50 feet	varies with genset size
HP Container Generator	~450 to ~1,130	< 500 to 1,250	varies with engine make and model used	designed for 8 hour operation	Automatic synchronization and load-sharing controls	varies with genset size	160 to 320	65 dBA at 50 feet	varies with genset size
GreenPower Container Generator	~450 to ~1,820	< 500 to 2,000	varies with engine make and model used	designed for 8 hour operation	Synchronizing and load-sharing power controls	varies with genset size	160 to 320	unknown	very low emissions

¹ Estimated based on 110% overrating for Standby output

Caterpillar

Caterpillar has been a major player in the power generation market for many years. They have a division dedicated to rental power (CAT Rental Power), which rents transportable reciprocating engine gensets produced by Caterpillar. Although the primary focus is on renting these units and selling used rental packages, new packages can also be purchased directly from the company. The XQ series of transportable gensets features diesel reciprocating engines from under 500 to 2,000 kW, as well as a 1,250 kW natural gas unit. Tables 3-2 and 3-3 give the specifications for these gensets³. Caterpillar generally relies on local dealers/distributors to sell and rent their products.

³ More detailed specifications can be found at <http://www.cat.com/cda/components/fullArticleNoNav?ids=98838&languageId=7>

**Table 3-2
Caterpillar Transportable Diesel Reciprocating Engine Gensets**

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions (ppm)	Quoted Cost
XQ500 Sound Attenuated Power Module (CAT 3456 ATAAC Engine)	455	500	36.3 gal/hr standby 32.7 gal/hr prime (100%) 36.8% η_e	600 gal (2,271 L) 24 hrs at 75% load	480/277 V, Switchgear included, Semi-automatic paralleling protection – 1,600 Amp circuit breaker w/ 24 V trip	27,170	189	70 dBA at 23 feet	EPA & CARB certified; NO _x < 6.9 CO < 8.5 HC < 1.0 PM 0.4 (g/hp-hr)	\$50,000 - \$100,000 used (\$100 - \$200/kW)
XQ600 Sound Attenuated Power Module (CAT 3412 Engine)	545	600	35.4 gal/hr standby 37% η_e	660 gal (2,500 L) 13-15 hrs	480 V, Switchgear included, Manual paralleling - manually operated circuit breaker w/ overload and fault protection	37,000	320	70 dBA at 50 feet	EPA Tier 1 and CARB certified	\$60,000 - \$120,000 used (\$100 - \$200/kW)
Dual XQ350 Rental Package (Twin CAT 3406 TA Engines)	640	700	Single Engine: 24.9 gal/hr prime (100%) 34% η_e	Each Engine: 400 gal (1,514 L)	480 V, Switchgear included, Automatic/Manual paralleling, 2 1200 Amp circuit breakers and 1 1200 Amp tie switch	32,840	208	68 dBA at 50 feet	EPA Tier 1 and CARB certified	
XQ750 Sound Attenuated Power Module (CAT 3412 Engine)	680	750		660 gal (2,500 L) 11-12 hrs	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	39,500	320	70 dBA at 50 feet	EPA Tier 1 and CARB certified	\$208,000 slightly used (\$277/kW)
XQ1000 Sound Attenuated Power Module (CAT 3508 B Engine)	910	1,000		Standard: 1,250 gal (4,372 L) 16-18 hrs, option for double	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	49,787	320	70 dBA at 50 feet	EPA Tier 1 and CARB certified	
XQ1500 Sound Attenuated Power Module (CAT 3512 B Engine)	1,360	1,500		Standard: 1,250 gal (4,372 L) 16-18 hrs, option for double	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	59,000	320	70 dBA at 50 feet	EPA Tier 1 and CARB certified	\$250,000-\$380,000 used (\$143-\$217/kW)

Commercial Transportable Products

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions (ppm)	Quoted Cost
XQ2000 Sound Attenuated Power Module (CAT 3516 B Engine)	1,825	2,000		Standard: 1,250 gal (4,372 L) 9-10 hrs, option for double	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	74,000	354	74 dBA at 50 feet	EPA Tier 1 and CARB certified	\$300,000-\$450,000 used (\$150-\$225/kW)

**Table 3-3
Caterpillar's Transportable Natural Gas Reciprocating Engine Genset**

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
XQ1250G Sound Attenuated Gas Power Module (CAT SCAC Engine)		1,250	34.2% η_e		480 V, Switchgear included, Automatic/Manual paralleling - manual circuit breaker w/ overload and fault protection	71,060	320	74 dBA at 50 feet	NO _x 1.0 CO 2.6 HC 4.4 (g/bhp-hr) NO _x 75 CO 332 HC 995 (ppm)	\$160,000-\$250,000 used (\$107-\$167/kW)

Cummins

Cummins has also been a major player in the power generation market for many years. Their rental unit, *Cummins Power for Rent*, offers trailer-mounted containerized reciprocating engine gensets up to 2,000 kW in size. Like Caterpillar, they also offer a transportable 1,250 kW natural gas engine. Again, the primary focus of the business is renting transportable units and selling used ones, but new units of all models are available from the company. Tables 3-4 and 3-5 give the specifications for Cummins' transportable gensets⁴. Local Cummins distributors handle the purchasing and renting of these units.

⁴ For more specifications, see: <http://www.cumminspower.com/powergenerationproducts/rentalpower/home.jhtml?SMIDENTITY=NO>

Table 3-4
Cummins Transportable Diesel Reciprocating Engine Gensets

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
500 kW Rental Package - Model DFED	455	500	35.9 gal/hr standby, 32.3 gal/hr prime (at 100%) 37.3% η_e	550 gal (2,082 L) – 21-23 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	37,000	200	76 dBA @ 7m	NO _x 9.85 CO 1.27 HC 0.2 PM 0.12 (g/hp-hr, standby)	\$95,000- \$120,000 (used)
750 kW Rental Package - Model DFHA	680	750	56.0 gal/hr standby, 50.3 gal/hr prime (at 100%) 35.8% η_e	1,750 gal (6,624 L) – 43-48 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	49,000	320	76 dBA @ 7m	NO _x 5.3 CO 0.5 HC 0.14 PM 0.12 (g/hp-hr, standby)	\$135,000- \$145,000 (used)
900 kW Rental Package - Model DFHC	818	900	60 gal/hr standby 36% η_e	1,750 gal (6,624 L) – 39-43 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	49,000	320	76 dBA @ 7m	unavailable	\$150,000- \$155,000 (used)
1000 kW Rental Package - Model DFJD	900	1,000	69.3 gal/hr standby, 62.0 gal/hr prime (at 100%) 38.5% η_e	1,750 gal (6,624 L) – 32-35 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	35,500	188	76 dBA @ 7m	NO _x 6.0 CO 0.44 HC 0.12 PM 0.05 (g/hp-hr, standby)	\$155,000- \$220,000 (used)
1250 kW Rental Package - Model DFLC	1,100	1,250	87.3 gal/hr standby, 76.9 gal/hr prime (at 100%) 38% η_e	1,750 gal (6,624 L) – 28-31 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	55,000	320	76 dBA @ 7m	NO _x 12.7 CO 1.0 HC 0.12 PM 0.06 g/hp-hr, standby)	\$165,000- \$175,000 (used)
1500 kW Rental Package - Model DFLE	1,250	1,500	103.6 gal/hr standby, 87.3 gal/hr prime (at 100%) 37.9% η_e	1,750 G (6,624 L) 23-27 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	60,140	320	Yes (unknown)	NO _x 8.5 CO 1.3 HC 0.17 PM 0.11 (g/hp-hr, standby)	\$185,000- \$265,000 (used)

Commercial Transportable Products

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
2000 kW Rental Package - Model DQKC	1,800	2,000	137.3 gal/hr standby, 123.2 gal/hr prime (at 100%) 38.7% η_e	2,030 G (7,684 L) – 20-22 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	79,225	320	76 dBA @ 7m	NO _x 7.0 CO 0.9 HC 0.2 PM 0.04 (g/hp-hr, standby)	\$320,000- \$345,000 (used)

**Table 3-5
Cummins' Transportable Natural Gas Reciprocating Engine Genset**

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
1250 kW Rental Package - Model QSV91G		1,250	unknown	unknown	Isolated bus paralleling control & base load utility paralleling features, paralleling circuit breaker & switchgear	70,550	400	85 dBA at 1 meter	unavailable	

General Electric

General Electric (GE) produces electronic products for a wide variety of applications, including power generation. Their GE Power Generation Rentals unit rents out machines with engines and equipment produced not only by GE, but other manufacturers as well. In fact, all of the GE Energy Rental machines in the California BUGS database featured engines produced by other companies. Regardless, they offer a wide range of transportable reciprocating engine gensets for rent and used sale. GE was not willing to give many specifications or information to third parties for new units, so the data on their new transportable gensets is limited. The information EPRI was able to obtain is found in Tables 3-6 and 3-7⁵.

**Table 3-6
GE Transportable Diesel Reciprocating Engine Gensets**

Model	Prime Output (kW) ¹	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
Diesel Powered Generators - various engines used	~450 to 1,660	< 500 to 1,825	varies with size	varies with size	varies by engine size	varies	160 - 320	Yes	Varies by engine model

⁵ To find out more about GE's Power Generation Rentals unit, visit http://www.gepower.com/prod_serv/serv/energy_rentals_cc/en/power_gen_rentals.htm.

Table 3-7
GE's Transportable Natural Gas Reciprocating Engine Genset

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
Natural Gas Reciprocating Generator	unknown	1,000	unavailable	unknown	unknown	unknown	unknown	Yes (unknown)	unavailable

Kohler

Kohler produces a large selection of appliances and products, including power generators⁶. They have been producing transportable reciprocating engine gensets for power rental applications for many years. Most of the business is handled by local distributors. Kohler Rental Power is focused on renting and selling used transportable power units, but also will sell new ones. Kohler offers a range of diesel reciprocating engine gensets up to 2,000 kW in size, and the specs for these units are provided in Table 3-8⁷.

Table 3-8
Kohler Transportable Diesel Reciprocating Engine Gensets

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
Industrial Rental Trailer-Mounted Generator Set 600ROZD-4N (DDC Series 2000)	unknown	600	44.8 gal/hr (100%), 22.2 gal/hr (50%) 35.5% η_e	650 gal (2,460 L)	208, 480 or 600 V, Load Lug 1,000 Amp circuit breakers in NEMA 1 enclosure	22,000	224	72 dBA at 7 meters (23 ft)	NO _x 6.462 CO 0.242 HC 0.195 PM 0.056 (g/bhp-hr)
Industrial Rental Trailer-Mounted Generator Set 800ROZD-4N (DDC Series 2000)	unknown	800	57.5 gal/hr (100%), 28.6 gal/hr (50%) 36.9% η_e	1,000 gal (3,785 L)	208, 480 or 600 V, Load Lug ,1400 Amp circuit breakers in NEMA 1 enclosure	37,000	320	78 dBA at 7 meters (23 ft)	NO _x 6.631 CO 0.339 HC 0.205 PM 0.047 (g/bhp-hr)
Industrial Rental Trailer-Mounted Generator Set 1000ROZD-4N (DDC Series 2000)	unknown	1,000	73.2 gal/hr (100%), 36.7 gal/hr (50%) 36.2% η_e	1,000 gal (3,785 L)	208, 480 or 600 V, Load Lug 1,600 Amp circuit breakers in NEMA 1 enclosure	37,000	320	78 dBA at 7 meters (23 ft)	Not available
Industrial Rental Trailer-Mounted Generator Set 1500ROZD-4N (DDC Series 4000)	unknown	1,500	99.7 gal/hr (100%), 50.6 gal/hr (50%) 39.9% η_e	1,000 gal (3,785 L)	208, 480 or 600 V, Load Lug 2,500 Amp circuit breakers in NEMA 1 enclosure	57,000	320	80 dBA at 7 meters (23 ft)	Not available

⁶ For more information, see: <http://www.kohlereventservices.com/resources/g5186a2c.pdf>

⁷ online information is located at contains these and more specifications on their units <http://www.kohlereventservices.com/resources/g5186a2c.pdf>

Commercial Transportable Products

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
Industrial Rental Trailer-Mounted Generator Set 1750ROZD-4N (DCC Series 4000)	unknown	1,750	114.9 gal/hr (100%) 62.6 gal/hr (50%) 40.4% η_e	1,000 gal (3,785 L)	208, 480 or 600 V, Load Lug 3,000 Amp circuit breakers in NEMA 1 enclosure	60,000	320	82 dBA at 7 meters (23 ft)	Not available
Industrial Rental Trailer-Mounted Generator Set 2000ROZD-4N (DCC Series 4000)	unknown	2,000	133.2 gal/hr (100%), 67.2 gal/hr (50%) 39.8% η_e	1,000 gal (3,785 L)	208, 480 or 600 V, Load Lug 3,000 Amp circuit breakers in NEMA 1 enclosure	61,000	320	82 dBA at 7 meters (23 ft)	unavailable

MQ Power

MQ Power is different than the equipment manufacturers that have previously been discussed. They take equipment from a variety of sources and assemble them into transportable genset packages. MQ Power assembles and sells to rental companies – they do not rent them out directly. MQ Power’s standard transportable DER units are shown in Table 3-9⁸. Table 3-9 provides a list of their standard packages and their specifications.

**Table 3-9
MQ Power Transportable Diesel Reciprocating Engine Gensets**

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
EGC-500DD (Detroit Diesel 8V2000 Engine)	450	500	32.7 gal/hr (100%), 18.1 gal/hr (50%) 36.4% η_e	800 gal (3,025 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	29,980	160	Yes (Unknown)	NO _x 6.8 HC 0.23 CO 0.63 PM 0.05 g/bhp-hr
EGC-500V (Volvo TAD1631GE Engine)	485	525	34.9 gal/hr (100%), 19 gal/hr (50%) 36.8% η_e	800 gal (3,025 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	26,920	160	Yes (Unknown)	NO _x 6.06 HC 0.28 CO 0.42 g/bhp-hr
EGC-750DD-20 (Detroit Diesel 12V2000 Engine)	675	750	54.7 gal/hr (100%), 26.9 gal/hr (50%) 32.7% η_e	600 gal (2,270 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	42,500	160	Yes (Unknown)	Not available

⁸ More information can be found at <http://www.multiquip.com/mqpower/index.html>, where detailed brochures list all of the standard and optional features included with their units

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
EGC-750C (Cummins QST30-G2 Engine)	725	800	60 gal/hr (100%), 26.9 gal/hr (50%) 32.0% η_e	1,000 gal (3,785 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	44,500	320	Yes (Unknown)	Not available
EGC-1000DD-20 (Detroit Diesel 16V2000/G81 Engine)	900	1,000	78.2 gal/hr (100%), 36.7 gal/hr (50%) 30.5% η_e	1,000 gal (3,785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	43,480	160	Yes (Unknown)	NO _x 6830 g/hr; HC 144 g/hr; CO 359 g/hr; PM 22.2 g/hr (100% load)
EGC-1000DD (Detroit Diesel 16V2000/G81 Engine)	900	1,000	78.2 gal/hr (100%), 36.7 gal/hr (50%) 30.5% η_e	1,000 gal (3,785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	45,200	320	Yes (Unknown)	NO _x 6830 g/hr; HC 144 g/hr; CO 359 g/hr; PM 22.2 g/hr (100% load)
EGC-1500C-20 (Cummins KTA50-G9 Engine)	1,250	1,500	104 gal/hr (100%), 56 gal/hr (50%) 31.9% η_e	1,000 gal (3,785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	45,240	160	Yes (Unknown)	NO _x 7.3 g/hr; HC 0.18 g/hr; CO 1.0 g/hr; PM 0.13 g/hr
EGC-1500C (Cummins KTA50-G9 Engine)	1,250	1,500	104 gal/hr (100%), 56 gal/hr (50%) 31.9% η_e	1,000 gal (3,785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	53,220	320	Yes (Unknown)	NO _x 7.3 g/hr; HC 0.18 g/hr; CO 1.0 g/hr; PM 0.13 g/hr

Stewart & Stevenson

Stewart & Stevenson combines engines, generators, controls, and equipment from various manufacturers and assembles their own transportable power gensets. Like MQ Power, the units are custom-built to meet the customer's needs. Stewart & Stevenson uses natural gas fueled engines in a number of their packages, especially for smaller-sized units. Listed in Tables 3-10 and 3-11 are the diesel and natural gas transportable genset packages⁹.

⁹ More information on these units can be found at <http://www.ssss.com/Home/Products/PowerGeneration/Custom+Packages/Mobile.htm?pm=140>

**Table 3-10
Stewart & Stevenson Transportable Diesel Reciprocating Engine Gensets**

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
RS1500D Power Generation Module (Deutz TBD620 Engine)	1,390	1,500	unavailable	1,250 gal (4,730 L)	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	50,500	320	Yes (unknown)	Fulfills all current emissions regulations	Units are custom made - price varies
RS2000D Power Generation Module (Deutz TBD620 Engine)	1,820	2,000	unavailable	1,100 gal (4,160 L)	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	56,700	320	Yes (unknown)	Fulfills all current emissions regulations	Units are custom made - price varies

**Table 3-11
Stewart & Stevenson Transportable Natural Gas Reciprocating Engine Gensets**

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
RS530GW Power Generation Module (Waukesha L36GSID Engine)	530	unknown	less than 7,600 Btu/ bhp-hr	8 inches W.C.	480 V, Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	48,500	320	Yes (unknown)	Three-way catalytic converter - less than 0.6 g/bhp hr NOx	Units are custom made - price varies
RS730GW Power Generation Module (Waukesha P48GSID Engine)	730	unknown	less than 8,000 Btu/ bhp-hr	8 inches W.C.	480 V, Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	51,500	320	Yes (unknown)	Three-way catalytic converter - less than 0.6 g/bhp hr NOx	Units are custom made - price varies
RS1000G Power Generation Module (Deutz TBG620V12 Engine)	970	1,000	unavailable	unknown	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	56,000	320	Yes (unknown)	unavailable - see engine manufacturer	Units are custom made - price varies

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
RS1350G Power Generation Module (Deutz TBG620V16 Engine)	1,280	1,350	unavailable	unknown	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	58,000	320	Yes (unknown)	unavailable - see engine manufacturer	Units are custom made - price varies

Waukesha

Waukesha produces a limited range of transportable gensets in the size range covered by this report, only up to 750 kW in size. The GSID series of engines is powered by diesel fuels, while the GL/GLD series is powered by natural gas¹⁰. Tables 3-12 and 3-13 summarize the units available greater than 500 kW in capacity.

Table 3-12
Waukesha Diesel Transportable Reciprocating Engine Gensets

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
Modulator VGF 36GSID	430	515	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	unknown	320	Yes (unknown)	unavailable
Modulator VGF 48GSID	565	680	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	unknown	320	Yes (unknown)	unavailable

Table 3-13
Waukesha Natural Gas Transportable Reciprocating Engine Gensets

Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions
Modulator VGF 36GL/GLD	475	575	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	31,700	320	Yes (unknown)	unavailable
Modulator VGF 48GL/GLD	565	680	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	40,200	320	Yes (unknown)	unavailable

¹⁰ Additional information on these units is limited, but can be found at <http://waukeshaengine.dresser.com/internet/businessunits/waukesha/pages/documents/publications/specsheets/7089.pdf>

Other Transportable Genset Manufacturers

Other genset manufacturers such as Alstom, Detroit Diesel and Allison produce gensets for transportable packages, but either their selection is limited, information is unavailable, or they don't package their own units. Alstom produces the Utility Grade Power Module, which is a transportable genset package consisting of a 2,000 kW diesel engine, but it appears this is the only transportable package they offer¹¹. Alstom has been undergoing major corporate restructuring for the past few years. Detroit Diesel produces diesel engines that are used in transportable gensets, but it appears that they rely solely on third party companies to package and distribute them. The website¹² provides a listing of standard Detroit Diesel/MTU generators available. Penn Detroit Diesel Allison is a conglomerate consulting company that provides rental power solutions using Penn Power, Detroit Diesel, and Allison Engines' combined resources. They were not willing to share information with third parties on the specific units that they offer. Their website¹³, provides some information and their staff will respond to serious inquiries. The Table 3-14 illustrates the range of reciprocating engine units available from these three manufacturers

**Table 3-14
Other Transportable Diesel Reciprocating Engine Genset Manufacturers**

Brand	Model	Prime Output (kW) ¹	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
Alstom	Utility Grade Power Module	~1,820	2,000	111.5 gal/hr (100%), 61.5 gal/hr (50%)	1,250 gal (4,731 L)	unknown	89,000	320	Yes (unknown)	NO _x 44.2 CO 0.95 HC 0.98 lb/hr	\$700,000- \$800,000 new, \$400,000 used rental
Detroit Diesel	Range of Gensets that can be used for mobile applications	~450 to ~2,550	< 500 to 2,800	varies with size	varies with size	varies with packager	varies	160-320	Yes (unknown)	designed to meet federal off-highway requirements	Detroit Diesel does not package mobile units
Penn Detroit Diesel Allison	Range of Rental Generator Systems	~450 to ~1,880	< 500 to 2,000	varies with size	varies with size	unknown	varies	160-320	Yes (unknown)	varies	Price varies according to the user's needs

In addition to these companies, many other smaller third-party packagers manufacture custom-made transportable gensets using both new and used prime movers

¹¹ For more information on Alstom's unit, see: <http://www.power.alstom.com/servlet/ContentServer?pagename=OpenMarket/Xcelerate/View&c=Page&cid=1023276882107>

¹² <http://www.ddcmtupowergeneration.com/diesel.html>

¹³ http://www.pennpowersystems.com/pennpower_rentgen1.html

Combustion Turbines (All Manufacturers)

Combustion turbines (CT) are used by utilities in strategic applications such as substations. They can provide T&D support in peaking duty and by providing relief to highly loaded circuits as a tool to defer T&D infrastructure upgrades. The favorable emissions from combustion turbines allow for permitting advantages and, when sited at urban substations, can be more attractive than diesel engines in the eye of the public. A number of combustion turbines are available in a transportable format in the 1 to 20+ MW size range. Figure 3-1 shows a typical example.



Figure 3-1
Solar Turbine's Taurus 60 Transportable Power Unit

Alstom Turbines produce three transportable turbine gensets, currently they only produce the 7,200 kW Tempest model. The 6,800 kW Tornado and smaller Typhoon units¹⁴ are no longer manufactured by Alstom today, but they are available used. Alstom has undergone major corporate restructuring and has sold off part of their turbine business to Siemens. GE produces a transportable turbine generator set, the TM2500 rated at 22.8 MW; the largest transportable turbine available. Rolls Royce produces the 3,200 kW Proteus and 10,000+ kW Avon models. Pratt & Whitney produces three mobile turbines, the 1.8 MW ST18 Trans-Pac, the 4.3 MW ST40 Trans-Pac (see Figure 3-2), and the 21 MW FT4A-11 Trans-Pac products. Finally, Solar Turbines is perhaps the largest producer of new transportable gensets in the United States market. The Centaur 30 (3,500 kW) and Taurus 60¹⁵ (5,200 kW) are packaged as transportable

¹⁴ More information on Alstom Rental Power can be found at <http://www.power.alstom.com/servlet/ContentServer?pagename=OpenMarket/Xcelerate/View&c=Page&cid=1023276882107>

¹⁵ For more information on Solar's mobile Taurus units, see <http://cfaspower.com/Solar%20T-60.pdf>

gensets, and Solar's other models can also be custom packaged for transportable gensets. The transportable combustion turbines are listed in Table 3-15.



Figure 3-2
Pratt & Whitney ST40 TransPak

**Table 3-15
Transportable Combustion Turbine Gensets**

Brand	Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
Alstom	Typhoon Gas Turbine Generating Set – four variants	4,350 - 5,250	4,350 - 5,250	varies with genset size			78,175	320	Yes (Unknown)		Discontinued; limited availability
Alstom	Tornado Gas Turbine Generating Set	6,750	6,750	unavailable			124,253	320	Yes (Unknown)	unavailable	Discontinued; limited availability
Alstom	Tempest Gas Turbine Generating Set	7,900	7,900	11,154 Btu/kWh	NG: 287-362 psig, Diesel: 15-30 psig		115,190	320	Yes (Unknown)	NO _x <10 CO <2 UHC <10 ppmvd	\$3.5 million new, \$3 million slightly used
GE	Dual Fuel Gas Turbine Generator Sets	2,700	2,700	unavailable	unknown		unknown	unknown	Yes (Unknown)	unavailable	
GE	TM2500	22,800	22,800	9,465 BTU/kW (LHV)		Voltage supplied at 13.8 kV			90 dBA @ 3m	25 ppm (on gas) 45 ppm (on diesel)	
Rolls Royce	Proteus 3.2 MW Mobile Genset	2,875	3,200	280 gal/hr (100%)	Minimum pressure: 160 psig	Manual paralleling; Auto Sync Relay, Westinghouse Generator Breaker	95,656	320	Yes (Unknown)	unavailable	\$1.6 Million new, \$800,000-\$1 Million used
Rolls Royce	Avon 10 MW Mobile Gas Turbine Generator	10,300	16,000	unavailable	Fuel supplied by separate tanker to fuel forwarding package	Automatic synchronizing unit (type PAS), under/over current and overvoltage protection	265,000	unknown	Yes (Unknown)	unavailable	\$2.5-\$3.5 Million, used
Pratt & Whitney	ST18 TransPak	1,600	1,800					320			
Pratt & Whitney	ST40 TransPak	4,300	3,820					320			
Pratt & Whitney	FTA4-11 TransPak	18,600	20,900	13,000 BTU / kWh (LHV)		Synchronys EM generator, battery bank and charger					
Solar Turbines	Saturn 20 1.2 MW Mobile Gas Turbine Generator	1,200	1,200	unavailable	unknown	Manual paralleling; switchgear, circuit breaker and synchronizing system included	Unknown	unknown	Yes (Unknown)	unavailable	

Commercial Transportable Products

Brand	Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption / Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Cost
Solar Turbines	Centaur 40 3.5 MW Mobile Gas Turbine Generator	3,500	3,500	unavailable	unknown	Manual paralleling; switchgear, circuit breaker and synchronizing system included	Unknown	unknown	Yes (Unknown)	unavailable	\$1.4 Million, less than 100 hours; <1 Million refurbished
Solar Turbines	Centaur 50 4.6 MW Mobile Gas Turbine Generator	4,600	4,600	unavailable	unknown	Manual paralleling; switchgear, circuit breaker and synchronizing system included	Unknown	unknown	Yes (Unknown)	unavailable	
Solar Turbines	Taurus 60 Mobile Power Unit	5,200	5,200	unavailable	unknown	Manual paralleling; Utility grade switchgear and protective relay module	unknown	1,006	Yes (Unknown)	SoLoNOx™ Dry Low NOx Combustion System - no visible emissions	\$2.5-\$3.5 Million, new; \$1.8-\$2.5 Million, slightly used
Solar Turbines	Taurus 70 Mobile Power Unit	unknown	7,500	unavailable	unknown	Manual paralleling; Utility grade switchgear and protective relay module	unknown	1,006	Yes (Unknown)	SoLoNOx™ Dry Low NOx Combustion System - no visible emissions	

* May not be available as a mobile package, or must be custom ordered

** Discontinued, but still available used

4

TRANSPORTABLE EQUIPMENT MARKETS

The transportable DER market is complex, with many players and stakeholders. There are a number of channels for product distribution, and regulatory and related issues also affect the market. Figure 4-1 shows the transportable DER marketplace structure.

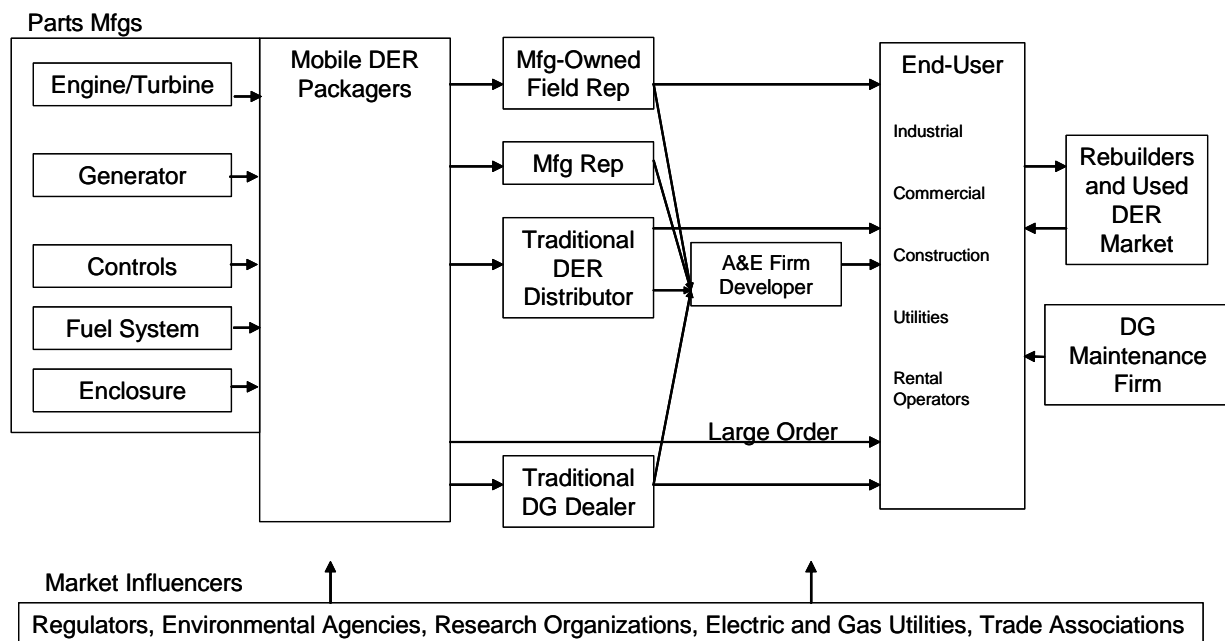


Figure 4-1
The Transportable DER Marketplace

The role of each stakeholder is described below. Different DER markets and regions may have slightly differently names for some of the stakeholders described.

Parts Manufacturers

A transportable DER package is an assembly of parts. Major parts that go into a transportable DER system include prime movers (reciprocating engine or combustion turbine,), generators, controls, interconnection equipment, enclosures, trailers, and fuel storage.

DER Packagers

Transportable DER packagers assemble complete transportable DER units. In many cases, the DER packager is also the prime mover manufacturer (e.g., Cummins, Caterpillar). In other cases, the packager does not manufacture any of the equipment themselves (e.g. MQ Power, Stewart & Stevenson). Sometimes, a manufacturer like GE will take on the role of a third-party packager, using engines and equipment from other companies in their own transportable/rental units.

Traditional DER Distributor and Traditional DER Dealer

In many cases the terms dealer and distributor are used interchangeably, but we have made a distinction. Dealers tend to be geographically oriented and are used in commodity markets. Dealers are usually not required to exclusively sell one manufacturer's DER units, although there are exceptions. Most small transportable DER units less than 30 kW in size are sold by dealers. Distributors, in contrast to dealers, tend to serve specialty markets and usually carry DER units from only one manufacturer. Their market segments usually involve larger units that are more expensive and have higher profit margins. For example, Caterpillar sells most of their larger transportable units through dealers. Both the dealer and the distributor buy DER units from the manufacturer, stock inventories and take the risks that accompany making sales and collecting payments. In any case, most manufacturers rely on both dealers and distributors to move some (if not all) of their units. An example of a large manufacturer who relies solely on dealers and distributors to sell/rent their transportable units is Detroit Diesel, as well as packagers to assemble transportable DER units powered by Detroit Diesel engines. Detroit Diesel still plays a major role in the transportable power market despite their lack of involvement in the packaging and rental marketplace.

Manufacturer-Owned Field Representatives and Manufacturer Representative

Manufacturer representatives perform a market function that is similar to that of distributors, in terms of providing direct customer contact. Manufacturer representatives tend to specialize in specific market areas, providing preliminary project budgetary pricing and technical support to customers. They also assist customers in setting up spare parts inventories and determining maintenance schedules and, if necessary, arranging for personnel training. Manufacturer representatives do not take possession of the DER units, however, and are not exposed to the risk of sales. Instead, they place orders for sales and the manufacturer ships the unit directly to the customer. Solar Turbines sells their transportable DER units primarily through manufacturing representatives.

The essential differences between manufacturer representatives and distributors are in the areas of customer service and after-sales support. Distributors are usually required by the manufacturer to carry a certain inventory of DER units and spare parts, and typically offer repair services. Distributors are able to ship units to the customer more quickly and can readily access replacement parts. Although manufacturer representatives provide customer support, they

usually do not stock an inventory and often must coordinate with the manufacturer for replacement parts.

A&E Firm

Architectural and engineering (A&E) firms design, develop, and install DER equipment at customers' sites. A&E firms have a smaller role in transportable DER project compared with traditional DER projects because the equipment is pre-packaged, often with the interconnection equipment, and is generally located outdoors, so fewer services (if any) are required from A&E firms.

End User

End users are customers that use the DER units at their locations. In many cases, transportable DER is used for rental power and the owner is the rental company. This market is covered in Section 5.

The Market Delivery System

Transportable DER equipment consists primarily of a prime mover and generator, and controls, sold as a "package," usually trailer-mounted. Electric interconnection and fuel connection/supply equipment are also usually included. The components of a typical DER genset are manufactured by several different companies and then assembled together by DER manufacturers or genset packagers. Packagers primarily assemble components manufactured by others, while DER manufacturers differ in their involvement in the assembly process.

There are a number of routes a genset can take from the manufacturer's production plant to the end user. These paths are illustrated in Figure 4-1. The third and fourth columns from the left show the intermediaries between the manufacturers/packagers and end-users. In general, going from top to bottom on these two columns,

- The size of the DER equipment gets smaller,
- The level of service provided decreases,
- Profit margin goes down, and
- The number of different manufacturers represented increases.

For example, for larger transportable DER equipment such as combustion turbines in the 1-15 MW size range, manufacturer-owned field representatives will sell and deliver the equipment directly to the end user, and thus provide a high degree of service and customer interaction. Small commodity-type DER equipment, such as small diesel units, are often sold by a genset dealer that may represent a number of different manufacturers through a catalog or website. In this situation, service and interaction may be limited.

Size of the Transportable DER Market

Little data is available on the installed base or annual sales of transportable DER, because they are usually not disaggregated from stationary DER units in most data sources. The BUGS (Back-up Generator) database, developed by the California Energy Commission, has an inventory of both transportable and stationary DER in California greater than 300 kW in the 2001-2003 timeframe. 970 transportable units, with a total capacity of 825,000 kW (850 kW average size) are in the database, compared with 4,907 stationary units. The transportable units make up 16 percent of the total units. To roughly estimate the installed base of transportable units greater than 300 kW in the United States, the 970 units in California is multiplied by the ratio of US commercial electricity sales over California commercial electricity sales, giving 11,000 units in the US.

The Used Equipment Market

A market for used and rebuilt transportable DER equipment exists in which used equipment, typically with low hours of operation is offered for sale. Most companies, with the exception of Cummins, do not sell their used rental units directly. Instead, online vendors such as CFAS Enterprises¹⁶, Aaron Equipment Company¹⁷, Wabash Power Equipment Company¹⁸, and Aggreko¹⁹ sell used rental units independently. Aggreko, unlike the other vendors, builds their own transportable genset packages from various equipment manufacturers for both rental and equipment sales. Aggreko units are shown in Table 3-1 as new units.

In addition to vendors, some websites like www.connectgreece.com provide used transportable genset listings, where sellers can post pictures and information, as well as a price, for their units. Transportable gensets can even be purchased in online auction sites like eBay²⁰. Currently this is a 750 kW diesel-fueled unit for sale for \$75,000 on eBay. However, the quality and condition of gensets purchased at these sites varies.

While some trailer-mounted gensets on vendors' sites come with a quoted price, for many gensets, the price is not listed. However, browsing through the selections that do contain prices gives one a rough idea to how much the gensets will sell for on the market, and this data has been collected and used to estimate the price of certain used transportable genset packages. In general, slightly used reciprocating engine packages cost anywhere from \$100 to \$300 per kW, with most falling somewhere around \$200 per kW. Combustion turbine packages are more expensive, typically ranging from \$250 to \$450 per kW, with most costing around \$350 per kW.

¹⁶ www.cfaspower.com/Mobile.html

¹⁷ www.aaronequipment.com

¹⁸ www.wabashpower.com/diesel.html

¹⁹ <http://www.aggreko.com/equipserv/Diesel-Generators.asp>

²⁰ www.ebay.com

Several combustion turbines were also offered as new, but in general, prices for new units are very difficult to obtain. For used transportable genset packages, the price depends mainly on the system’s use, wear and tear, size, and brand. In addition, some units come pre-packaged with interconnection equipment, sound-attenuated containers, and other options, while others may come only as a genset mounted on a trailer skid. With most vendor sites, prices can be negotiated.

Cummins sells used transportable gensets through an in-house subsidiary²¹, as well as through vendors. At this website, the price ranges one can expect to pay for a used transportable genset package are given. The packages include interconnection and control equipment, as well as the containers and trailers. The average per kW prices for the diesel units were taken and plotted vs. the standby kW rating to give an idea how the price per kW varies along with genset size. This graph is depicted in Figure 4-2. Although these numbers only represent Cummins reciprocating engine gensets, other companies’ transportable genset packages should have similar prices for their diesel units.

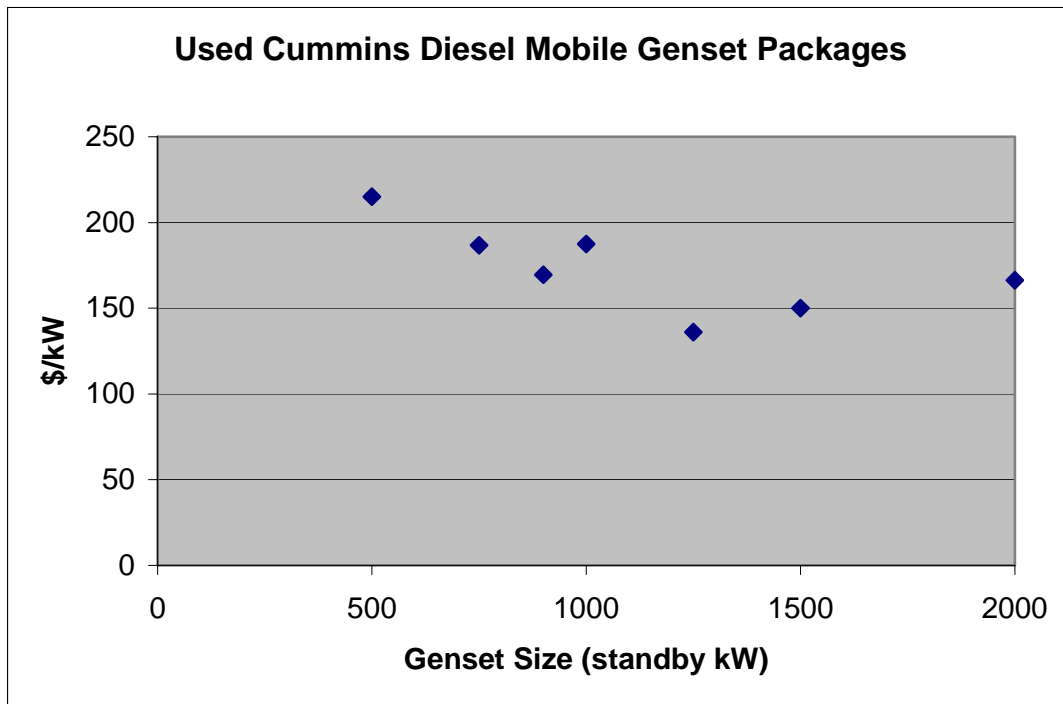


Figure 4-2
Used Cummins Diesel Transportable Genset Packages – Average Price vs. Size

For the most part, companies rely on vendors to sell all their used rental units, and they may provide units to vendors at a discounted price. The strongest market for transportable genset purchases is for slightly used rental packages, as opposed to new units, and in this used genset market, inexpensive units can be found. Table 4-1 on the following page shows the used and

²¹ www.usedcumminsgenerators.com

new transportable genset packages that are currently being sold by online vendors, along with their specs and quoted prices. All of the units are diesel-fueled except for the CAT XQ1250G, which is fueled by natural gas. In some cases, the prices are averaged. Transportable gensets with quoted prices could not be found for Kohler, GE, and some other manufacturers at the time of this report, but this does not mean they are not on the market.

Table 4-1
Example Used Transportable Gensets with Quoted Prices

Brand	Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Price
Alstom	Utility Grade Power Module	unknown	2000	111.5 gal/hr (100%), 61.5 gal/hr (50%)	1,250 gal (4,731 L)	unknown	89,000	320	Yes (Unknown)	NO _x 44.2 CO 0.95 HC 0.98 lb/hr	\$700,000-\$800,000 new, \$400,000 used rental
Caterpillar	XQ500 Sound Attenuated Power Module (CAT 3456 ATAAC Engine)	455	500	36.3 gal/hr standby, 32.7 gal/hr prime (at 100%)	600 gal (2,271 L) 24 hrs at 75%	480/277 V, Switchgear included, Semi-automatic paralleling protection - 1600 Amp circuit breaker w/ 24 V trip	27,170	189	70 dBA at 23 feet	EPA & CARB certified NO _x <6.9 CO <8.5 HC <1.0 PM 0.4 (g/hp-hr)	\$50,000-\$100,000 used
Caterpillar	XQ600 Sound Attenuated Power Module (CAT 3412 Engine)	545	600	unavailable	660 gal (2,500 L) 13-15 hrs	480 V, Switchgear included, Manual paralleling - manually operated circuit breaker w/ overload and fault protection	37,000	320	70 dBA at 50 feet	EPA and CARB certified	\$60,000-\$120,000 used
Caterpillar	XQ750 Sound Attenuated Power Module (CAT 3412 Engine)	680	750	unavailable	660 gal (2,500 L) 11-12 hrs	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	39,500	320	68 dBA at 50 feet	EPA and CARB certified	\$208,000 slightly used
Caterpillar	XQ900 Sound Attenuated Power Module	unknown	900	unavailable	unknown	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	unknown	unknown	70 dBA at 50 feet	EPA and CARB certified	\$120,000-\$150,000 used
Caterpillar	XQ1250G Sound Attenuated Gas Power Module (CAT SCAC Engine)	unknown	1,250	34.2% electric	unknown	480 V, Switchgear included, Automatic/Manual paralleling - manual circuit breaker w/ overload and fault protection	71,060	320	74 dBA at 50 feet	NO _x 1.0, CO 2.6, HC 4.4 (g/bhp-hr) NO _x 75, CO 332, HC 995 (ppm)	\$160,000-\$250,000 used
Caterpillar	XQ1500 Sound Attenuated Power Module (CAT 3512 B Engine)	1,360	1,500	unavailable	1,250 gal (4,372 L) 16-18 hrs	480 V, Switchgear included, Manual paralleling - manually operated circuit breaker w/ overload and fault protection	59,000	320	70 dBA at 50 feet	EPA and CARB certified	\$250,000-\$380,000 used
Caterpillar	XQ2000 Sound Attenuated Power Module (CAT 3516 B Engine)	1,825	2,000	unavailable	1,250 gal (4,372 L) 9-10 hrs	480 V, Switchgear included, Manual paralleling - manually operated circuit breaker w/ overload and fault protection	74,000	354	74 dBA at 50 feet	EPA and CARB certified	\$300,000-\$450,000 used
Cummins	500 kW Rental Package - Model DFED	455	500	35.9 gal/hr standby, 32.3 gal/hr prime (at 100%)	550 gal (2,082 L) 21-23 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	37,000	200	Yes (unknown)	NO _x 9.85, CO 1.27, HC 0.2, PM 0.12 (g/hp-hr, standby)	\$95,000-\$120,000 used
Cummins	750 kW Rental Package - Model DFHA	680	750	56.0 gal/hr standby, 50.3 gal/hr prime (at 100%)	1750 G (6624 L) - 43-48 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	49,000	320	Yes (unknown)	NO _x 5.3, CO 0.5, HC 0.14, PM 0.12 (g/hp-hr, standby)	\$135,000-\$145,000 used

Transportable Equipment Markets

Brand	Model	Prime Output (kW)	Standby Output (kW)	Fuel Consumption/ Efficiency	Fuel Storage/ Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Quoted Price
Cummins	900 kW Rental Package - Model DFHC	818	900	unavailable	1,750 gal (6,624 L) - 39-43 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	49,000	320	Yes (unknown)	unavailable	\$150,000-\$155,000 used
Cummins	1000 kW Rental Package - Model DFJD	900	1,000	69.3 gal/hr standby, 62.0 gal/hr prime (at 100%)	1,750 gal (6,624 L) 32-35 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	35,500	188	Yes (unknown)	NOx 6.0, CO 0.44, HC 0.12, PM 0.05 (g/hp-hr, standby)	\$155,000-\$220,000 used
Cummins	1250 kW Rental Package - Model DFLC	1,100	1,250	87.3 gal/hr standby, 76.9 gal/hr prime (at 100%)	1,750 gal (6,624 L) 28-31 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	55,000	320	Yes (unknown)	NOx 12.7, CO 1.0, HC 0.12, PM 0.06 (g/hp-hr, standby)	\$165,000-\$175,000 used
Cummins	1500 kW Rental Package - Model DFLE	1,250	1,500	103.6 gal/hr standby, 87.3 gal/hr prime (at 100%)	1,750 gal (6,624 L) 23-27 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	60,140	320	Yes (unknown)	NOx 8.5, CO 1.3, HC 0.17, PM 0.11 (g/hp-hr, standby)	\$185,000-\$265,000 used
Cummins	2000 kW Rental Package - Model DQKC	1,800	2,000	137.3 gal/hr standby, 123.2 gal/hr prime (at 100%)	2030 G (7684 L) - 20-22 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	79,225	320	Yes (unknown)	NOx 7.0, CO 0.9, HC 0.2, PM 0.04 (g/hp-hr, standby)	\$320,000-\$345,000 used
Rolls Royce	Proteus 3.2 MW Mobile Genset	2,875	3,200	280 gal/hr (100%)	Minimum pressure: 160 psig	Manual paralleling: Auto Sync Relay, Westinghouse Generator Breaker	95,656	320	Yes (unknown)	unavailable	\$1.6 Million new, \$800,000-\$1 Million used
Rolls Royce	Avon 10 MW Mobile Gas Turbine Generator	10,300	16,000	n/a	Fuel supplied by separate tanker to fuel forwarding package	Automatic synchronizing unit (type PAS), under/over current and overvoltage protection	265,000	unknown	Yes (unknown)	unavailable	\$2.5-\$3.5 Million, used
Solar Turbines	Centaur 40 3.5 MW Mobile Gas Turbine Generator	?	3,500	unavailable	unknown	Manual paralleling: switchgear, circuit breaker and synchronizing system included	unknown	unknown	Yes (unknown)	unavailable	\$1.4 Million, less than 100 hours; <1 Million refurbished
Solar Turbines	Taurus 60 Mobile Power Unit	?	5,200	unavailable	unknown	Manual paralleling: Utility grade switchgear and protective relay module	unknown	1006	Yes (unknown)	SoLoNOx™ Dry Low NOx Combustion System - no visible emissions	\$2.5-\$3.5 Million, new; \$1.8-\$2.5 Million, slightly used

5

RENTAL MARKET

The market for rental power units in the United States is strong, and has seen some growth in recent years due to increasing concerns about natural disasters and blackouts. Many of the top genset manufacturers, including Alstom, Caterpillar, Cummins, Detroit Diesel, Kohler, GE, and Solar Turbines, offer trailer-mounted rental packages in a variety of sizes to accommodate users' needs. Most of these rental packages include interconnection equipment and sound-attenuated enclosures for easy startup and quiet operation, with emission levels that are kept below federal off-highway requirements. Some equipment manufacturers have specific rental equipment divisions, while others rely on local distributors. Most offer equipment specification sheets either on their websites or by request, so potential users can determine if the genset will match their particular needs.

While not all genset manufacturers offer rental units, many of the large reciprocating engine and turbine manufacturers have rental packages ready for emergency situations. Some manufacturers like Caterpillar also rely on third party companies like Peterson Power Systems and Prime Energy Systems, which are not directly affiliated, to rent out their units. With the onslaught of hurricanes that hit Florida last summer, rental power units on the East coast were perhaps in higher demand than ever. The affect this temporary surge in business might have on the rental power market remains to be seen. Most of the time, rental packages are used by buildings/companies whose DER units require extended periods of maintenance, for construction sites, for temporary applications like county fairs or sporting events, or for sites without power because of local blackouts or storms.

Most reciprocating engine rental units do not exceed 2,000 kW. If more power is needed, multiple units are used – in some cases more than 20 units can be sited at a single location like a substation. Although transportable combustion turbine packages are available from several manufacturers, they are not always available for rent. Small reciprocating engines are the most common form of transportable power, and they dominate the current rental market. Table 5-1 below shows examples of the rental packages available in the United States.

**Table 5-1
Examples of Rental Packages Available in the U.S.**

Manufacturer	Reciprocating Engine Packages	Combustion Turbine Packages
Aggreko	TwinPack Generator (up to 800 kW), SuperHush Container Generator (up to 1250 kW), HP Container Generator (up to 1250 kW) and GreenPower Container Generator (up to 2000 kW)	N/A
Alstom	Alstom Utility Grade Power Module (Diesel) – 2 MW	Tempest Gas Turbine Genset (Dual Fuel NG/Diesel) – 7.9 MW
Caterpillar / Solar Turbines	Caterpillar XQ Series of Sound Attenuated Power Modules (Diesel) – up to 2 MW; NG unit available at 1250 kW	Solar Turbines Centaur and Taurus Transportable Gas Turbine Generators (Dual Fuel NG/Diesel) – 3.5 and 5.2 MW (may not be available for rent from manufacturer)
Cummins	Cummins Rental Packages (Diesel) – up to 2 MW; NG unit available at 1250 kW	N/A
Detroit Diesel	Range of transportable gensets (Diesel, some NG) – up to 2.8 MW	N/A
Kohler	Kohler Industrial Rental Trailer Mounted Gensets (Diesel) – up to 2 MW	N/A
General Electric	Diesel Powered Generators – up to 1.8 MW; NG Powered Generator – 1 MW	Dual Fuel Gas Turbine Generator Set (NG/Diesel) – 2.7 MW

Most of these companies rely on local distributors to handle their rental power transactions. The cost to obtain rental packages varies greatly depending on location, unit demand, and length of the contract. To gather price points, some rental companies were contacted to see how much it would cost to rent a 1,000 kW unit in Northern Virginia. For a 1,000 kW unit, Caterpillar charges \$1,370 per day, \$4,110 per week, and \$12,330 per month, for up to 8 hours of operation per day. A transportation fee will also be added depending on how far the units have to travel. GE charges considerably lower for their 1,000 kW unit - \$1,160 per day, \$3,480 per week, and \$10,440 per month - but they also charge \$1,620 for round trip transportation. Cummins' prices are somewhere in-between Caterpillar and GE – \$1,283 per day, \$3,850 per week, and \$11,550 per month for 8 hours/day of operation with their 1,000 kW unit. Cummins also has a standby rental power plan with significantly lower charges (\$1,091 per day, \$3,273 per week, and \$9,818 per month for their 1,000 kW diesel unit), but they also charge an additional \$130 per hour when operating more than one hour per day. For both Cummins rental plans, a transportation fee would also apply.

Without transportation costs, for 8 hours of daily operation, rental units 500 kW or greater generally cost between \$1.00 and \$1.50/kW/day for daily rentals; \$0.50 to \$0.65/kW/day for weekly rentals, and; \$0.35 to \$0.50/kW/day for monthly rentals. For all companies, the

\$/kW/day increases as units get smaller, and decreases as they get larger. In Table 5-2, the rental charges for 500, 1,000, and 2,000 kW units for Caterpillar and Cummins are presented to illustrate this point.

Table 5-2
Rental Charges for Caterpillar and Cummins 500, 1,000, and 2,000 kW Units*

Rental Unit	Daily Rate	\$/kW/day	Weekly Rate	\$/kW/day	Monthly Rate	\$/kW/day
Caterpillar XQ 500 rental package	\$765	\$1.53	\$2,295	\$0.66	\$6,885	\$0.49
Caterpillar XQ 1000 rental package	\$1,370	\$1.37	\$4,110	\$0.59	\$12,330	\$0.44
Caterpillar XQ 2000 rental package	\$2,340	\$1.17	\$7,020	\$0.50	\$21,060	\$0.38
Cummins 500 kW rental package	\$681	\$1.36	\$2,042	\$0.58	\$6,125	\$0.44
Cummins 1000 kW rental package	\$1,283	\$1.28	\$3,850	\$0.55	\$11,550	\$0.41
Cummins 2000 kW rental package	\$2,333	\$1.17	\$7,000	\$0.50	\$21,000	\$0.38

*Prices were quoted for the Northern Virginia area – they may vary in other locations.

If the unit needs to operate more than 8 hours a day, the rental companies charge a new rate for each extra hour of operation (roughly one tenth of the 8-hour daily rental rate). For customers who know they will be operating well over 8 hours a day, optional 16 and 24-hour plans are also available from most rental companies. The cost for a 16-hour day is typically 150% of the normal 8-hour cost, and the cost for a 24-hour day 200% of the normal cost.

In addition to renting the equipment, however, the customer must also pay for fuel costs. An analysis was performed using 500, 1,000 and 2,000 kW units, with three different costs for diesel fuel: \$1.50/gallon, \$1.80/gallon, and \$2.10/gallon. Cummins rental units are used, and a \$1,000 transportation fee is assumed. The prime kW rating, and the corresponding fuel consumption are used, and the analysis was performed for up to one year of operation. The first chart, Figure 5-1, plots the cents/kWh for daily rental up to one week. Figure 5-2 plots the cents/kWh for weekly rental, up to one month. The last chart, Figure 5-3, plots the cents/kWh for monthly rental, up to one year. In each figure, the transportable DER is operating 8 hours per day at full-load.

Analyzing the data, the transportation cost only has a significant effect on daily rentals, especially for smaller systems. Otherwise, the cents/kWh levels off fairly quickly. For daily rentals, a cost of 27-38 cents/kWh is expected. For weekly rentals, this cost decreases to 17-25 cents/kWh, and for monthly rentals, a rate of 15-22 cents/kWh is achieved. Lower diesel fuel costs and larger units lead to lower prices per kilowatt-hour.

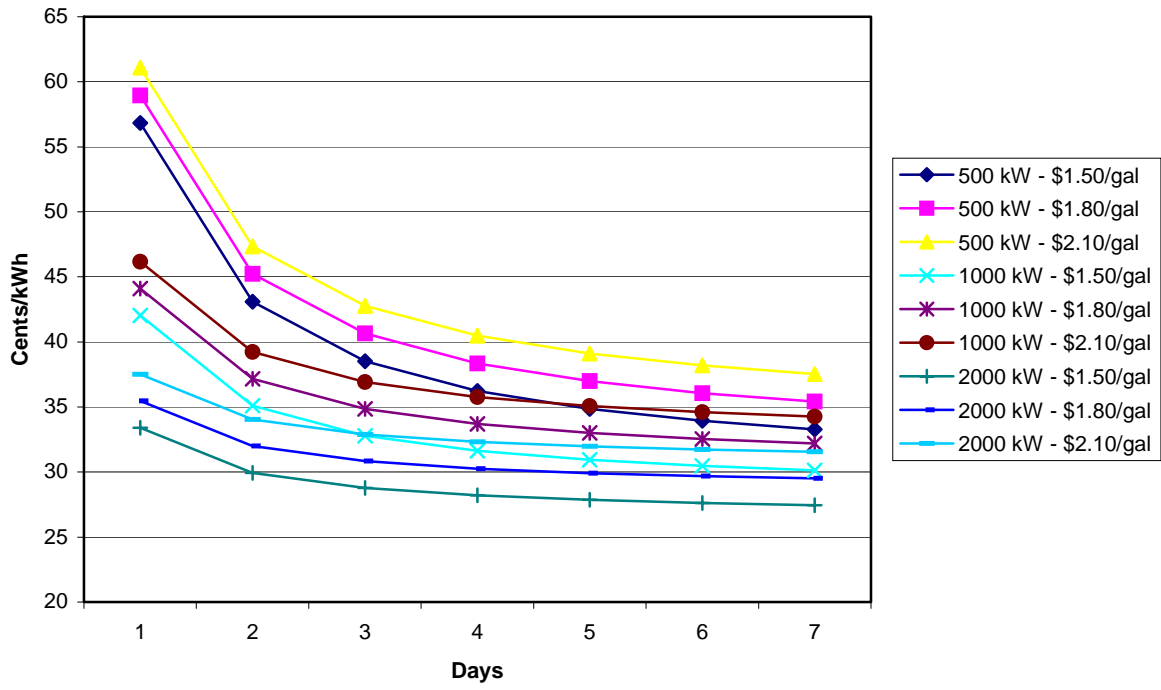


Figure 5-1
Cost-to-Generate for Daily Rentals

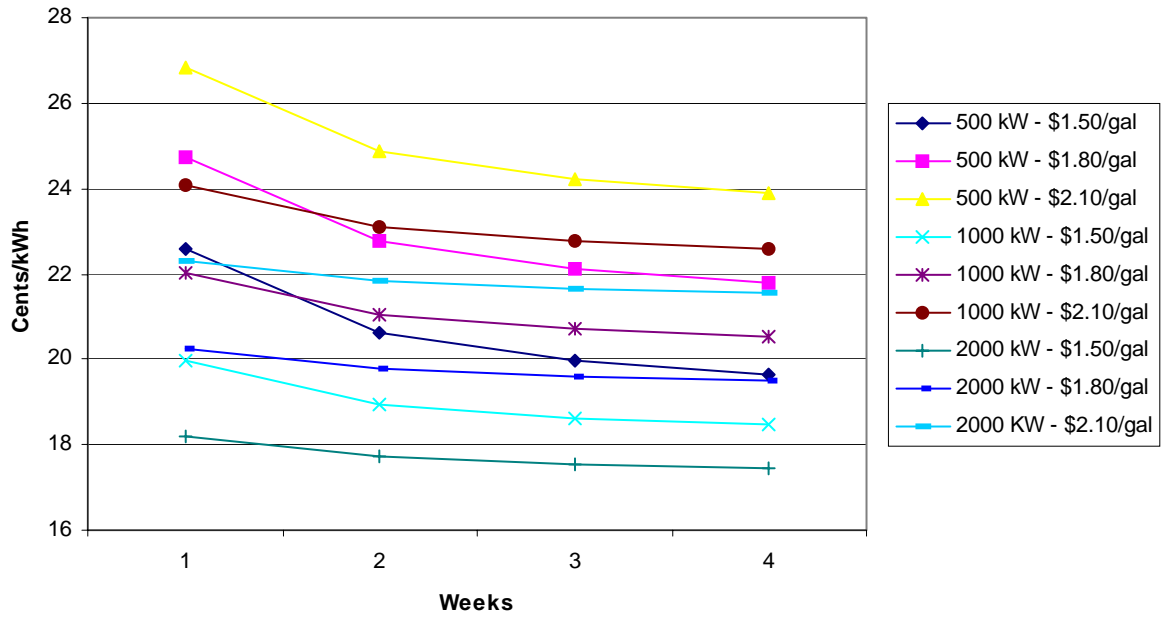


Figure 5-2
Cost-to-Generate for Weekly Rentals

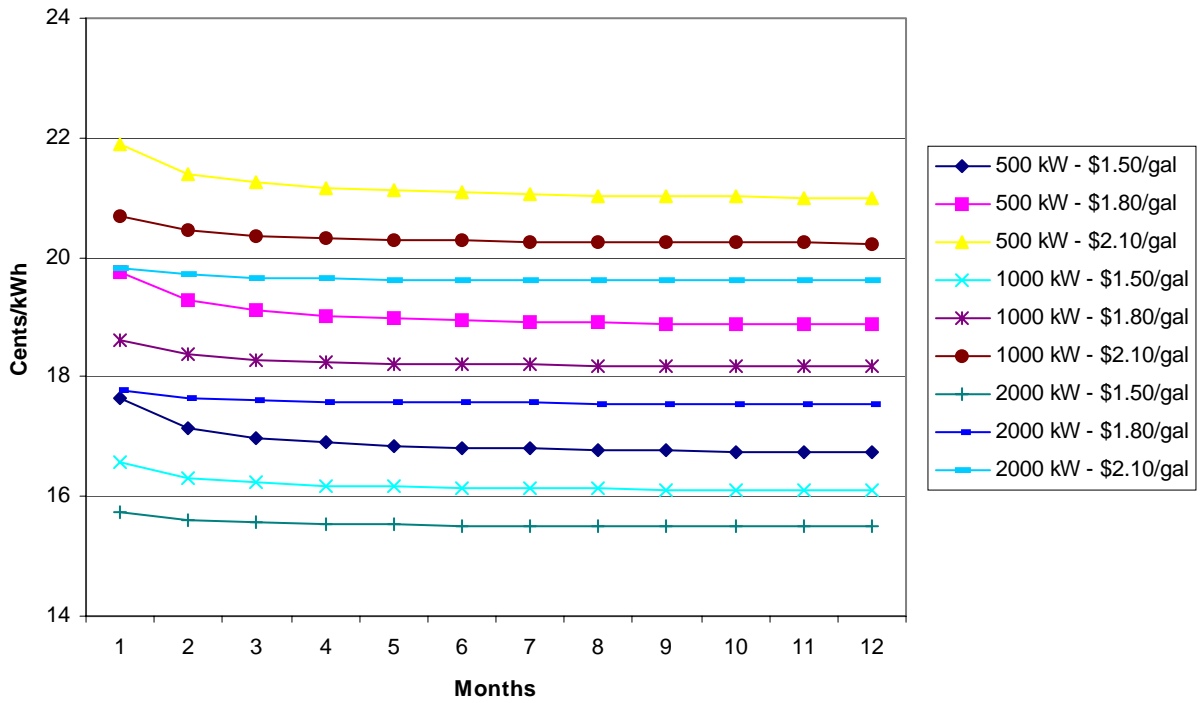


Figure 5-3
Cost-to-Generate for Monthly Rentals

6

LIQUIFIED NATURAL GAS FUEL OPTIONS

Background

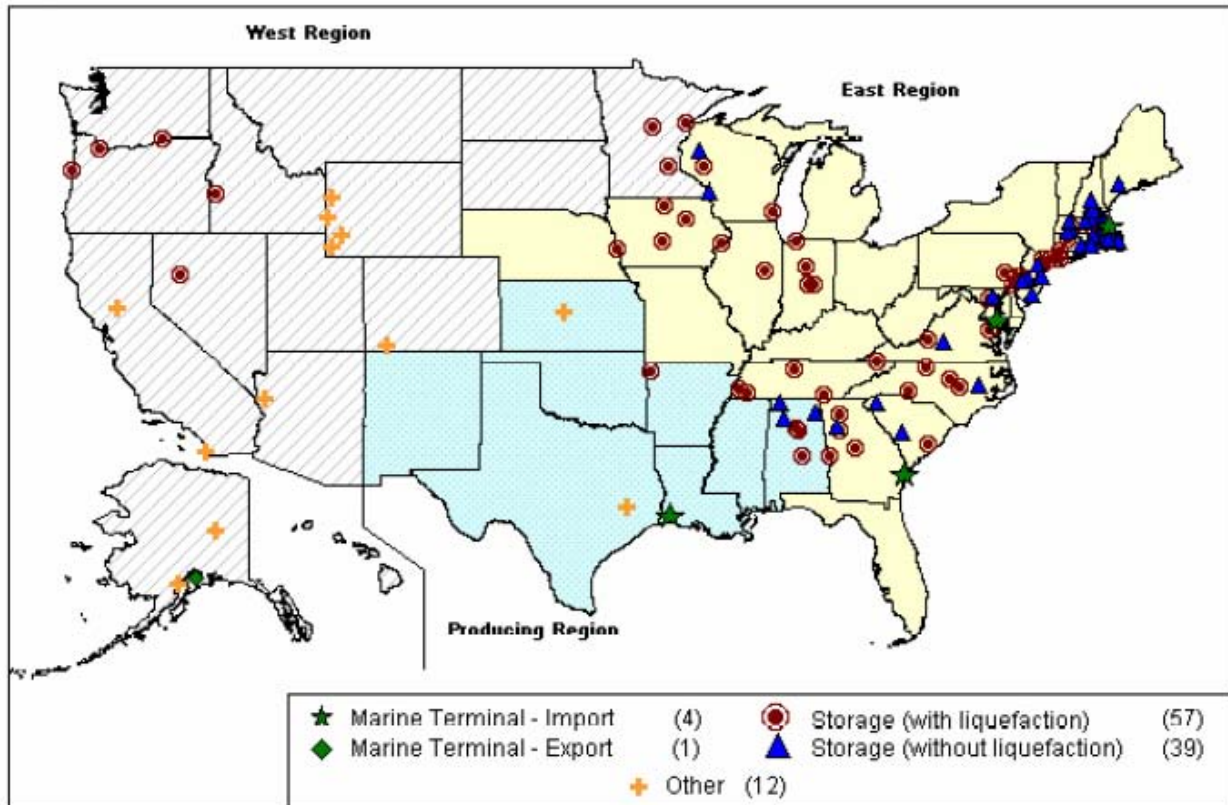
Natural gas, used as a fuel by many utilities and power generators throughout the United States, is normally transported through pipelines. However, when natural gas is transported over large distances (especially across oceans), liquefaction of the gas allows for cheaper and more flexible transport. In other cases, natural gas is liquefied for storage purposes. Liquefied natural gas (LNG) takes up approximately 600 times less volume than its gaseous form, and it can easily be transported by ocean tankers and trucks to any destination and also stored efficiently. The liquefaction and vaporization processes are relatively simple and inexpensive, especially when large amounts of LNG are involved.

To date, the main focus for LNG research has been imported natural gas. Several Asian and African countries have an abundance of natural gas reserves, but little domestic demand for the fuel. With the United States' reserves dwindling, imported LNG may soon become a large factor in the U.S. natural gas industry. The best way to transport natural gas across the oceans is to convert it into liquid form. The U.S. already has several import terminals that vaporize the LNG immediately and inject it into a pipeline. The problem is that natural gas from Asia and Africa typically has a higher Btu content than North American gas, and it must be brought down to a certain range for pipeline injection. This is done by mixing the gas with air or nitrogen immediately after vaporization to bring the methane content down to acceptable levels. Even with mixing, some equipment manufacturers, especially those that make combustion turbines, have reported performance problems and emissions concerns when using imported LNG. The liquefaction of LNG will become an important factor for large players in the natural gas industry, but there is another market for LNG that could potentially benefit – energy users in remote locations that don't have access to natural gas pipelines.

The possibility of transporting LNG domestically through trucks opens the door for new natural gas drilling operations that previously were not be feasible. If domestic natural gas is liquefied at the well, pipeline construction is not necessary, and the LNG can be transported via truck to any destination capable of storing and eventually vaporizing the fuel. Once vaporized, the natural gas can be used in any application. Domestic-source LNG has the same properties as pipeline natural gas – liquefaction and subsequent vaporization does not change the properties of the gas. Storage of LNG is typically handled with a pressurized nickel steel inner storage tank, surrounded by insulation and an outer storage tank made of either steel or concrete.

According to the Energy Information Administration, there are currently 96 LNG storage facilities in the United States, 57 of which contain liquefaction equipment. Nearly all of these facilities are connected to either the pipeline grid or local utility distribution systems (83 are

owned and operated by local distribution companies, and 13 are owned by interstate pipeline companies). With these facilities, owners opted to store gas in liquid form rather than investing in underground storage or additional upstream pipelines. Many of these facilities are located in the Northeast, where underground storage space is limited, and several exist in the South and Midwest. Figure 6-1 shows the distribution of these facilities in the United States.



Source: EIA: U.S. LNG Markets and Uses: June 2004 Update

Figure 6-1
U.S. Liquefied Natural Gas Facilities as of June 2004

Aside from utility and pipeline distribution companies, other companies with energy-producing facilities could benefit from LNG by investing in an LNG storage and vaporization device. If a steady source of LNG was guaranteed, the company could benefit from lower fuel costs than if they were to construct a natural gas pipeline to the facility. LNG liquefaction could become an attractive option for certain isolated natural gas fields and wells if more end-users began installing LNG storage and vaporization systems. New wells could also be constructed in areas where pipeline construction might be too expensive.

Another possibility for LNG is portable natural gas. A trailer-mounted LNG tank and vaporizer (or regasifiers) could act as a *transportable pipeline* for temporary sites. For utilities, the units could address breaks in the system or they could be used during periods of high demand. In addition, trailer-mounted LNG tank/vaporizer systems would be well suited for transportable

DER operations, and could provide a reliable and transportable source of fuel for the units. Even if trailer-mounted LNG tanks and vaporizers proves unfeasible, the possibility of LNG storage stations in locations where natural gas pipelines do not exist opens up more opportunities for NG-fueled transportable DER.

Any transportable DER unit designed to run on natural gas will operated on domestic-source LNG without any equipment modification. All the site requires is a storage tank and a vaporization system. Also, the vaporized LNG must be supplied at the proper pressure to the DER unit.

Using LNG with Distributed Generators

Spark ignition engines and combustion turbines can use domestic LNG with very little modification (sometimes none at all). Diesel engines can be retrofitted to burn a mixture of diesel fuel and LNG. This type of converted engine is commonly referred to as a dual fuel engines. Dual-fuel engines are considered a mature technology with a number of companies supplying commercial new dual-fuel engines (particularly in marine motive power), retrofit kits, and conversion services. An example of one such commercial offering is included in Appendix A. The principal advantages of dual-fuel engines over diesel engines are:

- The engines maintain their power rating
- NOx emissions are typically 30% that of uncontrolled diesel engines
- Thermal output does not change
- Fuel cost is often times less than running on diesel only
- No adverse affect to engine wear or O&M costs

In a dual fuel engine, both diesel and LNG are burned simultaneously in approximately 15% diesel to 85% gas ratio with the ratio dropping to 10% diesel to 90% gas at full power. In the cylinder, the diesel fuel is compression ignited, as it is normally done. The ignited diesel then acts as a spark plug to ignite the air-gas mixture. The combined combustion of the diesel fuel and natural gas generates the same brake mean effective pressure (BMEP) as the unmodified diesel engine does on diesel along.

In the retrofit conversion process, each cylinder outfitted with an electronically controlled multi-point gas injector. These are controlled by a new electronic control device which interfaces with the engine's factory engine control unit (ECU) to obtain control over the engines performance and injection of gas. Most manufacturers' ECU systems allow automated switching between diesel and gas depending on operating conditions. For example, during the start up and warm up period, the engine will operate using 100% diesel fuel after which, the ECU will begin to throttle back on the amount of diesel injected while introducing an appropriate amount of natural gas into the cylinders. It should be noted that while modified engines can run on diesel exclusively they cannot run on gas only. Therefore, these engines must have onsite diesel fuel storage.

A prior EPRI investigation²² found the installed cost of retrofit kits to be \$45 - \$61/kW, with larger sized engines having a lower install cost compared to smaller engines. The operation economics will depend on the number of hours the engine is used, the prevailing cost of supplied diesel and the cost of supplied natural gas. Typically, the economics favor longer run times applications where an dual-fuel engine will be expected to operate more than a few hundred hours per year.

²² *Market and Economic Assessment of Retrofit Dual-Fuel Diesel Generators*, EPRI, Palo Alto, CA: 2001. 1006391

7

CONCLUSIONS AND RECOMMENDATIONS

The transportable DER market has seen some growth in recent years, mainly due to the rise of the rental power market. Manufacturers like Caterpillar and Cummins have begun packaging reciprocating engines and combustion turbines in sound-attenuated, trailer-mounted containers for rental power, and to a lesser extent, for sales. For the most part, these companies tailor their units and business strategy for the rental market. Third party packagers like MQ Power and Stewart & Stevenson have recently emerged to provide a stronger market for new transportable equipment purchases. These companies take engines, generators, controls, and other equipment from various manufacturers and package them as brand new transportable DER units for sale. The used equipment market for transportable DER has also grown recently due to the proliferation of online vendors and auction sites. Overall, the market appears to be growing for both new and used transportable power gensets, as well as rental power.

The transportable genset market is dominated by small reciprocating engines that were originally designed for transportation applications. Ranging from less than 100 to 2,000 kW in size, they are ideal for a number of different applications. Their small size, familiar operation, cheap price, and tried-and-true performance make them an attractive option for transportable power producers. And because they are temporary, emissions are not as much of an issue as they are for the larger stationary units. Although diesel engines are the most prominent, natural gas engines are also available from most manufacturers. With large DER manufacturers, however, the primary focus appear to be on the rental power market, so new units may be more successfully obtained from third party packagers like MQ Power and Stewart and Stevenson.

For transportable applications larger than 2,000 kW in size, combustion turbines take over as the dominant player in the industry. However, the market for transportable power applications greater than 2,000 kW is not that large. Still, there are several options available from Solar Turbines, Rolls Royce, GE and Alstom. Although most of these companies focus on rental power applications and used equipment sales for their transportable units, new packages are also be available for sale. Large packagers like MQ Power currently only package reciprocating engine gensets, but other smaller companies custom package transportable combustion turbine units.

The rental and used equipment market for transportable DER is much larger than the market for new equipment. Some manufacturers only produce transportable gensets for rental power applications, and then proceed to sell their used equipment to vendors or other potential purchasers. Online vendors and auction sites for used transportable equipment have begun to flourish, and companies like Aggreko have successfully set a new business model putting together engines, equipment and parts together for primarily for transportable power rentals.

One potential problem with transportable DER (for NG-fueled engines and turbines) is maintaining a steady source of natural gas fuel. Many transportable applications may not have access to pipelines, so liquefied natural gas (LNG) could be used. A trailer-mounted LNG tank and vaporizer could act as a transportable pipeline for temporary sites. Domestic LNG produces natural gas that does not require any equipment modifications, as long as the fuel is supplied at the proper pressure. A variety of options exist for retrofitting existing diesel engines to use both diesel and LNG or buying a new dual-fuel engine.

Although the rental and used equipment markets for transportable DER are more prevalent than the market for new equipment, most companies will sell new units directly to end users. The possibility of LNG-fueled transportable DER is also promising for the market and could produce new opportunities. Overall, there is a large and growing market for transportable DER in the United States that should play an increasingly important role in the power-producing industry.

A

APPENDIX A: EXAMPLE SPECIFICATION SHEETS

This appendix contains three example specification sheets:

1. Diesel Engine: Cummins 1,000 kW Rental Package
2. Natural Gas Engine: Caterpillar XQ1250G Sound Attenuated Gas Power Module
3. Combustion Turbine: Solar Turbines Taurus 60 Transportable Power Unit
4. Combustion Turbine: Pratt & Whitney FT4A-11TransPac
5. Clean Air Power: Dual-fuel engine generators



1000kW Rental Package



Features

Cummins® Power Generation Sets

- Cummins engines, Newage Alternators and PowerCommand Controls - Designed, built, certified prototype tested and warranted by the only company that controls the process from start to finish.
- Supported exclusively worldwide by your Cummins Distributors.
- Utilize proven standard generator set designs.
- Includes jacket water heaters for more reliable operation in emergency standby applications.

Cummins Diesel Engines

- Lightweight, compact and excellent fuel economy.
- Operate at up to 45°C (113°F) with no effect on output.
- Equipped with Heavy Duty Air Cleaners and Bypass-type Oil Filters. Includes jacket water heaters for more reliable operation in emergency standby applications.

Newage® Alternators

- Designed and built by Cummins Power Generation.
- Fully automatic paralleling capability and voltage reconnectable (480/277VAC High Wye to 208/120VAC Low Wye).
- Oversized alternators for improved motor starting and low temperature rise in prime and continuous applications.
- Permanent Magnet excitation for improved performance in cyclic and non-linear load applications.

PowerCommand® Paralleling Controls

- The most advanced, reliable and capable generator set control system available in the market today.
- Integrated generator set governing, voltage regulation, protection and paralleling functionality in one easy-to-operate customer interface.
- Multiple unit and grid paralleling ready.
- Remote monitoring and networking operation capable.
- Integrated Ground Fault Indication.
- Optional freestanding, electronically operated closed-transition transfer switches are available.

Cummins Cooling System

- Optimized for maximum efficiency and minimum noise.
- Propylene glycol coolant for greater environmental protection.

Custom Switchgear

- Designed and built to meet severe customer requirements.
- Equipped for total remote automatic monitoring and control for stand alone, paralleling or emergency standby applications.
- Easy connection to existing installations using lugs or installed CAM-LOK® connectors.
- 2-unit parallel capability using installed switchgear, allowing 100% redundancy or increased capacity.
- 5-cycle closure, motor-operated circuit breaker for automatic paralleling.
- Convenient Shore Power connection provides power to interior lighting, jacket water heaters, battery charger and alternator anti-condensation space heaters allowing quick starts even in arduous applications.

ISO Container Enclosure

- Purpose built 20 foot standard ISO container.
- Easy-to-transport.
- Optimal unit protection with minimum size.
- Optimized fuel capacity with UL142 listed/NFPA30 compliant fuel tanks.
- Fluid containment design for greater environmental protection.
- Sound attenuated to minimize impact on local environment.
- Vertical cooling air and engine exhaust path to minimize sound level adjacent to the container.
- Equipped with 120VAC and 24VDC lighting.

Running Gear

- 23½ foot tandem axle sliding bogie chassis.
- Air Ride suspension equipped for the softest ride in the industry.
- Anti-Lock Brake System.
- 200,000 pound (static load) landing gear.

Ratings Definitions

Standby:	Prime (Unlimited Running Time):	Base Load (Continuous):
Applicable for supplying emergency power for the duration of normal power interruption. No sustained overload capability is available for this rating. Nominally rated. (Equivalent to Fuel Stop Power in accordance with ISO3046, AS2789, DIN6271, and BS5514.)	Applicable for supplying power in lieu of commercially purchased power. Prime power is the maximum power available at a variable load for an unlimited number of hours. A 10% overload capability is available for limited time. Nominally rated. (Equivalent to Prime Power in accordance with ISO8528 and Overload Power in accordance with ISO3046, AS2789, DIN6271, and BS5514.)	Applicable for supplying power continuously to a load for this rating. Nominally rated. Consult authorized distributor for rating. (Equivalent to Continuous Power in accordance with ISO8528, ISO3046, AS2789, DIN6271, and BS5514.)



Optional Features Shown

PowerCommand Control with AmpSentry Protection

- Integrated automatic voltage regulator and engine speed governor
- AmpSentry Protection guards the electrical integrity of the alternator and power system from the effects of overcurrent, over/under voltage, under frequency and overload conditions
- Control components designed to withstand the vibration levels typical in generator sets

Standard Control Description

- | | |
|---|--|
| <ul style="list-style-type: none"> • Analog % of current meter (amps) • Analog AC frequency meter • Analog AC voltage meter • Analog % of load meter (kW) • Cycle cranking control • Digital display panel • Emergency stop switch • Idle mode control • Menu switch | <ul style="list-style-type: none"> • Panel backlighting • Remote starting, 12 volt, 2 wire • Reset switch • Run-Off-Auto switch • Sealed front panel, gasketed door • Self diagnostics • Separate customer interconnection box • Voltmeter/Ammeter phase selector switch |
|---|--|

Standard Protection Functions

Warnings

- High Coolant Temperature
- High DC Voltage
- Low Coolant Temperature
- Low DC Voltage
- Low Oil Pressure
- Over Current
- Oil Pressure Sender Fault
- Overload Load Shed Contacts
- Temperature Sender Fault
- Up to Four Customer Fault Inputs
- Weak Battery

Shutdowns

- Emergency Stop
- Fail to Crank
- High AC Voltage
- High Coolant Temperature
- Low Coolant Level (option for alarm only)
- Low AC Voltage
- Low Oil Pressure
- Magnetic Pickup Failure
- Overcrank
- Overcurrent
- Overspeed
- Short Circuit
- Underfrequency

Standard Performance Data

AC Alternator Data

- Current by Phase
- Kilowatts
- Kilowatt Hours
- Power Factor
- Voltage Line to Line
- Voltage Line to Neutral

Engine Data

- Battery Voltage
- Coolant Temperature
- Engine Running Hours
- Engine Starts Counter
- Oil Pressure
- Oil Temperature
- RPM

Insert '00 1000 kW drawings

Model	Length		Width		Height		Weight (w/o Fuel)		Weight (with Fuel)		Fuel Capacity	
	in	mm	in	mm	in	mm	lbs	kg	lbs	kg	US Gal	liters
DFHD	282	7162	96	2438	150	3810	35500	16103	39902	18097	620	2347

Model	kW Rating		Cummins Engine Model	Sound Level	Generator Specification Sheet #	Hours of Operation (75% Load)	
	Standby	Prime				Standby	Prime
DFHD	1000 kW	900 kW	QST30-G5 (2P/2L)	72	S-1034d	12	14



Cummins Power Generation
 1400 73rd Avenue N.E.
 Minneapolis, MN 55432
 612-574-5000
 1-877-POWR-NOW (877-769-7669)
 Fax: 612-574-8087

See your distributor for more information.

Backfeed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is opened.

Cummins is a registered trademark of Cummins Inc. Power Rent is a service mark of Cummins Inc. PowerCommand is a registered trademark of Onan Corporation. AmpSentry is a trademark of Onan Corporation. Newage is a registered trademark of Newage Company.



XQ1250G SOUND ATTENUATED GAS POWER MODULE 60 Hz — 1250 eKW CONTINUOUS

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

FEATURES



EMISSIONS

- 1.0 gram/bhp-hr NOx standard or an optional 0.5 gram/bhp-hr NOx nominal with adjusted ambient capability.

TRANSIENT RESPONSE

- Meets ISO8528 Class 1 criteria with 25% block loads and unloads at 1.0 gram/bhp-hr NOx. Consult factory for block load capability at 0.5 gram/bhp-hr NOx.

CAT® GAS GENERATOR SETS

- Factory designed, certified prototype tested with torsional analysis. Production tested and delivered to you in a package that is ready to be connected to your fuel and power lines. Supported 100% by your Caterpillar dealer with warranty on parts and labor. Extended warranty available in some areas. The generator set was designed in an ISO9001 compliant facility. Generator set and components meet or exceed the following specifications: AS1359, AS2789, ABGSM TM3, BS4999, DIN6271, DIN6280, EGSA101P, JEM1359, IEC34/1, ISO3046/1, ISO8528, NEMA MG1-22.



CATERPILLAR® SR4B GENERATOR

- Single bearing, wye connected, static regulated, brushless permanent magnet excited generator designed to match the performance and output characteristics of the Caterpillar gas engine that drives it.

RELIABLE, FUEL EFFICIENT GAS

- The compact, four-stroke-cycle gas engine combines durability with minimum weight while providing exceptional dependability, economy and power density. The fuel system is designed for maximum performance on low pressure (2 – 5 psi) pipeline natural gas.

CATERPILLAR SWITCHGEAR

- Full utility grade relays for maximum safety and reliability. Circuit breakers, bus bars, and connection panel ready to connect.

EXCLUSIVE CATERPILLAR DIGITAL VOLTAGE REGULATOR

- Three-phase sensing and adjustable Volts-per-Hertz regulation give precise control, excellent block loading, and constant voltage in the normal operating range.

SOUND ATTENUATED ISO CONTAINER WITH SPILL CONTAINMENT

- For ease of transportation and protection.
- 74 dB(A) or lower at 50 ft per SAE J1074 measurement procedure. Container is designed with 110% Spill Containment of all engine fluids with level sensors and warning light.

CONTAINER AND EXHAUST SYSTEMS COMPATIBLE WITH AFTERTREATMENT SYSTEMS

- Container has access panel on roof of container for ability to bypass muffler and easily connect external aftertreatment systems.

XQ1250G RENTAL POWER MODULE

- Includes: gas knockdown regulator, positive crankcase ventilation, lube oil make-up system, a 40 ft, 3 axle air ride undercarriage and rental power decals as standard features.

LEHE2487-01

FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

System	Standard	Optional
Engine	1.0 gram/bhp-hr nominal emission level NOx Air cleaner, with service indicator Batteries, 2 sets Dual, 6 kW, jacket water heaters Lubricating oil Insulated muffler Radiator Service meter Sump pump Gas Engine Control Module (ADEM III based)	0.5 gram/bhp-hr nominal emission level NOx
Generator	SR4B brushless, 480 volt, PM excited three-phase Digital voltage regulator Space heater	4160 volt
Containerized Module	2 micron dry gas filter Air intake louvers Bus bar access door Sound attenuated (74 dB(A) @ 50 ft) 110% spill containment of all fluids with level sensors and warning light (option to remove) ISO hi-cube container Lockable doors Stainless steel hardware and hinges Vertical radiator and exhaust discharge plenum 24V service light Water ingress prevention system (option to remove)	120 VAC lighting Duplex receptacles Battery heater pads Motorized intake louvers Interior space heater Remote emergency stop Positive crankcase ventilation system (standard on rental) Lube oil make-up (standard on rental) Gas knockdown regulator (standard on rental)
Cooling	Standard cooling provides 104° ambient, for 1.0 gram/bhp-hr NOx, continuous rating	100° F ambient, for 0.5 gram/bhp-hr NOx, continuous rating
Switchgear	Floorstanding utility grade switchgear, 480V EMCP II+ components PLC based with alarm and control via touch screen display Manual operation and paralleling with or without PLC and touch screen Automatic start/stop with cool down timer Battery charger, heavy duty 20A Lock-out protective relaying: ANSI device 86 Utility grade relaying: ANSI device 27,47,51G, 59, 81O, 81U Generator circuit breaker, electrically operated Connection terminals, 3-phase and neutral Automatic paralleling Auxiliary power connections for jacket water heater, battery charger, space heaters	Floorstanding utility grade switchgear, 4160V Protective relaying: 50N, 50P, 51P, 59 Customer Interface Module Customer Communication Module Analog metering: W/WHIM, PFM, VARM, synchroscope

SPECIFICATIONS



CAT SR4B GENERATOR

Type.....	Static regulated brushless PM excited
Construction.....	Single bearing, close coupled
Three-phase.....	Wye connected — 6 lead
Insulation.....	Class H — 2 extra dips and bakes on random wound units
Enclosure.....	Drip proof
Alignment.....	Pilot shaft
Overspeed capability.....	130%
Voltage regulator.....	3-phase sensing with Volts-per-Hertz
Voltage regulation.....	Less than ± 5%
Voltage gain.....	Adjustable to compensate for engine speed droop and line loss
Wave form.....	Less than 5% deviation
TIF.....	Less than 50
THD.....	Less than 3%



CAT ENGINE

V-16, SCAC, 4-cycle watercooled gas	
Bore — mm (in).....	170 (6.7)
Stroke — mm (in).....	190 (7.5)
Displacement — L (cu in).....	69.0 (4210)
Compression ratio.....	11.1:1
Aspiration.....	Turbocharged-Separate Circuit Aftercooled
Fuel system.....	Electronic Ignition System
Governor type.....	Electronic Engine Control Module

SWITCHGEAR

480V/60 HZ

Floorstanding switchgear includes the following functions and features:

ELECTRONIC MODULAR CONTROL PANEL (EMCP II+) COMPONENTS

GENERATOR SET CONTROL (GSC)

Monitoring:

Sequentially rotating, backlit LCD display of engine hours, engine rpm, DC battery voltage, oil pressure, and water temperature. Includes pushbutton to hold display on any single parameter.

Protection:

Shutdowns — Overspeed, overcrank, high water temperature, low oil pressure, and emergency stop with LED indicator for each condition.

Alarms — Low coolant level

AC Metering:

Three-phase volts (L-L), amperes and frequency with phase select pushbutton, on backlit LCD. Metering accuracy is 0.5%.

Power Metering:

Real power, reactive power, percent rated power, power factor and energy output

Control:

Automatic starting with field adjustable cycle crank, failure to start (overcrank), and cooldown timer.

Programming and Diagnostics:

Includes field programmable set-points for engine control and monitoring variables and self diagnosis of EMCP II system component and wiring failures.

ALARM MODULE

Flashing LED warnings for: low coolant temperature, high coolant temperature (pre-alarm), low oil pressure (pre-alarm), engine control switch not in automatic, and low DC voltage. Includes alarm horn and acknowledge pushbutton.

ENGINE CONTROL SWITCH

Snap action rotary switch, four-position (off/reset, automatic, manual, stop/cooldown). Off/reset for engine shutdown and resetting faults, automatic for remote starting by customer contact closure, manual for local starting and manual paralleling, stop/cooldown for manual operation cooldown.

ALARM ACKNOWLEDGE/LAMP TEST SWITCH

Three-position, spring return to center switch for alarm acknowledge and lamp test of all discrete indicating lamps. Lamp test shall also sound the alarm horn.

TOUCH SCREEN DISPLAY

Display consists of multiple screens for monitoring and configuring switchgear alarms and setpoints.

The MAIN screen provides generator and utility volts, amps, frequency, kVA, kVAR, kW and Power Factor Metering data, generator breaker status, paralleling status, protective relaying status, and provides for start/load and stop/unload functions.

The SETUP screen provides user the ability to configure switchgear for load ramp value and time, local/remote control, configuring protective relaying for cooldown or shutdown on trip, and viewing of other factory configured setpoints.

The ANNUNCIATE screen provides real-time monitoring of switchgear alarms.

The ALARM screen provides alarm history and acknowledge to reset capability. (In addition to the mechanical Acknowledge Control/Lamp Test Switch also provided on the switchgear.)

The METERING screen provides individual phase metering, watt-hour metering and base load history.

SWITCHGEAR (continued)

EMERGENCY STOP PUSHBUTTON

Mushroom head, twist to reset, causes engine shutdown and tripping of the generator circuit breaker. Prevents engine starting when depressed.

AUTOMATIC PARALLELING

Automatically synchronizes and parallels generator with utility source. Also provides for manual paralleling.

MANUAL PARALLELING

Controls consist of generator and utility relaying, manual loading, potentiometer, synchronizing lights and switch. Protective relaying for manual paralleling provides for the same cooldown and shutdown alarm sequences as programmed for automatic paralleling.

CIRCUIT BREAKER

Fixed mounted, three-pole, manually operated, molded case circuit breaker with solid state trip unit for overload (time overcurrent) and fault (instantaneous) protection. Includes DC shunt trip coil activated on any generator set monitored fault. Circuit breaker is sized for full load capacity of the generator set at 0.8 power factor.

LOAD SHARE GOVERNOR

Electronic load sharing governor with speed adjust potentiometer, idle/rated switch, and isochronous/droop switch.

VOLTAGE REGULATOR

Standard Caterpillar generator-mounted digital voltage regulator with voltage adjust rheostat mounted in the floor standing switchgear.

CURRENT TRANSFORMERS (3)

Five-ampere secondary with shorting terminal strips

POTENTIAL TRANSFORMERS (3)

120 VAC secondary with primary and secondary fuse protection. Two connected to the generator side of the circuit breaker. One connected to the load side of the circuit breaker.

BUS BARS

Three-phase plus fully rated neutral bus bars with NEMA standard hole pattern for connection of customer load cables and generator cables. Bus bars are sized for full load capacity of the generator set at 0.8 power factor. Also includes ground bus, connected to the generator frame ground and container frame with holes for connection of field ground cable. Bus bars are accessible from outside of the power module via hinged, lockable cable access door.

ACCESSORY POWER

Three 240/120 VAC, 4-wire with ground, Edison Style shore power connections for jacket water heaters, generator space heater, and battery charger.

BATTERY CHARGER

24 VDC/20A battery charger with float/equalize modes and charging ammeter

TECHNICAL DATA

XQ1250G — 1800 rpm/60 Hz/480 Volts					
Emissions (NOx)		g/bhp-hr		1.0	
Aftercooler — SCAC temperature	Deg C	Deg F	54	130	54
Fuel pressure range	kPa	psi	14-34.5	2-5	14-34.5
Min. methane number			80		80
Package Performance Spec		DM5477		DM5478	
Power rating @ 0.8 pf (4)	ekW		1250		1250
Noise — package @ 15 m (50 ft)	dB(A)		74		74
Rating and Efficiency (100% Load)					
LHV of fuel	Btu/scf*****		925		925
Engine power	bhp		1818		1818
Engine efficiency (1)	%		37.1		36.1
Engine efficiency (2)	%		36.0		35.0
Electrical efficiency	%		34.2		33.3
Thermal efficiency	%		44.3		44.6
Total efficiency	%		80.3		79.6
Fuel Consumption (Heat Rate)					
100% load with fan (1)	Btu/bhp-hr	Btu/kW-hr	6863	9984	7055
Flow requirement @ 100% load	MMBtu/hr		12.4769		12.8260
100% load with fan (2)	Btu/bhp-hr	Btu/kW-hr	7078	10,297	7274
Flow requirement @ 100% load	MMBtu/hr		12.8678		13.2241
Ambient Capability (3)					
Altitude***	m	ft	740	2427	520
Ambient	Deg C	Deg F	40	104	38
Jacket water temperature (max. outlet)	Deg C	Deg F	92.2	198	92.2
Exhaust System					
Combustion air inlet flow rate	scfm	lb/hr	3931	17,435	4125
Exhaust stack gas temperature	Deg C	Deg F	530.0	986	523.3
Exhaust gas flow rate	cfm		11,484		11,939
Exhaust flange size (internal diameter)	mm	in	203.2	8.0	203.2
Alternator					
Motor starting capability @ 30% voltage dip*	kVA		3272		3272
Frame			824		824
Temperature rise	Deg C		105		105
Lube System					
Lube oil refill volume w/filter change for std. sump	L	Gal	401	106	401
Emissions (100% Load) (**)(****)					
NOx	g/bhp-hr	ppm	1.0	75	0.5
CO	g/bhp-hr	ppm	2.6	332	2.5
HC (total)	g/bhp-hr	ppm	4.4	995	5.4
HC (non-methane)	g/bhp-hr	ppm	0.66	76	0.81
Exhaust O ₂ (dry)	%		9.2		9.2

* Assumes synchronous driver.

** Emission data measurements are consistent with those described in EPA CFR 40 Part 89 Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. Data shown is based on steady state engine operating conditions of 25° C (77° F), 96.28 kPa (28.43 inches Hg) and fuel having an LHV of 35.6 MJ/N·m³ (905 Btu/cu ft) at 101.6 kPa (30 inches Hg) absolute and 0° C (32° F). Not to exceed emission data shown is subject to instrumentation, measurement, facility and engine fuel system adjustments.

*** For additional information on altitude capability contact factory.

**** PPM values corrected to 15% O₂.

$$***** \text{scf/hr} = \frac{(\text{Btu/bhp-hr})(\text{bhp})}{\text{Btu/scf}}$$

RATING DEFINITIONS AND CONDITIONS

Continuous — Output available without varying load for an unlimited time.

(1) **Rating and Fuel Consumption** are based on ISO3046/1 standard reference conditions of 25° C (77° F) and 100 kPa (29.61 inches hg). Fuel consumption tolerance is 0, +5% of full load data.

(2) **Rating and Fuel Consumption Tolerance** is ± 3% of full load data.

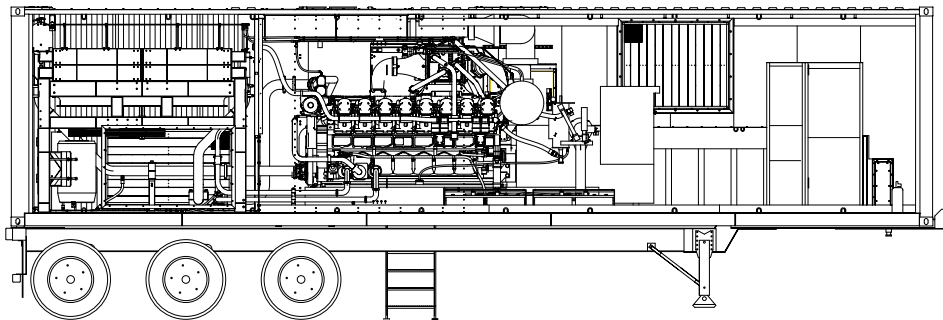
(3) **Rating and Fuel Consumption** based on ISO3046/1 conditions with nominal 2.5 kPa inlet restriction and 5 kPa exhaust restriction. All performance numbers listed on this page are at these conditions except fuel input (1).

(4) **Ratings** are based on pipeline natural gas having an LHV (low heat value) of 35.6 MJ/N·m³ (905 Btu/cu ft) and 80 MN. For values in excess of the altitude, temperature, inlet/exhaust restrictions, or for natural gas compositions different from the conditions listed, contact your local Caterpillar dealer.

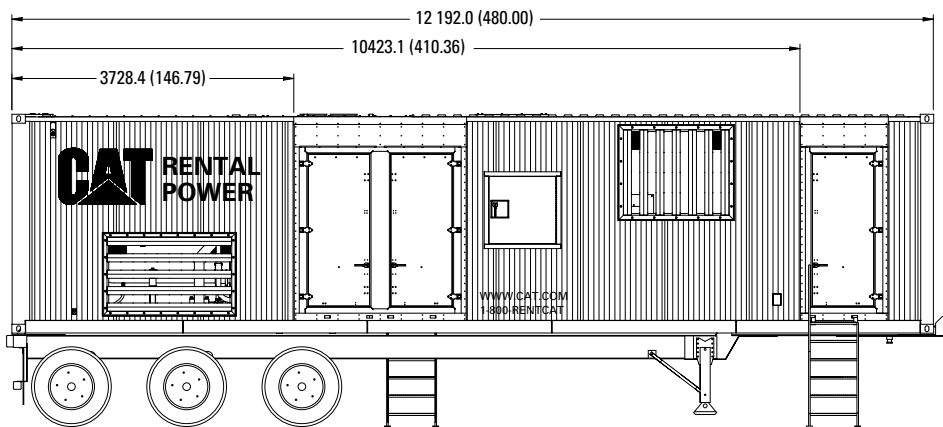
TECHNICAL DATA

Power Rating 60 Hz	ekW		Continuous 1250	
Engine and Container Information Engine model Container size Container dimensions	m	ft	12	G3516B 40 see below
Approximate Weight (Dry) — Container with Generator Set and Switchgear				
Including container	kg	lb	27 250	60,060
With undercarriage	kg	lb	32 241	71,060

CURBSIDE VIEW (Curbside wall removed to show roadside wall and interior components)



CURBSIDE VIEW



Container Dimensions		
Length	12 192.0 mm	480.00 in
Width	2438.4 mm	96.00 in
Height	4114.8 mm	162.00 in

Note: General configuration not to be used for installation. See general dimension drawings for detail.

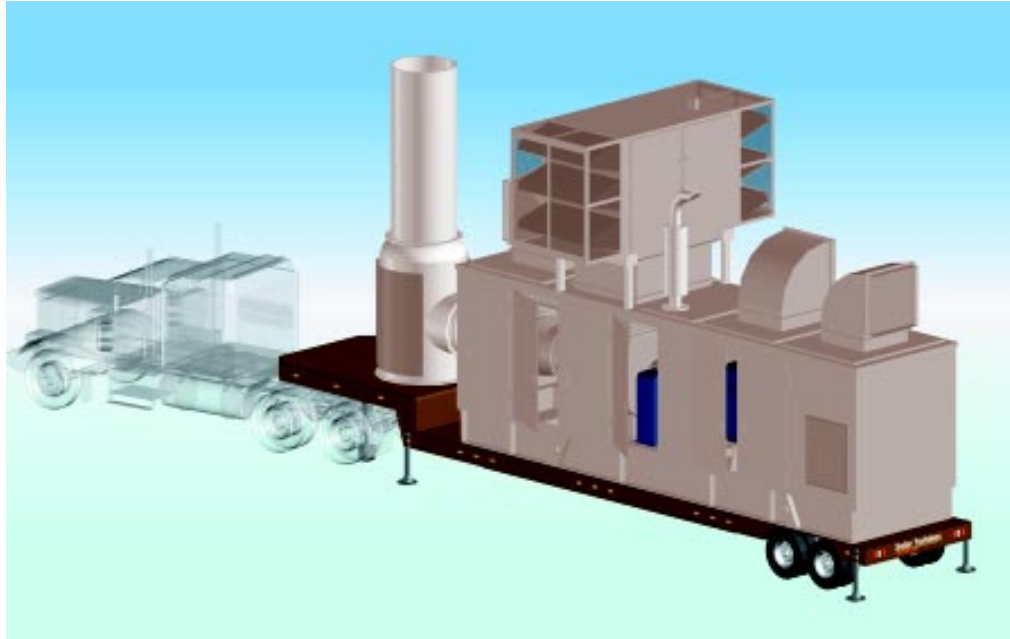
www.CAT-ElectricPower.com

TMI Reference No.: DM5477 (1.0 g/bhp-hr), DM5478 (0.5 g/bhp-hr)

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LEHE2487-01 (7-03)

Materials and specifications are subject to change without notice.
The International System of Units (SI) is used in this publication.



Mobile Power - When and Where You Need It

The *Taurus*[™] 60 Mobile Power Unit is the prime choice if you're looking to produce reliable, low-cost, on-site peaking power. Designed as an on-site generator system to optimize service for seasonal or cyclical loads, the *Taurus* 60 Mobile Generator System includes these key features:

Easy to Install and Relocate

- Highway Transportable
- Modular Design for Quick Set-Up and Connection
- No Concrete Foundation Required
- Compact Footprint to Minimize Space Requirements
- Ideal for Rental Fleets and Utility Equipment Pools

Environmentally Friendly

- Low Emissions State-of-the-Art *SoLoNOx*[™] Dry Low NO_x Combustion System
- No Visible Emissions
- Sound Attenuation Package for Quiet Operation
- Low Profile Design to Minimize Installed Height
- Easy to Permit

Flexible Solution

- Leasing and Rental Options Available
- 5-MW Size for Highly Flexible Capacity Addition and Operation
- Fuel Flexibility, Gas or Diesel with Dual Fuel Option

Complete Systems Solution

- Set-Up and Commissioning
- Site Preparation (If Needed)
- Ancillary Support Systems (If Needed)
- Wide Range of Product Support Programs

Operational Features

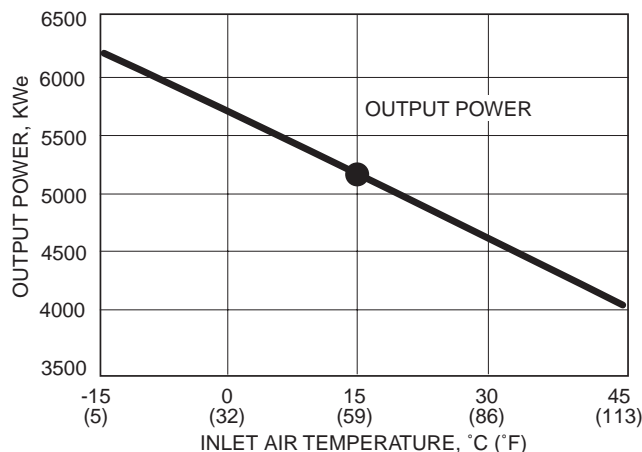
- Dispatchable to be On Line in Six Minutes (from cold start)
- Range of Control System Options for Remote Operation and SCADA Integration
- Utility Grade Switchgear and Protective Relay Module
- KVAR Control for Excellent Reactive Power Capability

Nominal Generator Set Performance

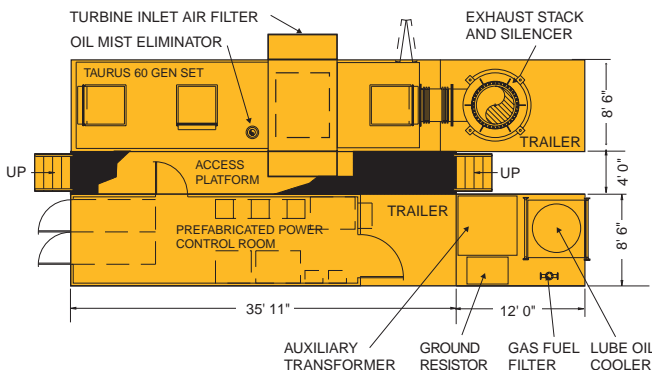
At the core of the Mobile Power Unit is the 5.2 MW *Taurus 60* industrial gas turbine, with a population of more than 900 units in the field. The Mobile Power Unit combines the features and benefits of the proven *Taurus 60* industrial gas turbine with a mobile system that is easy to relocate and connect.

Output Power, kWe
ISO: 15°C (59°F), sea level **5,200**

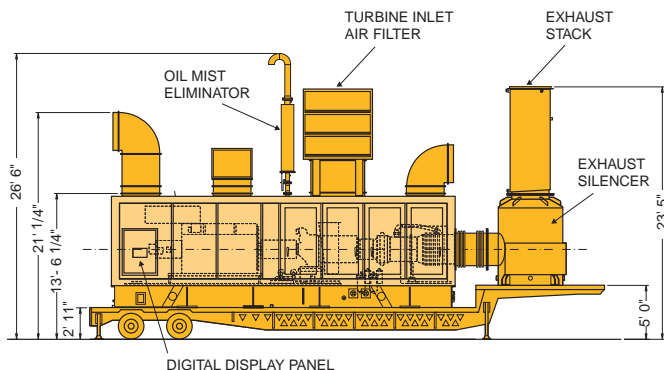
Heat Rate, (Btu/kWe-hr) **11,263**



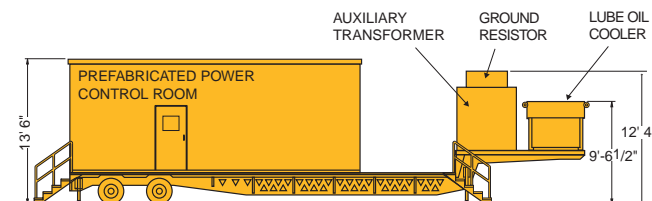
Typical Dimensions



Installation Plan View



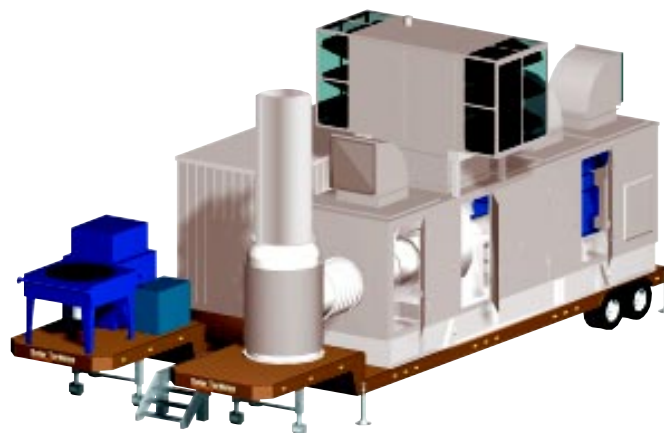
Generator Set Module



Power Control Module

Mobile Power - When and Where You Need It

For information on price, delivery and how the *Taurus 60* Mobile Power Unit can meet your needs for short-term capacity and reduce your exposure to market spikes, e-mail: powergen@solarturbines.com or call (619) 544-5352.



Sited Configuration of Taurus 60 Mobile Power Unit

Solar Turbines Incorporated
P.O. Box 85376
San Diego, CA 92186-5376 U.S.A.

Caterpillar is a trademark of Caterpillar Inc.
Solar, Taurus and SoLoNo₂ are trademarks of Solar Turbines Incorporated.
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DS60MPU/1000/5M

FOR MORE INFORMATION

Telephone: (+1) 619-544-5352
Telefax: (+1) 619-544-2444
Internet: www.solarturbines.com



Available for Rent, Lease or Purchase

Pratt & Whitney FT4A-11 Power Plant

Transportability

- ◆ Self-contained
- ◆ Trailer mounted
- ◆ Highway transportable
- ◆ Quick on-site assembly
- ◆ Small footprint
- ◆ No foundations required

Ideal Applications

- ◆ Peaking power
- ◆ Emergency power
- ◆ Isolated power
- ◆ Line support
- ◆ Reserve margin enhancement
- ◆ Peak shaving

Major Equipment

- ◆ Inlet ducts & filters
- ◆ GG4A-11 gas turbine
- ◆ FT4A-11 free turbine
- ◆ Lubrication and fuel systems
- ◆ Digital Fuel Control System
- ◆ Currently configured for diesel fuel, but can be converted to dual fuel or gas applications
- ◆ Hydraulic Starter
- ◆ CO2 Fire protection system
- ◆ Operating controls & switchboard
- ◆ Synchronous EM generator
- ◆ Current transformers
- ◆ Surge capacitors & resistors
- ◆ Battery bank and battery charger



The TransPac™ is a self-contained, transportable dual trailer power station. The unit is comprised of a control trailer and a power trailer. The control trailer provides for startup, operation and monitoring of the power plant. The power trailer contains a Pratt & Whitney GG4A-11 industrial gas turbine, free turbine, and EM synchronous generator.

A TransPac™ is ideal for peaking power, line support, reserve margin, isolated areas or emergencies. The trailer mounted power plant is highway transportable and can be setup within 5 days on-site. On-site assembly requires no special tooling. All hookups are externally mounted and run through cable trays for safety and easy maintenance. With battery racks located in storage compartments on the trailer, the unit has black start capability. The unit can achieve full output within 10 minutes of startup.

* Results based on actual field tests.

Power Generation: *

20.9 MW (peak output)
18.6 MW (base load)

Heat Rate: *

12,760 Btu/kWh (LHV peak output)
13,123 Btu/kWh (LHV base load)



Contact: JTS - Leasing

620 NW 35th Street, Boca Raton, FL 33431

Phone: (561) 417-4537

Fax: (561) 417-9894

Email: info@jetturbine.com

<http://www.jetturbine.com>

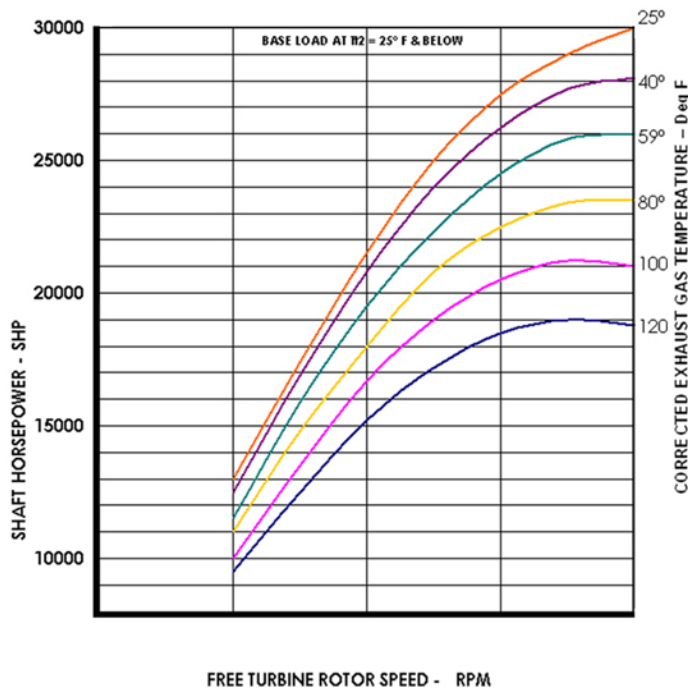
Performance Tests and Analysis

A series of performance tests were conducted on the FT4A-11 Transpac™. Electrical output and heat rate data was collected during three 30 minute base load tests and one peak output test. The test data was analyzed and corrected for inlet temperature and pressure following procedures outlined in the "FT4 Gas Turbine Engine Installation Handbook." The results of the tests and the applicable performance curves are as follows:

	Test #1	Test #2	Test #3	Peak
Generator Frequency (Hz)	60	60	60	60
Measured Output (KW)	20,002	19,997	19,985	23,078
Corrected Output (KW)	19,017	18,602	18,330	20,977
Measured Heat Rate (LHV)	13,160	13,138	13,068	12,762
Corrected Heat Rate (LHV)	13,167	13,130	13,071	12,760
Ambient Temperature (Deg F)	44.7	40.0	35.7	32.3
Ambient Barometric Pressure (Psia)	14.68	14.68	14.68	14.68
Compressor Inlet Temp. (Deg F)	51.1	46.9	41.8	37.5
Avg. Exhaust Temperature (Deg F)	1,151.4	1,144.3	1,130.7	1,220.0

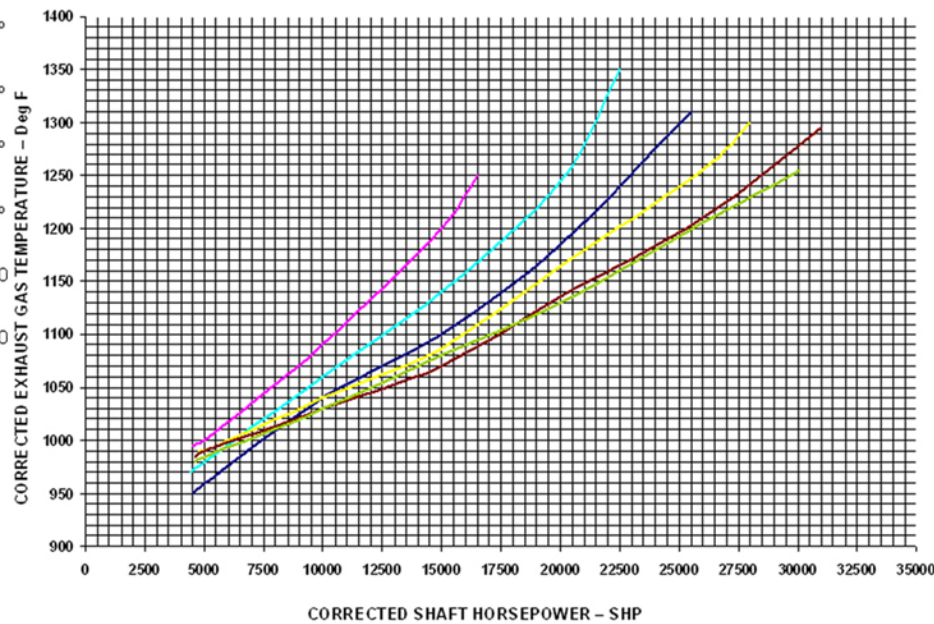
FT4A GAS TURBINE ENGINE

PERFORMANCE CALCULATIONS SAMPLE SPECIFICATION CURVE
ESTIMATED SHP AT MAX. CONTINUOUS POWER



FT4A GAS TURBINE ENGINE

ESTIMATED EXHAUST GAS TEMPERATURE & SHAFT HORSEPOWER





dual-fuel™ generator set

3500B single point gas injection - continuous power
3516B, 3512B, 3508B

what is dual-fuel™?

Clean Air Power's Dual-Fuel technology converts a diesel engine to a primarily natural gas engine. Dual-Fuel utilizes diesel fuel as a "liquid spark plug" to ignite the gas and provide power with high natural gas utilization and lower emissions.

dual-fuel generator sets

Production tested and delivered to you in a package that is ready to be connected to your fuel and power lines. Supported 100% by Clean Air Power with warranty on parts and labor. The generator set was designed and manufactured in an ISO9001 compliant facility.

application guidelines

Performance numbers herein are based on pipeline natural gas at ISO standard conditions of operation. Generator sets can also operate on many flare gasses and bio-fuels. All generators are 480 volts, unless otherwise noted. Clean Air Power will quote performance at specific conditions. For a quotation, contact the Power Systems group at 858-332-4800 or request a quotation online at www.cleanairpower.com.



features

- Low first cost
- Lower emissions
- Lower fuel costs
- Reduced maintenance costs
- Seamless transition to full diesel
- Field conversions of existing diesel standby units are available
- Low site gas supply requirement of 5 psi minimum
- Also available as a conversion kit

main technical characteristics

- Gaseous fuel injection at turbo suction
- Air fuel ratio control
- Full electronic engine control
- Air charge cooling (two-stage)
- Natural gas filtration
- Overfueling protection
- Secondary detonation protection
- Knock detection and prevention



5066 Santa Fe Street
San Diego, CA 92109
main 858.332.4800
fax 858.332.4890
info@cleanairpower.com
www.cleanairpower.com

“Dual-Fuel utilizes diesel fuel as a “liquid spark plug” to ignite the gas and provide power with high natural gas utilization and lower emissions.”

single point gas injection

for electronically fuel injected 3500B base genset

performance data

		3516	3512	3508
Usable Power	ekW	1600	1200	800
Engine Speed	RPM	1800		
Generator Freq.	Hz	60		
Load Factor	—	0.8		

		3516	3512	3508
Usable Power	ekW	1300	1000	650
Engine Speed	RPM	1500		
Generator Freq.	Hz	50		
Load Factor	—	0.8		

performance data across load ranges

Load (%)	BSNOx (g/hp-h)	BSFC* (BTU/kWe-hr)
50	3.1	13400 (-0+5%)
75	2.0	13000 (-0+5%)
100	2.0	12000 (-0+5%)

system descriptions

Natural Gas Injection System

- Gas Pressure Regulator – Regulation of higher pressure gas supply to required operating pressure.
- Mass Gas Flow Sensor – Measurement of gas to maintain air/fuel ratio control.
- Gas Temperature/Pressure Sensors – Supplemental to Mass Gas Flow Sensor for air/fuel ratio control.
- Gas Admission Valve - Butterfly valve for regulation of gas emission.

Air Fuel Ratio Monitoring System

- Air Control Valve(s) – Metering air in response to fuel.
- Air Temperature/Pressure Sensors – Air measurement for ECU signal.
- O2 Sensor - Measuring of air/fuel ratio.

Electronic Control System

- Electronic Control Unit (ECU) – Controls every aspect of Dual-Fuel operation.
- Diesel Control Interface – Enables OEM engine controller to work with Clean Air Power’s Dual-Fuel controller.

conditions and definitions

- Continuous Power Rating – Output available with varying load for an unlimited time, in accordance with ISO-3046. No overload operation is available for this rating.
- Ratings are based on ISO-3046 standard conditions [altitude = 110 m (361 ft), air inlet temperature = 25° C (77° F), barometric pressure = 100 kPa (29.53 in Hg), and relative humidity = 30%].
- Fuel rates are based on fuel oil of 35° API (16° C or 60° F) gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal).
- External dimensions and shipped weight remain unchanged from original full diesel specification.

operational parameters

Generator Frequency	60Hz
Generator Voltage	480V
Minimum Gas Pressure	5.0psig

engine specifications

- V-16, 4-Stroke-Cycle, Water Cooled Natural Gas/Diesel
- Bore - mm (in) 170 (6.7)
- Stroke - mm (in) 190 (7.5)
- Compression ratio 14.0:1



5066 Santa Fe Street
San Diego, CA 92109
main 858.332.4800
fax 858.332.4890
info@cleanairpower.com
www.cleanairpower.com

B

APPENDIX B: TRANSPORTABLE POWER UNITS

This appendix contains a spreadsheet with all of the transportable power units listed in this report, sorted by standby output.

**Table B-1
Transportable Gensets Sorted by Standby Output**

Manufacturer	Model	RE/CT	Prime Output (kW)	Standby Output (kW)	Fuel	Fuel Consumption/Efficiency	Fuel Storage/Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Rental/Used Market?
MQ Power	EGC-500DD (Detroit Diesel 8V2000 Engine)	RE	450	500	Diesel	32.7 gal/hr (100%), 18.1 gal/hr (50%)	800 G (3,025 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	29,980	160	Yes (Unknown)	NOx 6.8 g/bhp-hr; HC 0.23 g/bhp-hr; CO 0.63 g/bhp-hr; PM 0.05 g/bhp-hr	No
Caterpillar	XQ500 Sound Attenuated Power Module (CAT 3456 ATAAC Engine)	RE	455	500	Diesel	36.3 gal/hr standby, 32.7 gal/hr prime (100%)	600 G (2,271 L) - 24 hrs at 75%	480/277 V, Switchgear included, Semi-automatic paralleling protection - 1600 Amp circuit breaker w/ 24 V trip	27,170	189	70 dBA at 23 feet	EPA & CARB certified; NOx <6.9, CO <8.5, HC <1.0, PM 0.4 (g/hp-hr)	Yes
Cummins	500 kW Rental Package - Model DFED	RE	455	500	Diesel	35.9 gal/hr standby, 32.3 gal/hr prime (at 100%)	550 G (2,082 L) - 21-23 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	37,000	200	Yes (unknown)	NOx 9.85, CO 1.27, HC 0.2, PM 0.12 (g/hp-hr, standby)	Yes
Waukesha	Modulator VGF 36GSID	RE	430	515	Diesel	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	unknown	320	Yes (unknown)	unavailable	Yes
MQ Power	EGC-500V (Volvo TAD1631GE Engine)	RE	485	525	Diesel	34.9 gal/hr (100%), 19 gal/hr (50%)	800 G (3,025 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	26,920	160	Yes (Unknown)	NOx 6.06 g/bhp-hr; HC 0.28 g/bhp-hr; CO 0.42 g/bhp-hr	No
Waukesha	Modulator VGF 36GL/GLD	RE	475	575	NG	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	31,700	320	Yes (unknown)	unavailable	Yes
Stewart & Stevenson	RS530GW Power Generation Module (Waukesha L36GSID Engine)	RE	530	unknown	NG	less than 7600 Btu/ bhp-hr	8 inches W.C.	480 V, Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	48,500	320	Yes (unknown)	Three-way catalytic converter - less than 0.6 g/bhp hr NOx	No
Caterpillar	XQ600 Sound Attenuated Power Module (CAT 3412 Engine)	RE	545	600	Diesel	unavailable	660 G (2,500 L) - 13-15 hrs	480 V, Switchgear included, Manual paralleling - manually operated circuit breaker w/ overload and fault protection	37,000	320	70 dBA at 50 feet	EPA and CARB certified	Yes
Kohler	Industrial Rental Trailer-Mounted Generator Set 600ROZD-4N (DDC Series 2000)	RE	unknown	600	Diesel	44.8 gal/hr (100%), 22.2 gal/hr (50%)	650 G (2,460 L)	208, 480 or 600 V, Load Lug 1000 Amp circuit breakers in NEMA 1 enclosure	22,000	224	72 dBA at 7 meters (23 ft)	NOx 6.462, CO 0.242, HC 0.195 Particulates 0.056 (g/bhp-hr)	Yes

Appendix B: Transportable Power Units

Manufacturer	Model	RE/CT	Prime Output (kW)	Standby Output (kW)	Fuel	Fuel Consumption/ Efficiency	Fuel Storage/Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Rental/Used Market?
Waukesha	Modulator VGF 48GSID	RE	565	680	Diesel	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	unknown	320	Yes (unknown)	unavailable	Yes
Waukesha	Modulator VGF 48GL/GLD	RE	565	680	NG	unavailable	unknown	Mounted and wired switchgear/control panel with encased circuit breaker	40,200	320	Yes (unknown)	unavailable	Yes
Caterpillar	Dual XQ350 Rental Package (Twin CAT 3406 TA Engines)	RE	640	700	Diesel	Single Engine: 24.9 gal/hr prime (100%)	Each Engine: 400 G (1514 L)	480 V, Switchgear included, Automatic/Manual paralleling, 2 1200 Amp circuit breakers and 1 1200 Amp tie switch	32,840	208	68 dBA at 50 feet	EPA and CARB certified	Yes
Stewart & Stevenson	RS730GW Power Generation Module (Waukesha P48GSID Engine)	RE	730	unknown	NG	less than 8000 Btu/ bhp-hr	8 inches W.C.	480 V, Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	51,500	320	Yes (unknown)	Three-way catalytic converter - less than 0.6 g/bhp hr NOx	No
MQ Power	EGC-750DD-20 (Detroit Diesel 12V2000 Engine)	RE	675	750	Diesel	54.7 gal/hr (100%), 26.9 gal/hr (50%)	600 G (2270 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	42,500	160	Yes (Unknown)	unavailable - see engine manufacturer	No
Caterpillar	XQ750 Sound Attenuated Power Module (CAT 3412 Engine)	RE	680	750	Diesel	unavailable	660 G (2500 L) - 11-12 hrs	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	39,500	320	70 dBA at 50 feet	EPA and CARB certified	Yes
Cummins	750 kW Rental Package - Model DFHA	RE	680	750	Diesel	56.0 gal/hr standby, 50.3 gal/hr prime (at 100%)	1,750 G (6624 L) - 43-48 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	49,000	320	Yes (unknown)	NOx 5.3, CO 0.5, HC 0.14, PM 0.12 (g/hp-hr, standby)	Yes
Kohler	Industrial Rental Trailer-Mounted Generator Set 800ROZD-4N (DDC Series 2000)	RE	unknown	800	Diesel	57.5 gal/hr (100%), 28.6 gal/hr (50%)	1,000 G (3785 L)	208, 480 or 600 V, Load Lug 1400 Amp circuit breakers in NEMA 1 enclosure	37,000	320	78 dBA at 7 meters (23 ft)	NOx 6.631, CO 0.339, HC 0.205, Particulates 0.047 (g/bhp-hr)	Yes
MQ Power	EGC-750C (Cummins QST30-G2 Engine)	RE	725	800	Diesel	60 gal/hr (100%), 26.9 gal/hr (50%)	1,000 G (3785 L)	208/120, 480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	44,500	320	Yes (Unknown)	unavailable - see engine manufacturer	No
Aggreko	TwinPack Uninterruptible Generator	RE	unknown	<500 to 800	Diesel	varies with genset size	designed for 8 hour operation	Variety of plug and connection configurations	varies with genset size	160	48-55 dBA at 50 feet	varies with genset size	Yes
Cummins	900 kW Rental Package - Model DFHC	RE	818	900	Diesel	unavailable	1,750 G (6624 L) - 39-43 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and	49,000	320	Yes (unknown)	unavailable	Yes

Appendix B: Transportable Power Units

Manufacturer	Model	RE/CT	Prime Output (kW)	Standby Output (kW)	Fuel	Fuel Consumption/ Efficiency	Fuel Storage/Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft2)	Sound Attenuation	Emissions	Rental/Used Market?
								PowerCommand® Paralleling Controls included					
Caterpillar	XQ1000 Sound Attenuated Power Module (CAT 3508 B Engine)	RE	910	1,000	Diesel	9,540 Btu/kWh	Standard: 1,250 G (4,372 L) - 16-18 hrs, option for double	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	49,787	320	70 dBA at 50 feet	EPA and CARB certified	Yes
Cummins	1000 kW Rental Package - Model DFJD	RE	900	1,000	Diesel	69.3 gal/hr standby, 62.0 gal/hr prime (at 100%)	1750 G (6624 L) - 32-35 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	35,500	188	Yes (unknown)	NOx 6.0, CO 0.44, HC 0.12, PM 0.05 (g/hp-hr, standby)	Yes
Kohler	Industrial Rental Trailer-Mounted Generator Set 1000ROZD-4N (DDC Series 2000)	RE	unknown	1,000	Diesel	73.2 gal/hr (100%), 36.7 gal/hr (50%)	1000 G (3785 L)	208, 480 or 600 V, Load Lug 1600 Amp circuit breakers in NEMA 1 enclosure	37,000	320	78 dBA at 7 meters (23 ft)	unavailable	Yes
MQ Power	EGC-1000DD-20 (Detroit Diesel 16V2000/G81 Engine)	RE	900	1,000	Diesel	78.2 gal/hr (100%), 36.7 gal/hr (50%)	1000 G (3785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	43,480	160	Yes (Unknown)	NOx 6830 g/hr; HC 144 g/hr; CO 359 g/hr; PM 22.2 g/hr (100% load)	No
MQ Power	EGC-1000DD (Detroit Diesel 16V2000/G81 Engine)	RE	900	1,000	Diesel	78.2 gal/hr (100%), 36.7 gal/hr (50%)	1000 G (3785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	45,200	320	Yes (Unknown)	NOx 6830 g/hr; HC 144 g/hr; CO 359 g/hr; PM 22.2 g/hr (100% load)	No
Stewart & Stevenson	RS1000G Power Generation Module (Deutz TBG620V12 Engine)	RE	970	1,000	NG	unavailable	unknown	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	56,000	320	Yes (unknown)	unavailable - see engine manufacturer	No
GE	Natural Gas Reciprocating Generator	RE	unknown	1,000	NG	unavailable	unknown	unknown	unknown	unknown	Yes (unknown)	unavailable	Yes
Solar Turbines	Saturn 20 1.2 MW Mobile Gas Turbine Generator	CT	unknown	1,200	NG/ Diesel	unavailable	unknown	Manual paralleling; switchgear, circuit breaker and synchronizing system included	unknown	unknown	Yes (Unknown)	unavailable	Yes
Cummins	1250 kW Rental Package - Model DFLC	RE	1,100	1,250	Diesel	87.3 gal/hr standby, 76.9 gal/hr prime (at 100%)	1750 G (6624 L) - 28-31 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	55,000	320	Yes (unknown)	NOx 12.7, CO 1.0, HC 0.12, PM 0.06 (g/hp-hr, standby)	Yes
Caterpillar	XQ1250G Sound Attenuated Gas Power Module (CAT SCAC Engine)	RE	unknown	1,250	NG	34.2% electric	unknown	480 V, Switchgear included, Automatic/Manual paralleling - manual circuit breaker w/ overload and fault protection	71,060	320	74 dBA at 50 feet	NOx 1.0, CO 2.6, HC 4.4 (g/bhp-hr) NOx 75, CO 332, HC 995 (ppm)	Yes

Appendix B: Transportable Power Units

Manufacturer	Model	RE/CT	Prime Output (kW)	Standby Output (kW)	Fuel	Fuel Consumption/ Efficiency	Fuel Storage/Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft ²)	Sound Attenuation	Emissions	Rental/Used Market?
Cummins	1,250 kW Rental Package - Model QSV91G	RE	unknown	1,250	NG	unknown	unknown	Isolated bus paralleling control & base load utility paralleling features, paralleling circuit breaker & switchgear	70,550	400	85 dBA at 1 meter	unavailable	Yes
Aggreko	SuperHush Container Generator	RE	unknown	<500 to 1,250	Diesel	varies with genset size	designed for 8 hour operation	Output connections are mounted in a dedicated compartment	varies with genset size	160 (320 for 1250 kW unit)	48-55 dBA at 50 feet	varies with genset size	Yes
Aggreko	HP Container Generator	RE	unknown	<500 to 1,250	Diesel	varies with genset size	designed for 8 hour operation	Automatic synchronization and load-sharing controls	varies with genset size	160 (320 for 1250 kW unit)	65 dBA at 50 feet	varies with genset size	Yes
Stewart & Stevenson	RS1350G Power Generation Module (Deutz TBG620V16 Engine)	RE	1,280	1,350	NG	unavailable	unknown	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	58,000	320	Yes (unknown)	unavailable - see engine manufacturer	No
Caterpillar	XQ1500 Sound Attenuated Power Module (CAT 3512 B Engine)	RE	1,360	1,500	Diesel	unavailable	Standard: 1,250 G (4,372 L) - 16-18 hrs, option for double	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	59,000	320	70 dBA at 50 feet	EPA and CARB certified	Yes
Cummins	1500 kW Rental Package - Model DFLE	RE	1,250	1,500	Diesel	103.6 gal/hr standby, 87.3 gal/hr prime (at 100%)	1,750 G (6,624 L) - 23-27 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	60,140	320	Yes (unknown)	NOx 8.5, CO 1.3, HC 0.17, PM 0.11 (g/hp-hr, standby)	Yes
Kohler	Industrial Rental Trailer-Mounted Generator Set 1500ROZD-4N (DDC Series 4000)	RE	unknown	1,500	Diesel	99.7 gal/hr (100%), 50.6 gal/hr (50%)	1,000 G (3,785 L)	208, 480 or 600 V, Load Lug 2500 Amp circuit breakers in NEMA 1 enclosure	57,000	320	80 dBA at 7 meters (23 ft)	unavailable	Yes
MQ Power	EGC-1500C-20 (Cummins KTA50-G9 Engine)	RE	1,250	1,500	Diesel	104 gal/hr (100%), 56 gal/hr (50%)	1,000 G (3,785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	45,240	160	Yes (Unknown)	NOx 7.3 g/hp-hr; HC 0.18 g/hp-hr; CO 1.0 g/hp-hr; PM 0.13 g/hp-hr	No
MQ Power	EGC-1500C (Cummins KTA50-G9 Engine)	RE	1,250	1,500	Diesel	104 gal/hr (100%), 56 gal/hr (50%)	1,000 G (3,785 L)	480/277 V, Automatic Start/Stop, Digital control with NFPA shutdowns, Optional Parallel Operating System	53,220	320	Yes (Unknown)	NOx 7.3 g/hp-hr; HC 0.18 g/hp-hr; CO 1.0 g/hp-hr; PM 0.13 g/hp-hr	No
Stewart & Stevenson	RS1500D Power Generation Module (Deutz TBD620 Engine)	RE	1,390	1,500	Diesel	unavailable	4,730 L (1,250 G)	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	50,500	320	Yes (unknown)	Fulfills all current emissions regulations	No

Appendix B: Transportable Power Units

Manufacturer	Model	RE/CT	Prime Output (kW)	Standby Output (kW)	Fuel	Fuel Consumption/ Efficiency	Fuel Storage/Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft2)	Sound Attenuation	Emissions	Rental/Used Market?
Pratt & Whitney	ST18 TransPak	CT	1,600	1,800	NG					320			Yes
Kohler	Industrial Rental Trailer-Mounted Generator Set 1750ROZD-4N (DDC Series 4000)	RE	unknown	1,750	Diesel	114.9 gal/hr (100%), 62.6 gal/hr (50%)	1,000 G (3785 L)	208, 480 or 600 V, Load Lug 3,000 Amp circuit breakers in NEMA 1 enclosure	60,000	320	82dBA at 7 meters (23 ft)	unavailable	Yes
GE	Diesel Powered Generators - various engines used	RE	unknown	<500 to 1,825	Diesel	varies with size	varies with size	unknown	varies	160-320	Yes (unknown)	varies	Yes
Caterpillar	XQ2000 Sound Attenuated Power Module (CAT 3516 B Engine)	RE	1,825	2,000	Diesel	unavailable	Standard: 1,250 G (4,372 L) - 9-10 hrs, option for double	480 V, Switchgear included, Manual paralleling - generator-mounted circuit breaker w/ overload and fault protection	74,000	354	74 dBA at 50 feet	EPA and CARB certified	Yes
Cummins	2000 kW Rental Package - Model DQKC	RE	1,800	2,000	Diesel	137.3 gal/hr standby, 123.2 gal/hr prime (at 100%)	2,030 G (7,684 L) - 20-22 hrs at 75%	480/208 V, Custom switchgear, Automatic transfer switch and PowerCommand® Paralleling Controls included	79,225	320	Yes (unknown)	NOx 7.0, CO 0.9, HC 0.2, PM 0.04 (g/hp-hr, standby)	Yes
Kohler	Industrial Rental Trailer-Mounted Generator Set 2000ROZD-4N (DDC Series 4000)	RE	unknown	2,000	Diesel	133.2 gal/hr (100%), 67.2 gal/hr (50%)	1,000 G (3785 L)	208, 480 or 600 V, Load Lug 3000 Amp circuit breakers in NEMA 1 enclosure	61,000	320	82dBA at 7 meters (23 ft)	unavailable	Yes
Stewart & Stevenson	RS2000D Power Generation Module (Deutz TBD620 Engine)	RE	1,820	2,000	Diesel	unavailable	4,160 L (1100 G)	Isochronous, parallel load sharing or parallel baseload operation, Automatic synchronizing and load control module	56,700	320	Yes (unknown)	Fulfills all current emissions regulations	No
Aggreko	GreenPower Container Generator	RE	unknown	<500 to 2,000	Diesel	varies with genset size	designed for 8 hour operation	Synchronizing and load-sharing power controls	varies with genset size	160-320	unknown	very low emissions	Yes
Alstom	Utility Grade Power Module	RE	unknown	2,000	Diesel	111.5 gal/hr (100%), 61.5 gal/hr (50%)	1,250 G (4,731 L)	unknown	89,000	320	Yes (unknown)	NOx 44.2 lb/hr, CO 0.95 lb/hr, Total HC 0.98 lb/hr	Yes
Penn Detroit Diesel Allison	Range of Rental Generator Systems	RE	unknown	<500 to 2,000	Diesel	varies with size	varies with size	unknown	varies	160-320	Yes (unknown)	varies	Yes
Detroit Diesel	Range of Gensets that can be used for mobile applications	RE	unknown	<500 to 2,800	Diesel	varies with size	varies with size	varies with packager	varies	160-320	Yes (unknown)	designed to meet federal off-highway requirements	Yes
GE	Dual Fuel Gas Turbine Generator Sets	CT	unknown	2,700	NG/ Diesel	unavailable	unknown	unknown	unknown	unknown	Yes (Unknown)	unavailable	Yes

Appendix B: Transportable Power Units

Manufacturer	Model	RE/CT	Prime Output (kW)	Standby Output (kW)	Fuel	Fuel Consumption/ Efficiency	Fuel Storage/Pressure	Interconnection Equipment	Weight (lbs)	Footprint (ft2)	Sound Attenuation	Emissions	Rental/Used Market?
Rolls Royce	Proteus 3.2 MW Mobile Genset	CT	2,875	3,200	NG/ Diesel	280 gal/hr (100%)	Minimum pressure: 160 psig	Manual paralleling: Auto Sync Relay, Westinghouse Generator Breaker	95,656	320	Yes (Unknown)	unavailable	Yes
Solar Turbines	Centaur 40 3.5 MW Mobile Gas Turbine Generator	CT	unknown	3,500	NG/ Diesel	unavailable	unknown	Manual paralleling; switchgear, circuit breaker and synchronizing system included	unknown	unknown	Yes (Unknown)	unavailable	Yes
Pratt & Whitney	ST40 TransPak	CT	4,300	3,820	NG/ Diesel					3200			Yes
Solar Turbines	Centaur 50 4.6 MW Mobile Gas Turbine Generator	CT	unknown	4,600	NG/ Diesel	unavailable	unknown	Manual paralleling; switchgear, circuit breaker and synchronizing system included	unknown	unknown	Yes (Unknown)	unavailable	Yes
Alstom	Typhoon Gas Turbine Generating Set	CT	unknown	4,350-5,250	NG/ Diesel	varies with genset size	unknown	unknown	varies with genset size	320	Yes (Unknown)	unavailable	Yes
Solar Turbines	Taurus 60 Transportable Power Unit	CT	unknown	5,200	NG/ Diesel	unavailable	unknown	Manual paralleling; Utility grade switchgear and protective relay module	unknown	1006	Yes (Unknown)	SoLoNOx™ Dry Low NOx Combustion System - no visible emissions	Yes
Alstom	Tornado Gas Turbine Generating Set	CT	unknown	6,750	NG/ Diesel	unavailable	unknown	unknown	unknown	320	Yes (Unknown)	unavailable	Yes
Solar Turbines	Taurus 70 Transportable Power Unit	CT	unknown	7,500	NG/ Diesel	unavailable	unknown	Manual paralleling; Utility grade switchgear and protective relay module	unknown	1006	Yes (Unknown)	SoLoNOx™ Dry Low NOx Combustion System - no visible emissions	Yes
Alstom	Tempest Gas Turbine Generating Set	CT	unknown	7,900	NG/ Diesel	11,154 Btu/kWh	NG: 287-362 psig, Diesel: 15-30 psig	unknown	115,190	320	Yes (Unknown)	NOx <10 vppmd, CO <2 ppm, Total UHC <10 ppm	Yes
Rolls Royce	Avon 10 MW Mobile Gas Turbine Generator	CT	10,300	16,000	NG/ Diesel	unavailable	Fuel supplied by separate tanker to fuel forwarding package	Automatic synchronizing unit (type PAS), under/over current and overvoltage protection	265,000	unknown	Yes (Unknown)	unavailable	Yes
Pratt & Whitney	FTA4-11 TransPak	CT	18,600	20,900	NG	13,000 BTU / kWh (LHV)		Synchronys EM generator, battery bank and charger					
GE	TM2500	CT	22,800		NG	9,465 BTU/kWh (LHV)		Power supplied at 13.8 kV		~2,000	90 dBA @ 3m		Yes

Note: Most transportable DER units are available in both the used and rental markets

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