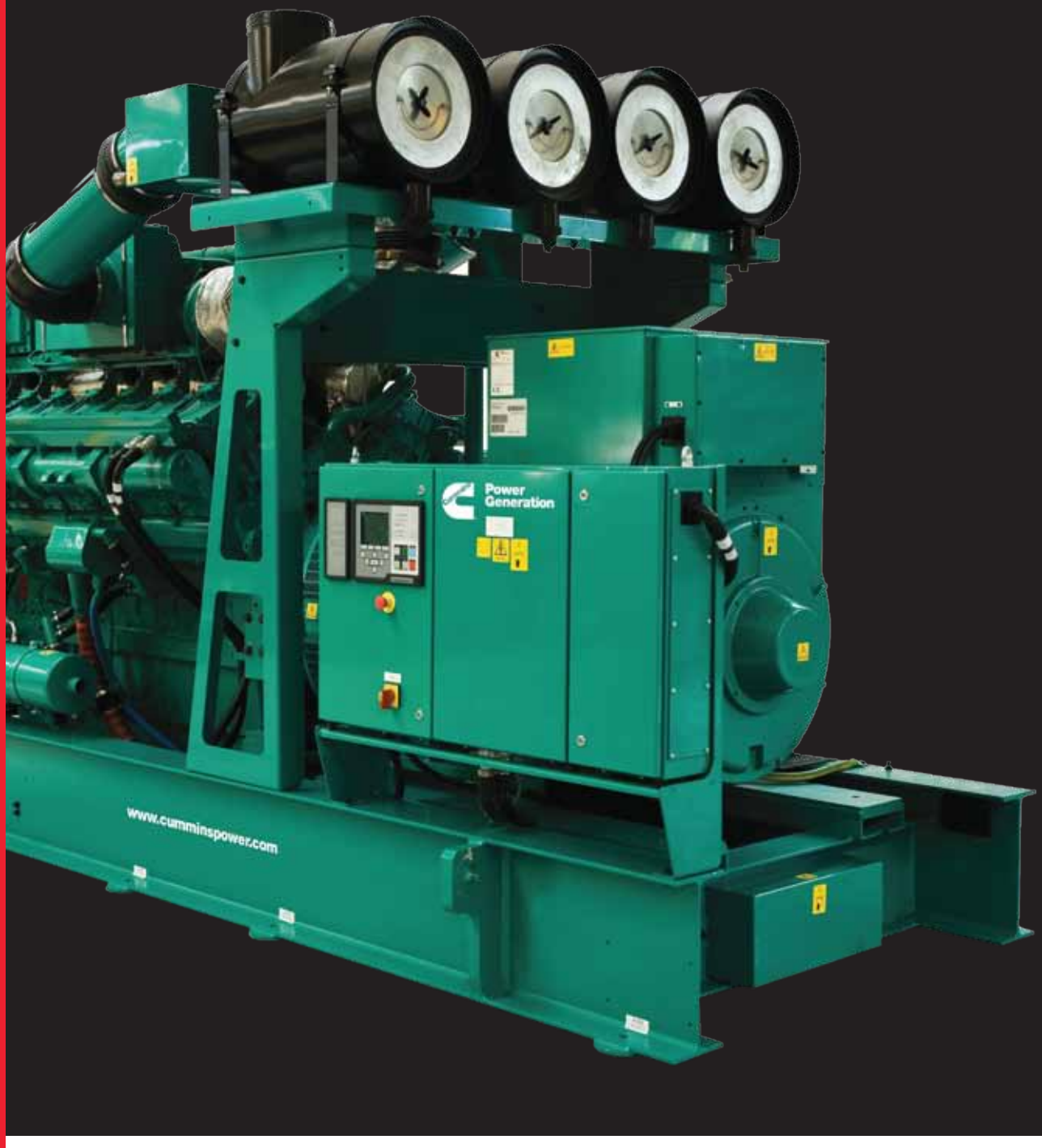
CUMMINS GAS SOLUTIONS
FOR YOUR POWER NEEDS



ENERGY SOLUTIONS (PVT) LIMITED

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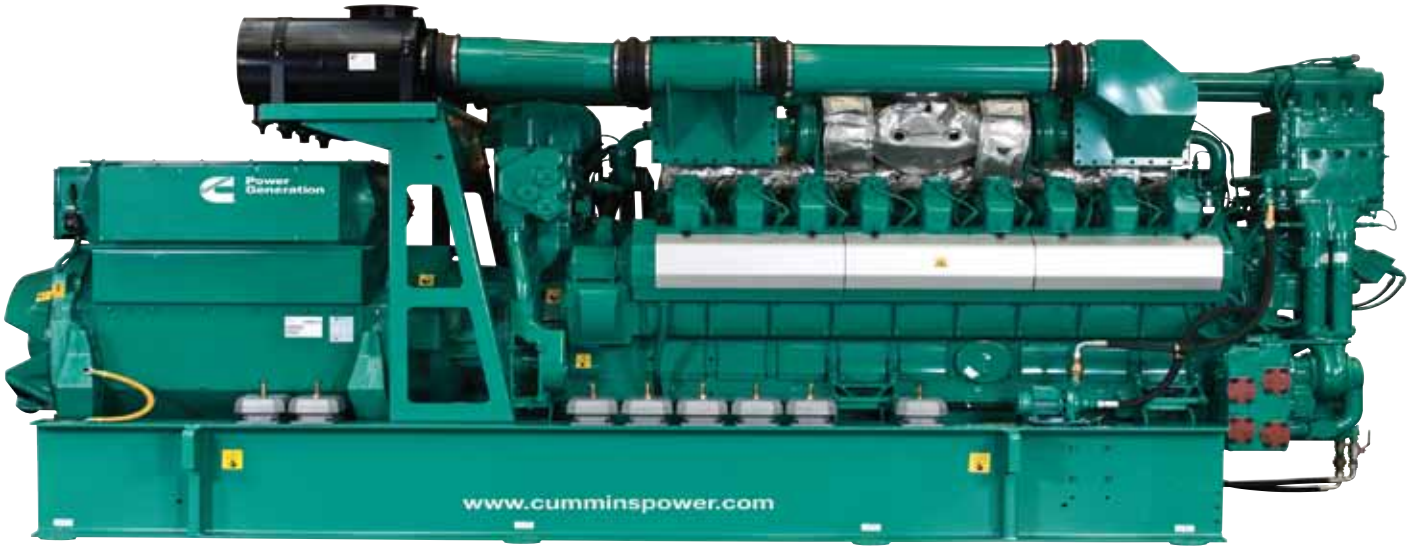
Power Generation



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Cummins Energy Solutions Business (ESB) has signed Energy Solutions (Private) Limited (ESL) as their Gas Generating Set Distributor and Service Provider for Pakistan.

Justin O'Flynn, General Manager EMER, Cummins Power Generation (UK), handing over the partnership contract to Mohammad Nadeem Sadiq, Director & COO, Energy Solutions (Pvt.) Limited.

The contract was made between Mr. Justin O'Flynn- General Manager Europe, Russia and Middle East, Cummins and Mr. Muhammad Tariq Haq- Director and CEO, Energy Solutions Private Limited in September, 2013.

Mr. Tariq Haq, the Distributer Principal of Cummins Gas Power Generation in Pakistan, on the occasion stated, "With so many USPs, Cummins gas generators are heads and shoulders above other contemporary products. Ability to run on low methane gas, strength to accept 50-70% block loads, fuel consumption matching the best-in-class, inbuilt reliability because of lower BMEPs, low(est) life cycle cost, high(est) IRR, etc., are some of the features which make Cummins gas generators a highly coveted brand worldwide."

"ESL is indeed fortunate to represent Cummins gas generators in Pakistan market. For ESL management, it is a milestone achieved as our twenty one year old association with Cummins has revived. Our love for Cummins which never waned has vindicated our belief that you can get what you sincerely strive for", he added.

On the occasion of exchanging copies of contract, ESL arranged befitting day long introductory seminars in the cities of Karachi and Lahore providing a wholesome platform to Cummins Gas Power Generation in Pakistan to address the local market. The seminars were well attended by consultants, customers, contractors, etc.

Energy Solutions (Private) Limited- An Overview

Energy Solutions (Private) Limited (ESL) is a Sales and Service Company in Power Generation business and operates in conjunction with Shirazi Trading Company (STC), which is an Atlas Group Company. It has been created with a mission to help customers select, install, operate and maintain power generation equipment from 1kVA to 2500 kVA with focus on high horsepower machines. The Company believes in “doing what has been said and delivering what has been promised”. The management of ESL knows what this age-old cliché means to the customers, employees and the society at large.

Energy Solutions (Private) Limited (ESL) is a Company run and managed by professionals having a wide experience in power generation. The main strength of ESL is its ability to provide value adding engineering services, with focus on doing job right the first time around. This is precisely why customers like Banks, Telecommunication Companies and those in Oil and Gas sector find solace while working with ESL.

ESL has become the trusted source of complete gas powered packages using original Cummins engines from UK. It has been selected by Cummins Power Generation UK purely on account of its ability to provide quality services to its customers.

The value package provided by ESL to its customers includes:

- Turn key energy solutions including IPP, Co-generation, Tri-generation and waste to energy projects.
- Paralleling, synchronizing and load sharing solutions of new and legacy systems.
- Operation & Maintenance (O&M) Solutions for all sectors, from parts supply to full owning and operating contracts over 10 years.
- Service availability across Pakistan with strategic offices placed in the heart of the markets we serve.

With so many Unique Selling Points (USPs), Cummins gas generators are heads and shoulders above other contemporary products. Ability to run on low methane gas, strength to accept 50-70% block loads, fuel consumption matching the best-in-class, inbuilt reliability because of lower BMEPs, low(est) life cycle cost, high(est) IRR, etc., are some of the features which make Cummins gas generators a highly coveted brand worldwide.

Our Mission:

To help customers select, install, operate and maintain power generation equipment. This, we believe, can only be achieved with a truly sincere approach, absolutely safe practices while at work and away, a sincere spirit to serve, a keen desire to create lifelong customers and continuous efforts to develop our own skills and that of our supply chain partners including our own workforce.

Our Vision:

We are in business to help our customers find the best, cost effective energy solutions as a result of sincere hard work, safe habits, superior services and salesmanship that builds long term relationships.

Our Focus:

To maximize benefits for all stake holders by means of:

- Distributing products and services in accordance with the requirements and values of our Principals.
- Devising customized value packages.
- Delighting customers with a sincere spirit to serve.
- Delivering services in excess of customer's expectations and contract value.
- Developing skills of our people and partners as a vehicle to continuous improvement.
- Depending on people and partners to gel them into a team, which can set high standards of supplies and services.

Our Strengths:

- Professional management
- Long term approach
- Sincerity
- Cradle to grave services
- Value adding engineering practices
- Project management eyeing "best-in-class" cycle time
- Teamwork
- Commitment
- Never "give up" attitude
- Putting our foot in the customer's shoes---Feeling the pain of customer and putting him first

Our Quality Policy:

We recognize that there is no end to the road to quality. We also fully understand that quality can only be achieved with:

- A mindset to do the job on time, first time, and every time.
- Practicing what we preach.
- Identifying critical mass and eliminating waste from whatever we do.
- Fully documented processes.
- Continuous investment in people to develop their skills and continuous improvement in our ways of working (WoW) through small incremental steps.
- Learning from the “Best Practices” of others.
- Benchmarking against “Best-in-Class” performance(s).

Our Health, Safety, Security and Environment (HSSE) Policy:

We undertake to act in strict compliance with the following policy:

- We shall adequately control threats to health and safety because of our work.
- We shall indulge in meaningful consultation with our co-workers in matters relating to HSSE and ensure their active participation.
- We shall provide information, training, guidance, etc., to our employees and devise a system of effective audits as a tool for continuous improvement and achievement of business excellence.
- We shall contain work related accidents, injuries and illnesses as far as possible.
- We shall review policies with regard to HSSE from time to time and implement effective changes.
- We shall treat matters relating to HSSE as importantly as our day-to-day business and keep employees involved.
- We shall promote a culture which ensures active involvement of all employees in HSSE at work and at home so that they are least affected by accidents.
- We shall create an environment, which shall ensure minimum loss and interruption to the business.
- We shall adopt a policy of obtaining clearance before proceeding for work.
- We shall address HSSE matters from the top organizational level just as we should do for quality and training.

ESL Customer Care

Energy Solutions (Private) Limited- ESL has, as a part of its corporate social responsibility, started a Customer Care section in its website. The purpose is to emphasize importance of safety, quality and continuous improvement (training) in our day-to-day work. Our top management stands committed to make these a cornerstone of its business. The target audience is ESL employees, customers, suppliers and society at large.

We also conduct free of cost training programmes at our own or the customers' premises to fulfill our mission of spreading awareness.

We will continue to update the information and add more from time to time. Please reach us at www.ESLpk.com/CustomerCare.html and keep watching for what is new.

- Safety of Our People and Family
- HSSE Training and Awareness
- The Safety Culture We should Adopt
- Why should We Invest in Avoiding an Accident?
- Role of Leader in HSSE
- Safety Considerations while Handling Generators
- Safety Concerns while Handling Diesel
- Five **S** Approach to Our HSSE Commitment
- Safety of Our Generators and Our Personnel
- Actions which Must Precede Start of Work on Generator
- Check Out Before You Step Out - Talk Not Tick
- Discretion is Better than Valor - Lockout and Tag Out (LOTO)
- Return to Service after Lockout
- Defensive Driving Techniques
- Why Use Diesel Generators
- Power Generation - FAQs (Frequently Asked Questions)
- Know Your Generators
- How an Alternator and a Voltage Regulator Work
- Important Considerations before You Make a Generator Buying Decision
- Cummins High Performance Lean Burn Gas Generators – Technology of Tomorrow Unleashed Today
- Co-Generation – Killing Many Birds with One Stone
- Allow No Interruption in Operations - Use Bumpless Transfer between Utility
- Improving Life and Overhaul Interval of Our Generators to Several Thousand Hours
- Maintenance Considerations for Improving Life and Overhaul Interval of Our Generators to Several Thousand Hours
- Run in Your New or Recently Overhauled Diesel Generator
- Do the Parts Talk?
- Annual Maintenance Contract - Ten Commandments
- Sizing Our Generators
- Steps in Sizing Our Generators
- How Power Factor can Influence the Sizing of Generator Sets for Motor Starting Loads
- How Various Loads Affect the Sizing of Generator Sets
- Gensizing for Motors
- How to Select a Generating Set for My Home?
- How to Select a Generating Set for My Workplace?
- Duty Rating of Our Generators
- Understanding Power Factor of Our Plant
- Improving Fuel Consumption of Our Generators
- Paralleling of Generators - Is the Sum of the Parts Greater than the Whole?
- Paralleling and Synchronizing Aksa Gensets
- Paralleling Generators of Different Makes, Models and Manufacturers
- Measuring, Metering and Monitoring Generators
- Output Derating of Our Generators
- Don't Kill Your Engine by Operating at Light Loads
- Guidelines to Prevent Wet Stacking Caused by Operations at Light Loads
- Understanding the Difference between Three-Phase and Single Phase Generators
- Converting Our Generators from Three-Phase Power to Single Phase
- Converting Our Generators from 60Hz to 50Hz Power
- Dos and Don’ts of Portable Generators
- Rid Yourself from Continuous Load Shedding
- Cummins Installation, Operations & Maintenance Manual
- Diesel Generating Sets Installation-Recommendations Manual
- Glossary of Terms

Ten Reasons Why Customers Buy Cummins Gas Generators Worldwide

1) Cummins Gas Generators are known for their single-step-load-acceptance (torque load) capability of 50-70%. For large motors, you may use a single Cummins gas generator instead of more than one of others. It is due to:

a) State of the art Cummins governing system. This keeps monitoring peak pressures, exhaust temperatures and knocks of individual cylinders and then adjusts the ignition timing of individual cylinders to get maximum output from each cylinder.

b) The fact that the conventional type governing system monitors only the engine rpm. When the rpm changes, it starts altering the air fuel mixture. On the other hand, Cummins governing system keeps monitoring the engine rpm as well as the KWm (load) on engine. As soon as KWm changes, it governs the engine rpm through multiple actuators.

c) The main and most important reason that Cummins uses smaller, multiple turbo chargers instead of a big single turbo charger. Smaller turbo chargers easily and rapidly recover their original high rpm as compared to a single, large turbine.

2) Cummins Gas Generators are known for their ability to respond to transient loads and are ideal for applications requiring very fast recovery of voltage and frequency.

a) Due to the reasons cited above, frequency (engine rpm) stabilizes in shortest possible time.

b) For voltage stability Cummins uses its own patent state of the art AVR system, which is integrated with mother board (engine governor, etc.) of the controller. This reacts faster than the conventional type AVR resulting in faster recovery and regulation of the voltage.

3) Cummins Gas Generators are known for their suitability to operate on low methane index natural gas and continue to operate whilst others may shut down especially during Pakistani winter(s).

a) This is due to lower BMEP, for example, Cummins operates at 14 to 16 BMEP whereas competitors operate at 18 BMEP.

4) Cummins Gas Generators are known for no or low deration at high temperatures and altitudes compared with others.

a) It is due to the reasons explained above in 1 and 3.

5) Cummins Gas Generators may actually accomplish: hours to top overhaul in excess of 30,000 hours and major overhaul in excess of 60,000 hours.

a) It is due to their robust design. They have a construction corresponding to high BMEPs but actually operate at lower BMEP values.

6) Cummins Gas Generators are known for high total efficiencies making them ideal for co-generation and tri-generation.

a) It is due to high exhaust temperatures and exhaust mass flow rates.

7) Cummins Gas Generators are tested at LHV of gas (33.44 MJ/Nm^3) which is nearest to that supplied by SSGC and SNGPL (around 33 MJ/Nm^3), whereas others test their generators on a much better fuel quality. This means that the data provided by Cummins sheets would be closer to real life performance than those of others, which will derate a lot more than Cummins in Pakistan. Hence,

a) Cummins Gas Generators may actually have the lowest fuel consumption at high temperatures, high altitudes with gas quality available in Pakistan.

8) Cummins Gas Generators are known for their lowest Break Mean Effective Pressure (BMEP), low compression ratios, high displacement per kWhe. These features make them last longer, wear smaller, use less parts and consume less lube oil.

9) Cummins Gas Generators are known for their low(est) Total Cost of Ownership, high(est) Net Present Value and highest Internal Rate of Return (IRR).

10) Cummins Gas Generators are known for their ruggedness, reliability and ability to operate in island mode at high altitudes and high temperatures with deteriorating gas quality. These features make them the first choice of World's largest rental companies (e.g. Aggreko) and consultants.

a) Though a late entrant in Pakistan market, Cummins Gas Generators are known for their successful track record in AKUH, Shaukat Khanum Hospital, ATS Synthetic, PPL, University of Engineering & Technology Lahore, PAEC, etc.

Cummins High Performance Lean Burn Gas Generators- Technology of Tomorrow, Unleashed Today!

Reciprocating engines are of two basic types- spark ignition (SI) and compression ignition (CI). Spark ignition engines for power generation use natural gas as the preferred fuel, although they can also be set up to run on propane, gasoline, or landfill gas. Compression ignition engines (often called diesel engines) operate on diesel fuel or heavy oil.

Diesel engines are increasingly confined to emergency standby because of spiraling fuel costs, storage issues and air emission concerns particularly in the West. Consequently, the natural gas-fueled SI engine is now the engine of choice for the higher-duty-cycle stationary power market and is driven by economic and environmental pressures for power density improvements (more output per unit of engine displacement), increased fuel efficiency and reduced emissions.

A lean burn gaseous fueled generator set is a very good alternative to diesel or stoichiometric gas powered generator sets.

What are the air to fuel ratios achievable in Lean Burn gas engines compared with other types?

Lean burn technology uses high air to fuel ratio (λ=1.7) and excess oxygen to gain overall output efficiency at greatly reduced NOx emissions. These efficiency levels often exceed those of equivalent sized diesel products. Exhaust emissions are significantly lower than stoichiometric gas engines (λ=1) and greatly reduced from a diesel engine. Chemically correct, stoichiometric gas engines run with a normal air to fuel ratio of 15:1. True lean burn gas engines can go as high as 25:1 when full power is not needed, resulting in better fuel economy. When full power is needed it can revert to a stoichiometric ratio or richer. Diesel engines, on the other hand, have air to fuel ratio of 25:1 or 30:1 at full load to 85:1 or 100:1 at no load.

Why is a lean burn gas generator more expensive than a diesel generator of the same size?

Many natural gas spark ignition engines are derived from diesel engines, i.e., they use the same block, crankshaft, main bearings, camshaft, and connecting rods as the diesel engine. However, natural gas spark ignition engines operate at:

1. Modest compression ratios in the range of 9:1 to 12:1 (compared with diesel engines in the range of 12:1 to 17:1) to prevent auto ignition and knock which can cause serious engine damage.

2. Lower brake mean effective pressures (BMEP - 16 to 18 bar compared with 24 bar of diesel) and
3. Lower peak combustion pressure levels (120 bar vs. 180 bar for diesel engine).

Due to the essentially lower BMEP, the spark ignition versions of diesel engines often produce only 60 to 80 percent of the power output of the parent diesel. Consequently, the $/kW capital costs of natural gas spark ignition engines are generally higher than the diesel engines from which they were derived.

How does a lean burn gas engine behave when subject to high starting torques?

Lean burn combustion technology results in more complete combustion of the gaseous fuel and cooler combustion temperatures. However, there is a trade off for the improved efficiency and emissions, which is:

1. The rapid starting as compared to a diesel engine and
2. High percentage of single step load acceptance capability.

A diesel powered generator set is generally fast responding and able to pick up large load steps without reasonable voltage and frequency variation. Often a diesel genset can pick up 100 percent of rated power in a single step and recover quickly. The load step capability of a lean burn gaseous generator set is normally in a range of 10-75 percent. The difference in response is a result of the differences in fuel delivery systems of the CI and SI engine technologies. The wide range of percentage difference in SI engines is due to the various system technologies within the lean burn spectrum

What is the difference between lean burn engines designed for efficiency and performance?

Within the spectrum of lean burn technology, generator sets are of two types- one optimized for performance (tolerance to temperature, altitude and load steps), the other optimized for efficiency. The latter uses a single large turbo charger as opposed to multiple turbo chargers. These higher efficiency models are designed primarily for operation parallel to a utility grid and pose challenges when operating in Island mode (not connected to a utility grid).

The greatest trade-off of these single turbo models is the ability to pick up a large load in a single step. While Cummins multi-turbo units with twin governors, twin actuators, twin gas control valves can pick up a load step of 50-75 percent of rating with reasonable performance, single turbo, high efficiency models are limited to 10-25 percent of the advertised rating. Single turbo units can be utilized in island mode only after special attention is paid to the load step size and sequence.

Why is the maintenance interval of a lean burn gas generator higher than a diesel engine?

Operation of a lean burn SI engine at lower BMEP and smaller peak combustion pressures results in substantially lower loads on the engine components and the bearings. This, when combined with cleaner combustion environment of natural gas, keeps the lube oil cleaner and healthier for longer. As a result of these, spark ignition engines offer the benefits of substantially extended component life (to the order of twice and beyond) compared to their diesel parents. This is why we find time to overhaul of 60,000 hours and even beyond for a 16 BMEP SI engine.

Why is a lean burn gas generator difficult to run on island mode as compared with a diesel generator?

A lean burn gas engine cannot rapidly adapt to changes in load compared with a diesel engine. Two reasons which are often cited are:

1. Natural gas has a much lower energy density (1m^3 of NG is equivalent to 1litre of diesel). Hence with a richer fuel (diesel) it is easier to follow the varying load and keep frequency and voltage under regulation. The higher volume of natural gas that has to enter the cylinder makes the process of adapting to rapidly varying loads more difficult hence the difficulty in using gas engines in island mode.

2. There is a considerable difference in the reaction speed between diesels and gas engines. This is because diesel engines always have excess air in the cylinder. With suddenly increasing load, you just have to add more fuel and the engine will respond. In diesel engines, this can transpire in less than 1 /16 of a cycle. With modern, lean-burn, gas engines, the fuel to air ratio is critical and must be maintained at all times. If you want more power, you cannot just add more fuel, you have to wait for more air as well. Unlike diesel, oxygen is not available inside the cylinder, it has to be fetched from outside through increased activity by the turbocharger(s). Hence, it can take many cycles to go from (say) 30% to 60% load.

Like diesel generators, Cummins lean burn gas generators are highly suitable for island mode operations while others are not. Why?

Cummins lean burn gas generators proactively anticipate increase in upcoming load by intelligently sensing dip in voltage instead of reacting to subsequent dip in RPM at the flywheel. Consequently, Cummins own factory built, specially designed multiple turbochargers rapidly fulfill increased demand for more air in the cylinders. Since, increased amount of air / gas mixture is available for combustion instantly after application of a block load (motor starting torque), Cummins gas engines are ideally suited for island mode operations whilst others simply watch and wonder.

What is the advantage of a lower BMEP SI engine over a higher BMEP SI machine?

Some manufacturers of lean burn SI engines offer higher BMEP vs. Cummins (18 bar instead of 16 bar of Cummins). Higher BMEP levels increase power output, improve efficiency and result in lower specific costs ($/kW). BMEP is increased by forcing a larger mass of cooler and denser air through increased turbo charging (defined as air compression by a turbine driven by exhaust gases boosting air pressure on a 3:1 to 4:1 ratio), improved after-cooling (LT cooling circuit), etc. However, higher BMEP increases thermal and pneumatic stresses within the engine, and poses issues with regard to continued engine durability and reliability. We may also see increased engine oil consumption.

How does a lean burn engine respond to fuels other than natural gas?

Lean burn technology has the ability to operate on gas with a wide range of quality. A measurement called the Methane Number (MN) is used to determine fuel gas suitability as an engine fuel. Most natural gas has an MN from 70 to 97, and pipeline quality gas typically has an MN of about 75. Gas from landfills or sewage treatment facilities is typically of lower quality, but is often suitable for use in lean burn engines. Cummins' lean burn gas engine generators can operate on gas with an MN of 50 or greater, providing excellent fuel flexibility. However, gas with an MN below 70 may require derating of the generator output.

Cummins superiority over other contemporary products:

On account of above cited reasons, Cummins gas generators stand out in the following ways:

1. Truly island mode machine
2. Torque load capability of 50-70%
3. Fast recovery in the wake of transient loads
4. Low deration
5. Operations at low Methane Numbers without losing power
6. Lower wear, higher maintenance intervals (as compared with published numbers), lower consumption of parts
7. Arguably, the lowest fuel consumption in Pakistan in the context of high temperatures, high altitudes, deteriorating LHV and MN of the gas supplied by SSGC and SNGPL.

Co-generation- the Hallmark of Cummins!

Steam is very powerful. It does not only run an engine but also possesses the ability of air conditioning besides its various other uses. Diesel and/or gas generators not only produce electrical power but may also produce steam which may be used for heating or cooling. This is like killing many birds with one stone. Technically, this is known as Co-generation.

Co-generation, also known as Combined Heat and Power (CHP), is the on-site production of multiple types of energy- usually electricity, heating and/or cooling- from a single source of fuel. Co-generation replaces the traditional methods of acquiring energy, such as:

1. Purchasing electricity from the power grid, like Karachi Electric (KE) or WAPDA.
2. Separately burning natural gas or oil in a furnace to produce heat or steam.
3. Using the resultant steam to produce air-conditioning through vapor absorption cycle.

The traditional method of purchasing electric energy from KE or WAPDA is very inefficient and wastes almost 75 percent of the energy in the original fuel due to production (generation) and transportation (transmission) losses. Typically the energy balance is as under:

1. Energy input- 100%
2. Energy wasted in generation- 60%
3. Energy wasted in transmission- 10 to 15%
4. Energy delivered as electrical output- 30%

On-site co-generation systems convert 70 percent to 90 percent of the energy in the fuel that is burned into useful electricity or heat.

Let's try to understand which power generation installations are the most suitable for co-generation. Almost any facility with a simultaneous need for both electric and thermal energy is a potential candidate for the energy saving benefits of co-generation- that is, on-site systems that produce both electric power and thermal energy from a single source of fuel. Ask yourself the following questions and if answers to all are "yes", then your facility may be a good candidate for a co-generation application.

1. Is the electrical load of your facility consistently greater than 1,000 kW?

Note: Facilities with larger energy needs can generate larger savings and have a shorter payback period.

2. Is the thermal load of your facility equal to 1 million Btu / hr or more?

(a) This could take the form of hot water, an absorption chiller load, low-pressure steam- or a combination of all three.

3. Is the duration of your simultaneous need for heating/cooling and electric power greater than 4,000 hours per year?

4. Is the cost of electricity significantly higher than cost of natural gas?

(a) Greater the differential between the price of electricity and the price of natural gas (equivalent Btu basis), greater the likelihood of savings.

5. Is the reliability of electric service a matter of concern?

(a) For many commercial and industrial facilities, a power outage can be very costly. On-site co-generation systems- when designed properly- offer significantly better reliability than local utilities. They are less vulnerable to vandalism and transformer or transmission line failures, and, with proper maintenance, will offer decades of reliable operation.

Sources of Heat:
The thermal energy contained in the exhaust gas and cooling systems generally represents 60 to 70 percent of the inlet fuel energy. Waste heat from engine is available in the following:

1. Engine exhaust
2. Jacket coolant
3. Lube oil cooler and
4. Turbocharger's intercooler and after-cooler (if so equipped).

Amount of heat recovered is in direct proportion to the:

1. Exhaust gas mass flow rate, exhaust temperatures and minimum temperature exhaust can be cooled down to.
2. Mass flow rate of cooling water in LT and HT circuits and maximum outlet temperatures achieved respectively from both.

It is important to note that:

- Heat in the engine jacket coolant accounts for up to 30 percent of the energy input and is capable of producing 90 to 95°C hot water.
- Engine exhaust heat carries 30 to 50 percent of the available waste heat. Exhaust temperatures of 450 to 650°C are usual.
- By recovering heat in the cooling systems and exhaust, approximately 70 to 80 percent of the fuel's energy can be effectively utilized to produce both power and useful thermal energy.
- Exhaust heat is typically used to generate hot water to about 100°C or low-pressure steam (up to 150 psig).
- Only a portion of the exhaust heat can be recovered since exhaust gas outlet temperatures are generally kept above a certain level (120 to 180°C) to prevent the corrosive effects of condensation in the exhaust piping.
- Exhaust heat recovery can be independent of the engine cooling system or coupled with it. For example, hot water from the engine cooling can be used as feed water or feed water pre-heat to the exhaust recovery unit. In a typical heating system, jacket cooling, lube oil cooling, single stage after-cooling and exhaust gas heat recovery are all integrated for steam production.

- Heat which is required to convert feed-water at 100°F (38°C) into steam at 150 psig (15 bar) is equal to 1128 BTU.
- Quantity of 100 to 150- psig steam which is required to produce one ton of refrigeration/air-conditioning is 10 lb (4.5 Kg).

It is due to the above reasons that Cummins gas generators are the most efficient for co-generation. This Total Efficiency is the hallmark of Cummins gas generators and the basis of Lowest Total Cost of Ownership! For more advice and information on co-generation, please contact us at customercare@eslpk.com.

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Gas Engine Powered
Generating Sets
315 kWe 50 Hz
331 kWe 60 Hz
QSK 19G Series Engines

Power Generation

Standard Genset Features

Single Source Responsibility
Design, manufacture and testing of engine, alternator, control system and complete generating set are all produced by companies within the Cummins Group

International Integrity
Assurance and strength of a worldwide major corporation backing the product

Global Backing
24 hour spares and service availability in 72 countries

Single Source Warranty
Total product guaranteed by Cummins Power Generation

Packaged Self-Contained Units
Integrated unit with built-in anti-vibration system, control panel, starting system and other accessories

Cummins Engine
- Heavy duty 4 cycle water cooled engine
- MCM700/SGM558 full authority electronic management
- Woodward PROACT actuator to drive throttle valve.
- CENSE engine monitoring system

Ready Filled
Every set comes filled with lube oil

Alternator
- Brushless Group-made machine
- Close voltage regulation
- Rotor and exciter impregnated with oil and acid resisting resin
- 12 lead reconnectable
- Exceptional short circuit capability
- Low waveform distortion with non linear loads

Ratings
All kW Power ratings based on a 32°C ambient temperature reference. Refer to factory for deration for temperatures above 32°C.

Chassis
Built-in anti-vibration system
Bonded rubber units fitted as standard eliminate need for rubber mats or spring mountings

PCC PowerCommand Control control system
- Microprocessor control
- Integrated voltage regulation
- Superior alternator and genset protection system
- Accurate battery monitoring system
- Totally reliable and proven system

Ratings									
50 Hz					60 Hz				
Model	kWe	kVA*	rpm	Pressure bar (G)	Model	kWe	kVA*	rpm	Pressure bar (G)
315 GFBA	315	394	1500	14	334 GFBA	334	417	1800	12.4

*@ 0.8pf

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Model - 575 GQHA
Frequency : 50 Hz
Fuel Type : Natural Gas MI 75+
Emissions Performance NOx : 500 mg/Nm³
LT water Inlet Temperature : 48°C (118°F)
HT water Outlet Temperature : 85°C (185°F)

Power Generation

Genset Outline	0500-4380

Fuel Consumption (ISO3046/1)	See note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW	2,4,6,7	1599	1450	1250	895
Mechanical Efficiency ISO3046/1, percent	2,4,7	37.65%	37.06%	36.17%	33.43%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	35.96%	35.47%	34.73%	32.02%

Engine	
Engine manufacturer	Cummins
Engine Model	QSK38G
Configuration	V12
Displacement, L (cu.in)	38 (2300)
Aspiration	Turbocharged (2)
Gross Engine Power Output, kWm (hp)	602 (807)
BMEP, bar (psi)	12.8 (185)
Bore, mm (in)	159 (6.25)
Stroke, mm (in)	159 (6.25)
Rated speed, rpm	1500
Piston Speed, m/s (ft/min)	7.95
Compression ratio	12:1
Lube oil Capacity, L (qt)	145 (1332)
Overspeed limit rpm	2375
Regenerative Power, kW	N/A
Full Load Lubricating Oil Consumptionm g/kWm-hr	0.15 g/kWm/hr
Fuel	
Min Gas Supply Pressure to Engine - barG (psiG)	0.35 (5)
Minimum Methane Index	75
Starting System	
Electric Starter Voltage, Volts	24
Minimum Battery Capacity @ 40₀ C	2 X 180 AH
Air Starter Pressure, barg (psig)	NA
Air Starter Flow Nm3/s (scfm)	NA
Genset Dimensions	
Genset length, mm	3900
Genset Width, mm	2100
Genset Height, mm	2250
Genset Weight (wet) kg	9700

ENERGY SOLUTIONS (PVT) LIMITED

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Model: C1160 N5C
Frequency: 50 Hz
Fuel Type: Natural Gas MI 73 +
Emissions Performance NOx: 500 Mg/Nm^3
LT Water Inlet Temperature: 50°C (122°F)
HT Water Outlet Temp: 95°C (203°F)

Generator set data sheet
1160 kW continuous

Our energy working for you.

Power Generation

Measured Sound Performance Data Sheet:	MSP-1008
Prototype Test Summary Data:	PTS-258
Remote Radiator Cooling Outline:	0500-5090

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	2985 (10.19)	2718 (9.28)	2312 (7.9)	1662 (5.68)
Mechanical Efficiency ISO3046/1, percent	2,4,7	40.1%	39.6%	38.9%	36.5%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	38.9%	38.4%	37.6%	34.9%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSK60G
Configuration	V16
Displacement, L (cu.in)	60.3 (3683)
Aspiration	Turbocharged (2)
Gross Engine Power Output, kWm (hp)	1196 (1603)
BMEP, bar (psi)	16.1 (233)
Bore, mm (in)	159 (6.26)
Stroke, mm (in)	190 (7.48)
Rated Speed, rpm	1500
Piston Speed, m/s (ft/min)	9.5 (1870)
Compression Ratio	11.4:1
Lube Oil Capacity, L (qt)	380 (401)
Overspeed Limit, rpm	2070
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.15 (0.11)
Fuel	
Gas supply pressure to engine inlet, bar (psi)	0.18 (2.61)
Minimum Methane Index	73
Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	450
Air Starter Pressure, barg (psig)	NA
Air Starter Flow Nm^3/s (scfm)	NA
Genset Dimensions (see note 1)	
Genset Length, m (ft)	5.00 (16.39)
Genset Width, m (ft)	2.33 (7.64)
Genset Height, m (ft)	2.97 (9.75)
Genset Weight (wet), kg (lbs)	13924 (30,697)

ENERGY SOLUTIONS (PVT) LIMITED

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Model: C1540 N5C
Frequency: 50 Hz
Fuel Type: Natural Gas MI 63 +
Emissions Performance NOx: 500 mg/Nm^3 (1.2 g/hp-h)
LT Water Inlet Temperature: 50°C (122°F)
HT Water Outlet Temp: 110°C (230°F)

Generator set data sheet
1540 kW continuous

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Cummins Power Generation

Measured Sound Performance Data Sheet:	MSP-1059
Prototype Test Summary Data:	PTS - 280
Remote Radiator Cooling Outline:	0500-5074

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	4094 (13.98)	3694 (12.62)	3149 (10.75)	2281 (7.79)
Mechanical Efficiency ISO3046/1, percent	2,4,7	38.7%	38.6%	37.8%	35.0%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	37.6%	37.5%	36.7%	33.8%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSV91G
Configuration	V18
Displacement, L (cu.in)	91.6 (5591)
Aspiration	Turbocharged (4)
Gross Engine Power Output, kWm (hp)	1586 (2126)
BMEP, bar (psi)	13.9 (202)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1500
Piston Speed, m/s (ft/min)	10 (1968)
Compression Ratio	11.4:1
Lube Oil Capacity, L (qt)	560 (592)
Overspeed Limit, rpm	1800
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.5 (0.38)
Fuel	
Gas supply pressure to engine inlet, bar (psi)	0.2 (3.0)
Minimum Methane Index	63
Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	720
Air Starter Pressure, barg (psig)	10.3 (150)
^{3}/s (scfm)	0.37 (780)
Genset Dimensions (see note 1)	
Genset Length, m (ft)	6.24 (20.48)
Genset Width, m (ft)	2.10 (76.89)
Genset Height, m (ft)	2.97 (9.75)
Genset Weight (wet), kg (lbs)	19337 (42,631)

ENERGY SOLUTIONS (PVT) LIMITED

www.eslpk.com | 111-222-ESL (375) | www.power.cummins.com

Model: C1750 N5C
Frequency: 50 Hz
Fuel Type: Natural Gas MI 67 +
Emissions Performance NOx: 500 mg/Nm^3 (1.2 g/hp-h)
LT Water Inlet Temperature: 50°C (122°F)
HT Water Outlet Temp: 95°C (203°F)

Generator set data sheet
1750 kW continuous

Our energy working for you.

Cummins Power Generation

Measured Sound Performance Data Sheet:	MSP - 1058
Prototype Test Summary Data:	PTS - 281
Remote Radiator Cooling Outline:	0500-5074

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	4602 (15.72)	4151 (14.18)	3541 (12.09)	2527 (8.63)
Mechanical Efficiency ISO3046/1, percent	2,4,7	39.2%	39.1%	38.1%	35.8%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	38.0%	37.9%	37.1%	34.6%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSV91G
Configuration	V18
Displacement, L (cu.in)	91.6 (5591)
Aspiration	Turbocharged (4)
Gross Engine Power Output, kWm (hp)	1802 (2416)
BMEP, bar (psi)	16 (232)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1500
Piston Speed, m/s (ft/min)	10 (1968)
Compression Ratio	11.4:1
Lube Oil Capacity, L (qt)	560 (592)
Overspeed Limit, rpm	1800
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.5 (0.37)

Fuel	
Gas supply pressure to engine inlet, bar (psi)[7]	0.2 (2.9)
Minimum Methane Index	67

Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	720
Air Starter Pressure, barg (psig)	10.3 (150)
Air Starter Flow Nm^3/s (scfm)	0.37 (780)

Genset Dimensions (see note 1)	
Genset Length, m (ft)	6.31 (20.68)
Genset Width, m (ft)	2.10 (6.91)
Genset Height, m (ft)	2.97 (9.75)
Genset Weight (wet), kg (lbs)	21017 (46,334)

ENERGY SOLUTIONS (PVT) LIMITED

www.eslpk.com | 111-222-ESL (375) | www.power.cummins.com

Model: C2000 N5C
Frequency: 50 Hz
Fuel Type: Natural Gas MI 73 +
Emissions Performance NOx: 500 mg/Nm^3 (1.0 g/hp-h)
LT Water Inlet Temperature: 40°C (104°F)
HT Water Outlet Temp: 92°C (198°F)

Generator set data sheet
2000 kW continuous

Our energy working for you.

Cummins Power Generation

Measured Sound Performance Data Sheet:	MSP-1039
Prototype Test Summary Data:	PTS-269
Remote Radiator Cooling Outline:	0500-5095

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	4900 (16.73)	4478 (15.29)	3806 (13)	2744 (9.37)
Mechanical Efficiency ISO3046/1, percent	2,4,7	42.2%	41.5%	40.8%	37.9%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	40.8%	40.2%	39.4%	36.4%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSV91G
Configuration	V18
Displacement, L (cu.in)	91.6 (5591)
Aspiration	Turbocharged (1)
Gross Engine Power Output, kWm (hp)	2066 (2769)
BMEP, bar (psi)	18.3 (265)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1500
Piston Speed, m/s (ft/min)	10 (1968
Compression Ratio	12.5
Lube Oil Capacity, L (qt)	550 (581)
Overspeed Limit, rpm	1800
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.4 (0.3)
Fuel	
Gas supply pressure to engine inlet, bar (psi)[7]	0.2 (2.9)
Minimum Methane Index	73
Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	780
Air Starter Pressure, barg (psig)	10.3 (150)
Air Starter Flow Nm^3/s (scfm)	0.37 (780)
Genset Dimensions (see note 1)	
Genset Length, m (ft)	6.07 (19.9)
Genset Width, m (ft)	2.16 (7.1)
Genset Height, m (ft)	2.78 (9.1)
Genset Weight (wet), kg (lbs)	20477 (45,144)

ENERGY SOLUTIONS (PVT) LIMITED

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Gas Population List of Pakistan

S. No.	Customer Name	Model	Capacity	Location	Installation Year
1	Aga Khan University Hospital	C1540 N5C	1540 KW	Karachi	2011
2	Aga Khan University Hospital	C1540 N5C	1540 KW	Karachi	2005
3	Aga Khan University Hospital	C1750 N5C	1750 KW	Karachi	2003
4	Atlas Engineering Pvt. Ltd.	C1540 N5C	1540 KW	Karachi	2005
5	ATS Synthetic Pvt. Ltd.	C1540 N5C	1540 KW	Lahore	2011
6	ATS Synthetic Pvt. Ltd.	C1540 N5C	1540 KW	Lahore	2011
7	ATS Synthetic Pvt. Ltd.	C1540 N5C	1540 KW	Lahore	2005
8	ATS Synthetic Pvt. Ltd.	C1540 N5C	1540 KW	Lahore	2005
9	ATS Synthetic Pvt. Ltd.	C1540 N5C	1540 KW	Lahore	2005
10	Ayesha Textile Mills Ltd.	C1540 N5C	1540 KW	Lahore	2004
11	Ayesha Textile Mills Ltd.	C1540 N5C	1540 KW	Lahore	2004
12	Ayesha Textile Mills Ltd.	C1540 N5C	1540 KW	Lahore	2004
13	Ayesha Textile Mills Ltd.	C1540 N5C	1540 KW	Lahore	2004
14	Engro Foods Ltd.	C1540 N5C	1540 KW	Sahiwal	2012
15	Engro Foods Ltd.	C1540 N5C	1540 KW	Sahiwal	2011
16	Haleeb Foods Pvt. Ltd.	C1540 N5C	1540 KW	Lahore	2005
17	Millac Pvt. Ltd.	C315	315 KW	Karachi	2009
18	Pakistan Atomic Energy Commission	C1160 N5C	1160 KW	Islamabad	2005
19	Pakistan Atomic Energy Commission	C1160 N5C	1160 KW	Islamabad	2005
20	Pakistan Atomic Energy Commission	C1160 N5C	1160 KW	Islamabad	2005
21	Pakistan Petroleum Ltd.	C1540 N5C	1540 KW	Kandhkot	2010
22	Pakistan Petroleum Ltd.	C1540 N5C	1540 KW	Kandhkot	2010
23	Pakistan Petroleum Ltd.	C1540 N5C	1540 KW	Kandhkot	2010
24	Philips Electrical Industires of Pakistan	C315	315 KW	Karachi	2004
25	Philips Electrical Industires of Pakistan	C315	315 KW	Karachi	2004
26	Philips Electrical Industires of Pakistan	C315	315 KW	Karachi	2004
27	Philips Electrical Industires of Pakistan	C315	315 KW	Karachi	2004
28	Shahtaj Textile Ltd.	C1750 N5C	1750 KW	Lahore	2011
29	Shahtaj Textile Ltd.	C1750 N5C	1750 KW	Lahore	2011
30	Shaukat Khanum Memorial Hospital	C1370 N5C	1370 KW	Lahore	2005
31	Sui Southern Gas Pipelines Ltd.	C315	315 KW	Faisalabad	2011
32	University of Engineering & Technology	C1160 N5C	1160 KW	Lahore	2008
33	University of Engineering & Technology	C1160 N5C	1160 KW	Lahore	2005
34	University of Engineering & Technology	C1160 N5C	1160 KW	Lahore	2005

Cummins Gas Project Gallery:

1. Aga Khan University Hospital (AKUH):

Aga Khan University Hospital has three Cummins gas generators of 2 x 1540 kW and 1 x 1750 kW at 11kV operating on 24 by seven basis round the year. Two of these generators were installed in the year 2003. Since then these generators are proving their mettle and providing uninterrupted power to the university & hospital. Satisfied with the performance of the first two and the support provided directly by Cummins ESB, UK, the hospital opted for the third generator in 2011. The first two generators exceeded 60,000 hours of operation before going for an overhaul and are a telltale demonstration of the reliability and ruggedness of Cummins gas products.

2. ATS Synthetic Private Limited:

Cummins ESB is proud to be associated with ATS Synthetic for many years. ATS Synthetic is one of the largest synthetic plants in the country. It has continued to show its confidence in ESL services and Cummins gas products and has placed another order for 2 x 1540 KW @ 11,000 Volts Cummins Power Generation Gas gensets. These gensets are continuously subjected to very high torques. The first three sets have exceeded 60,000 hours of operations and their performance is a clear manifestation of Cummins high reliability, durability and lowest total cost of operations. The total number of Cummins gas generators operating at this facility is now five and a telltale demonstration of the usefulness of Cummins gas solutions.

3. Public Sector Organization:

Cummins has installed 3 x 1MW gas generators at a public sector organization. These generators have been installed underground with long and torturous ducts for air induction and extraction of engine exhaust. The air induction and exhaust systems have been designed in such a way that the engine is neither derated nor suffers from high exhaust temperatures. Large and properly designed air extraction system keeps the plant room cool and comfortable.

Furthermore, a clean and tidy soundproofing of the entire power plant has also been carried out. This has been accomplished through installation of acoustic louvers and critical silencers. The entire design and installation was carried out under the supervision of ESL Director Technical. ESL has been maintaining these sets since its inception.

4. Shahtaj Textile Limited:

Shahtaj Textile Limited (a Shahnawaz Group Company) opted for Cummins gas generators mainly on account of its ability to start large compressor motors. The customer carried out an in-depth analysis of all contemporary products prior to a purchase decision and selected Cummins because it promised to handle its large block loads (almost as efficiently and smoothly as diesel generators can do). Cummins has lived up to its reputation. This site is an ideal demonstration of Cummins single-step-load acceptance (torque load) capability.

Cummins values its association with Shahtaj Textile (Shahnawaz Group)- one of the finest weaving plants and promises maximum support to this customer.

ESL also considers Shahtaj project as a flagship project for the entire textile industry. These generators are a telltale demonstration of Cummins Energy Solutions in terms of no or very low deration, operations at low gas pressures, ability to handle compressor motors of 600 kW, steam generation from exhaust heat and low total cost of operations.

5. Shaukhat Khanam Hospital, Lahore

Cummins Energy Solutions supplied 1 x 1370 kW Cummins Gas generator to Shaukat Khanum Hospital. ESL is maintaining this set since its inception. It has also synchronized this generator with other diesel and gas generators of various makes, models and manufacturers.

Cummins gas generator has completed ten years of installation in the hospital and has fully proved its worth to handle mission critical requirements of the hospital on a 24 by seven basis. The total cost of ownership of this generator is also low and comparable to best in class performance. According to hospital authorities, the generator has paid itself back many times over. Ability to handle large block loads is an additional feature.

6. University Of Engineering & Technology (UET), Lahore

There can't be a better place to exhibit and express your high-tech equipment than an Engineering University.

University of Engineering & Technology (UET) has three 1.14 MW @ 11kV Cummins Gas gensets to provide the campus, libraries and hostels uninterrupted power on 24 by seven basis. These sets are fully maintained by ESL in addition to a number of diesel gensets supplied by the company. ESL has also synchronized 4 x 500 kVA diesel genset @ 400V with 3 x 1.14 MW Cummins Gas genset of 11kV after stepping up diesel genset voltage from 400V to 11kV. This is also another example of a customer who started with one Cummins gas generator and gradually increased the fleet to three- surely a manifestation of confidence in Cummins product quality.

2014

January

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

February

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

March

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

April

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

May

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

June

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

July

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

August

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

October

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

November

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

December

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

2015

January

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

February

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

March

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

April

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

May

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

June

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

July

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

August

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

September

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

October

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

November

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

December

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

2016

January

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

February

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					

March

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

April

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

May

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

October

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

November

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

December

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

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