DESIGNED FOR EXTREMES TO POWER YOUR WORLD.

HSK78G

Gas Generator Series

Presenter: Fernando Pinzon & Andy Kitchen

Date: 5th April 2019

Time: 15:30-16:00

AGENDA

- The Power of Cummins
- Global Manufacturing & Distribution Footprint
- European Market Requirements & Overview
- HSK78G Model Coverage
- Development Focus
- Engine Features & Components
- Generator Set Components
- Key Product Features
- Global Service Capability

THE POWER OF CUMMINS

Our Story

WHY WE EXIST

OUR MISSION

Making people's lives better by powering a more prosperous world

WHAT WE WANT TO ACCOMPLISH

OUR VISION

Innovating for our customers to power their success

190
Countries & territories

62,610
Global employees

1.5M+
Engines built in 2018

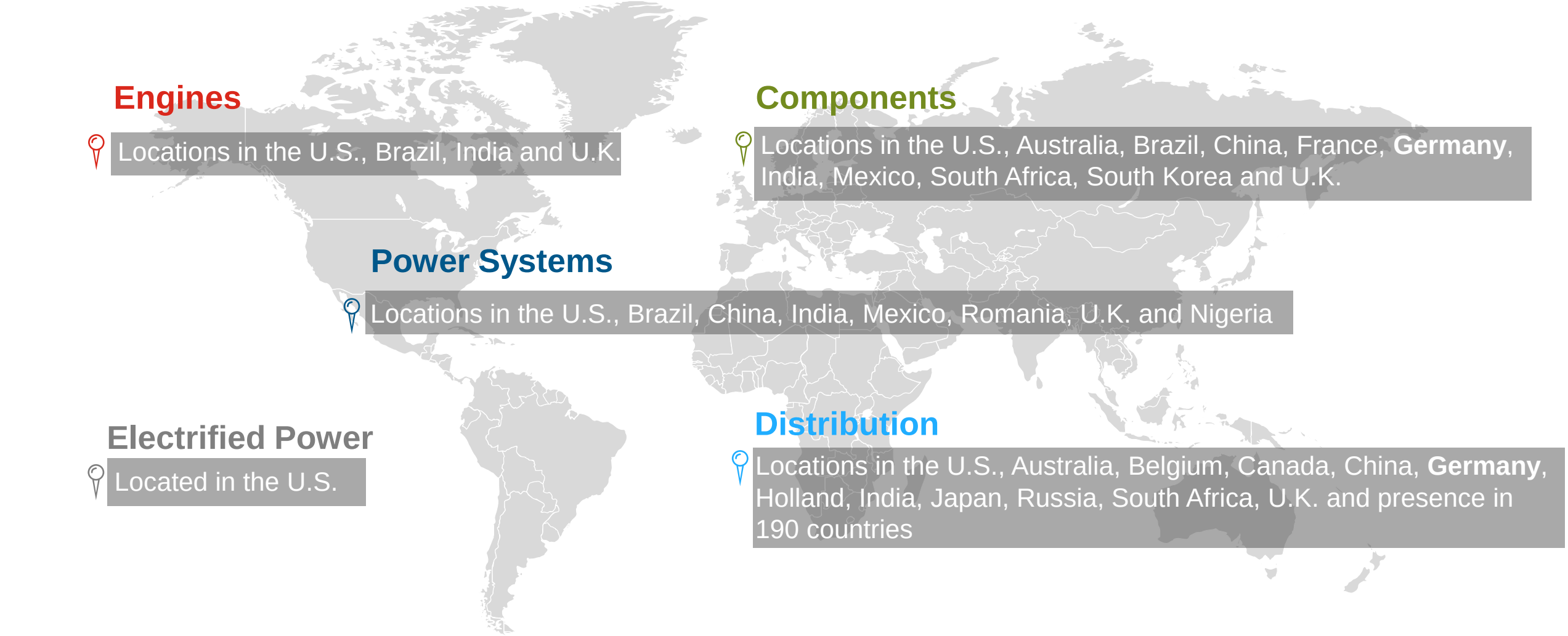
8,000
Wholly-owned & independent distributor & dealer locations

$894M
Invested in research & development in 2018

100
Years of industry leadership

2018 Sales: $23.8B
2018 EBITDA: $3.5B
2018 EBITDA%: 14.6%

GLOBAL MANUFACTURING & DISTRIBUTION FOOTPRINT



Engines

Locations in the U.S., Brazil, India and U.K.

Components

Locations in the U.S., Australia, Brazil, China, France, **Germany**, India, Mexico, South Africa, South Korea and U.K.

Power Systems

Locations in the U.S., Brazil, China, India, Mexico, Romania, U.K. and Nigeria

Electrified Power

Located in the U.S.

Distribution

Locations in the U.S., Australia, Belgium, Canada, China, **Germany**, Holland, India, Japan, Russia, South Africa, U.K. and presence in 190 countries

**For the EBU, CBU, PSBU and EPBU, this list reflects only the principal manufacturing facilities. Engines and engine components are manufactured by joint ventures or independent licensees at plants in the US, China, India, Russia, Japan, Sweden and Mexico. For the DBU, list reflects principal distribution facilities that serve all segments.*

EUROPEAN MARKET REQUIREMENTS

Cogeneration

The recovery of the waste heat the lean burn generator already produces for heating buildings and water and to create steam.

Trigeneration

Thermal energy streams generated by the heat recovery system produce chilled water by linking absorption chillers to the cogeneration process. Used to improve energy efficiency and reduce operating costs.

Prime/Continuous Power

Maximum power a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year.

Peaking Power

Generator set applied in various modes of operation to supplement utility. Supplied a continuous constant base power for a limited time while the utility provides the power for the remaining load

Grid Parallel

OR

Island Mode

EUROPEAN MARKET OVERVIEW

Commercial and Institutional

Airports | Universities | Hospitals
Prison Bases | Shopping Malls

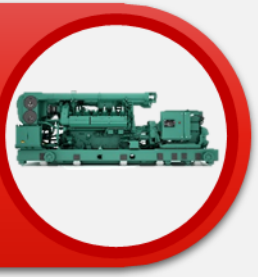
Utility

Landfills | WWTP | Grid Firming
Anaerobic Digesters | IPP

Industrial

Mining | Manufacturing | Oil & Gas
Greenhouse & Agriculture

HSK78G MODEL COVERAGE



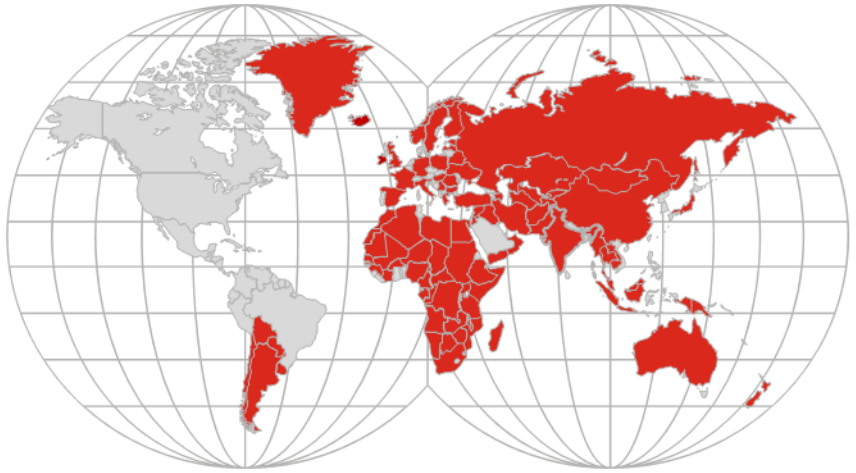


Image displays countries that adopt 50Hz frequency

50Hz Model	Continuous Rating	Pipeline Base Fuel Rating	Low BTU Fuel Rating	Low MN Fuel Rating
C2000N5CD	2MWe	•	•	
C1800N5CD	1.8MWe	•	•	
C1600N5CD	1.6MWe	•	•	•

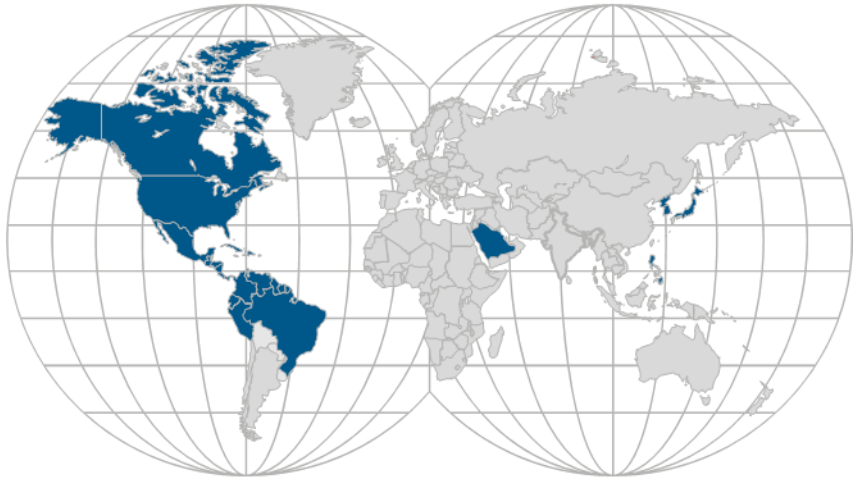
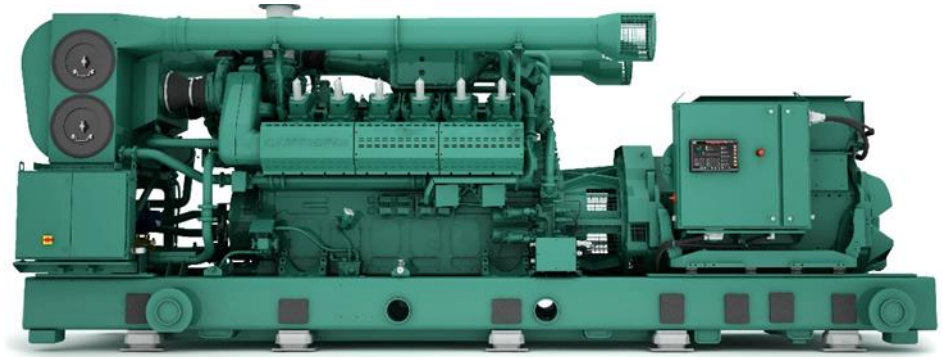


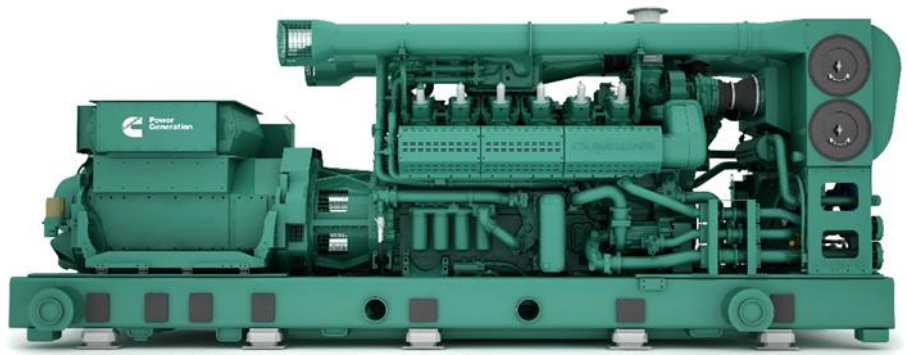
Image displays countries that adopt 60Hz frequency

60Hz Model	Power Output	Pipeline Base Fuel Rating	Low BTU Fuel Rating	Low MN Fuel Rating
C2000N6CD	2MWe	•	•	
C1800N6CD	1.8MWe	•	•	
C1600N6CD	1.6MWe	•	•	•

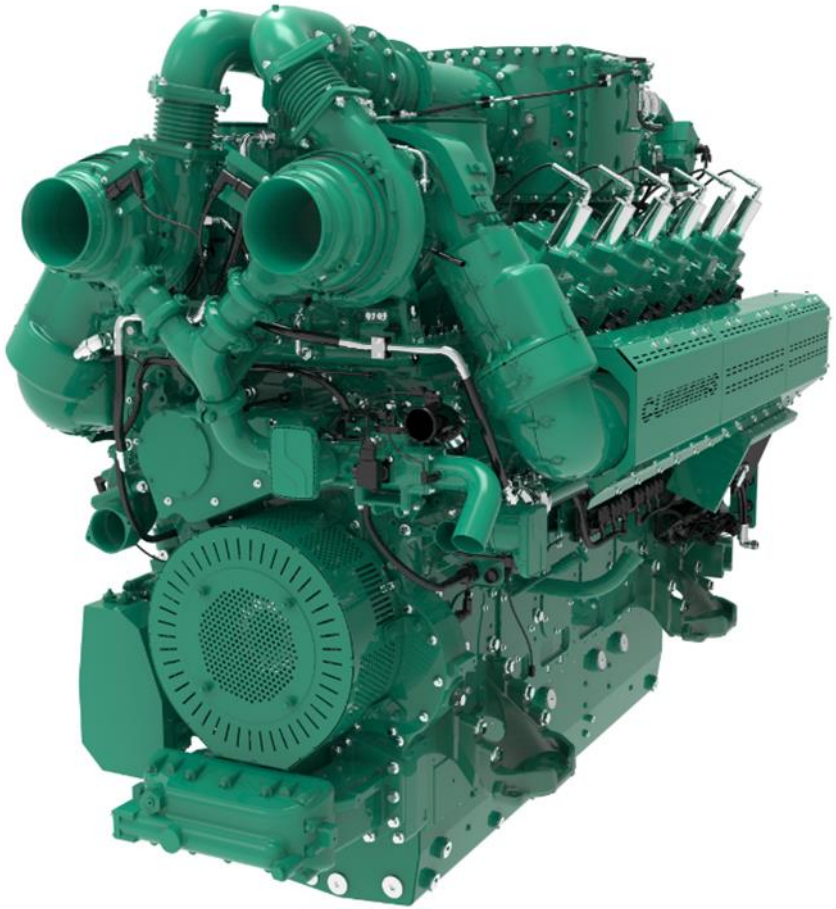
HSK78G DEVELOPMENT FOCUS

- Power Density
- Fuel Flexibility
- High Efficiency
- Extreme Environment Capability
- Transient Response
- Low Emissions
- Designed for Compliance
- Ease of Serviceability
- Compact Package Size
- Advanced Controls





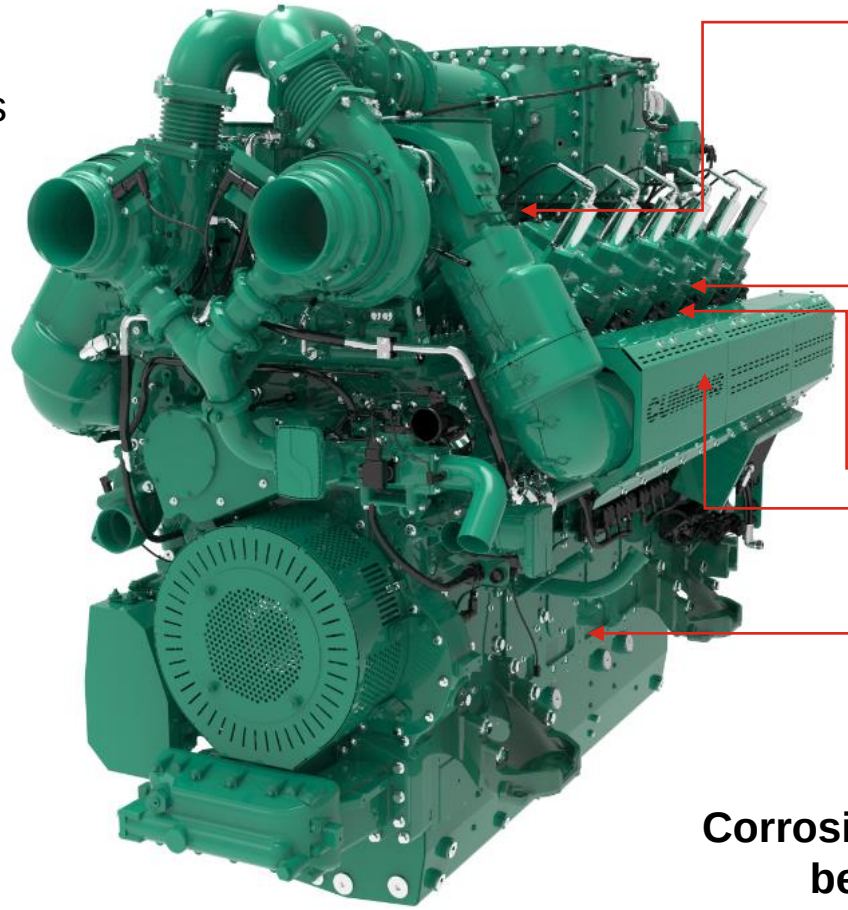
HSK78G ENGINE FEATURES



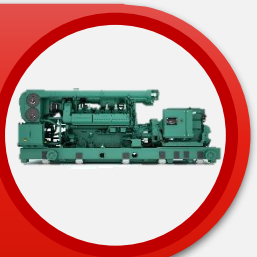
- **12 cylinder; 78L**
- **Standard Compression ratio**: 13:1
- **Emissions options**:
  - 250 mg/Nm3 (0.5 g/hp-hr) NOx
  - 500 mg/Nm3 (1.0 g/hp-hr) NOx
- **Engine speed**: 1500RPM
- **Gas pressure**:
  - 2 psi (150mbar) Minimum at FSOV
  - Fuel dependent
- **Cummins CM2358 electronic engine controller**

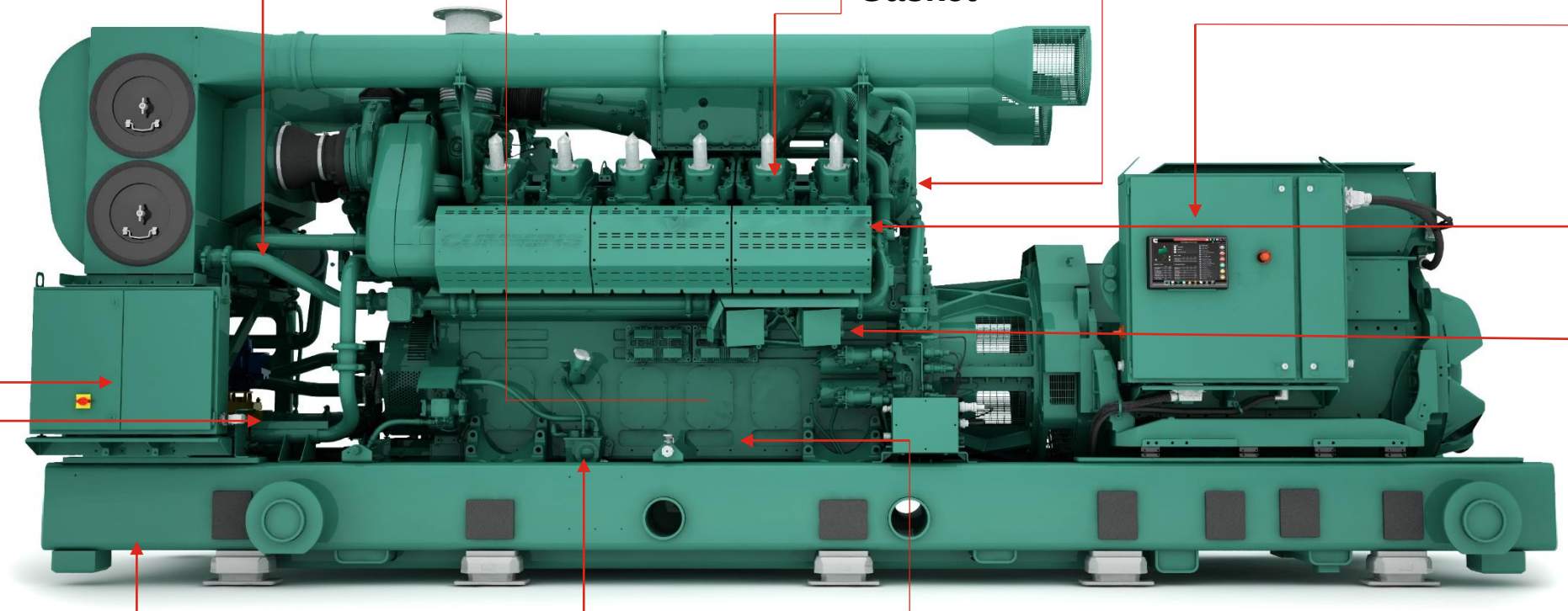
HSK78G ENGINE COMPONENTS

- Target 40K/80K hour service intervals
- Hydraulically tensioned cylinder head and main bearing fasteners
- Competitive stroke to bore ratio
- Robust cylinder spacing, design protected for V20

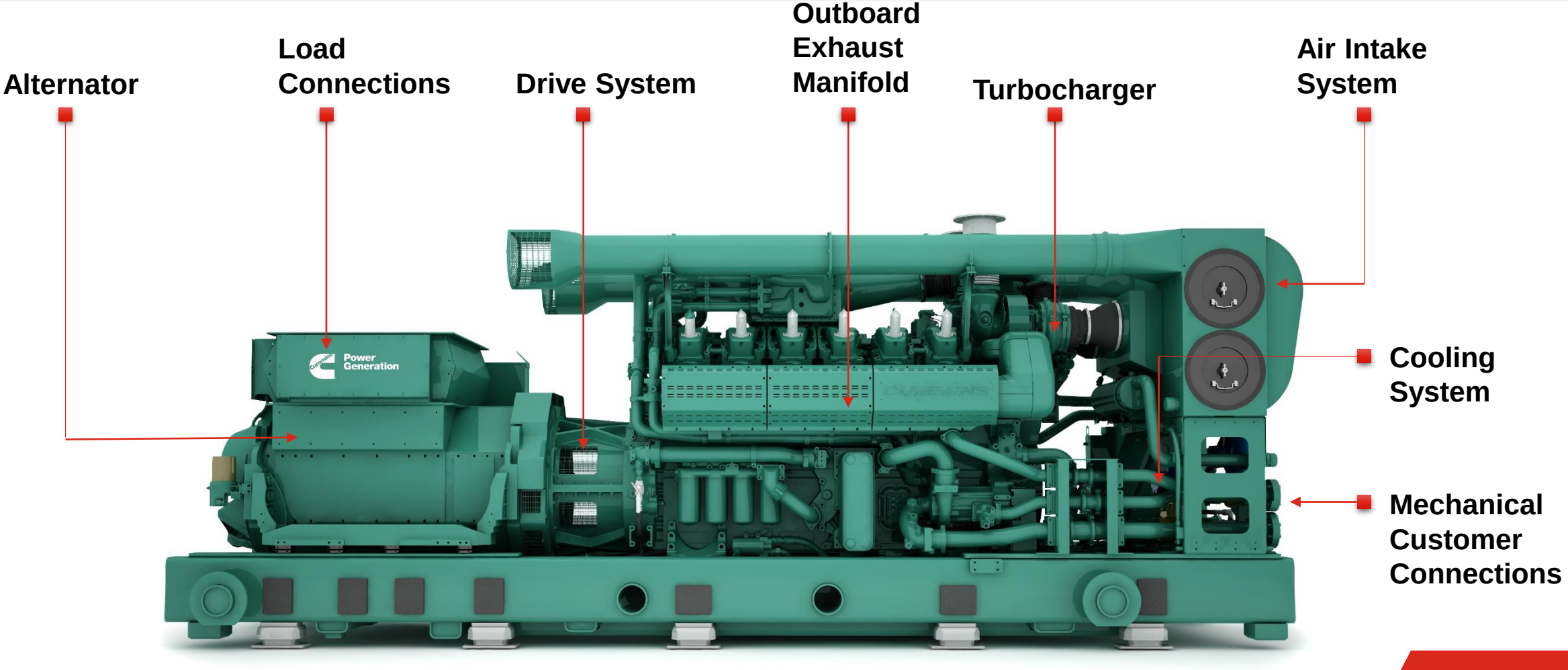


HSK78G GENERATOR SET COMPONENTS

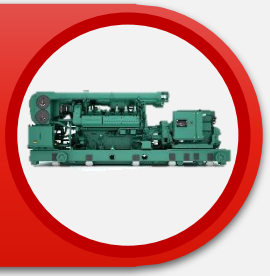




HSK78G GENERATOR SET COMPONENTS



HSK78G KEY PRODUCT FEATURES



- High Efficiency
- Low NOx Emissions
- Cogeneration
- Fuel Flexibility
- Advanced Control Systems
- Transient Performance
- Compliance
- Serviceability

HIGH EFFICIENCY

Pipeline NG	*50 Hz, 2000 kWe* Standard Turbo		*50 Hz, 2000 kWe* High Ambient Turbo		*60 Hz, 2000 kWe* Standard Turbo		*60 Hz, 2000 kWe* High Ambient Turbo	
	500 mg/Nm³	250 mg/Nm³	500 mg/Nm³	250 mg/Nm³	1.0 g/hp-hr	0.5 g/hp-hr	1.0 g/hp-hr	0.5 g/hp-hr
Electrical Efficiency	**44.2**	43.2	43.8	42.3	**43.5**	42.6	43.1	42.0
Thermal Efficiency	**45.9**	46.6	46.3	47.1	**45.4**	46.2	45.9	46.6
Total Efficiency	90.1	89.8	90.1	89.4	88.9	88.8	89.0	88.6

44.2% (50 Hz)

43.5% (60 Hz)

down to **70** MN

Low Fuel Costs

ISO Standards Compliance

LOW NOx EMISSIONS

Emissions Requirements	Pipeline Natural Gas
Germany TA Luft Stationary	NOx/CO/VOC (mg/Nm³) 500/300/ -
EU Regional Minimum Stringency from Dec 2018, Medium Combustion Plant Directive (MCP)	NOx/SO2/Dust @5% O_2 (mg/Nm³) 253/ - / -

Factory Offerings for 500 and 250 mg/Nm³ NOx

No need for Selective Catalytic Reduction (SCR) that increases CapEx and OpEx

COGENERATION SOLUTION

Metric	50Hz HSK78G Base Rating	60Hz HSK78G Base Rating
Power	2000 kWe	2000 kWe
ISO Electrical Efficiency (ISO3046, 50Hz, 500mg NOx, 70 MN)	44.2%	43.5%
Thermal Efficiency	45.9%	45.4%
Thermal Output	**2077 kWth**	**2087 kWth**

- Heating, Cooling & Steam Generation
- Low Energy Costs in the Long Term
- No Electricity Price Increases
- Significant Environmental Benefits

FUEL FLEXIBILITY

Flexible Fuel System

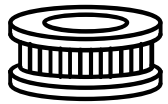
- Flare gas and other low MN fuels down to 40MN
- Biogas fuels (400 BTU/scf [15.7 MJ/Nm^3]) without derate
- Ultra-low BTU fuels down to 273 BTU/scf without derate
- Contaminant level capability on very aggressive fuels
- Coal Mine Methane (30% methane & air, 273 BTU/scf min LHV)

Fuel Variation

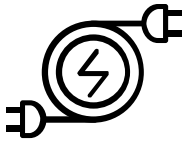
- CH4 variation: 30-95 vol%
- CH4 variation per minute: 10 vol%
- Variation exceeding above will require methane feedforward feature

Good Uptime & Operational Costs Avoidance

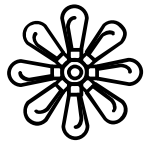
ADVANCED CONTROL SYSTEMS



Individual cylinder knock and exhaust port temperature sensing that allows real-time indication of engine knock and excessive exhaust gas temperatures



Spark plug voltage sensor sending spark breakdown voltage feedback and monitoring the life of the spark plug to diagnose ignition failures related to the spark plug or ignition coil



Alternator bearing detect potential onset of bearing and winding failure

NOx sensor embedded in the control algorithm to directly measure and control NOx, ensuring emissions compliance

Data life logging and trending on control Human Machine Interface (HMI) panel

TRANSIENT PERFORMANCE

ISO8528 G1 Recovery Time With 4 Steps To Full Load

- 586kW first step (29.3%) at G1
- Frequency and voltage dip and recovery times are in line with G1 for lower load steps

Frequency Regulation

- Steady state = isochronous
- Random = +/- 0.25% maximum

Discrete Voltage Regulation: +/- 0.5% Maximum

- 100% Load Rejection Without Tripping

Over Speed

- 20 seconds required to get back to stable frequency

Start To ‘Ready To Load’ Time Of 30 Seconds

HSK78G ENGINE CONTROL FEATURES

Combustion Control

- Fuel flexibility, improved BTE and reduced Knock

NOx Control

- Improved BTE and NOx management

Flex Fuel Control

- Improved system commissioning

Air (Charge) Handling

- Improved transient response and speed governing

HSK78G ENGINE CONTROL FEATURES

Condensation Management

- Improved durability

Analysis Led Controls Development

- Efficient development process and troubleshooting

Telematics Capable Core 2 Software

- Remote monitoring

Two Derate Options

- Requested derate
- Self-derate caused by heavy knock

COMPLIANCE

50Hz

AUSTRALIA

- Compliant with the following Codes
  - Electrical Code, AS/NZS 3000
  - Fuel Code, AS/NZS 3814
  - Standby Code, AS/NZS 3009

EU AND ASIA

- CE Marked
- EU Grid Code Compliant and Certified

RUSSIA

- EAC Marked – Russian Customs Union

NIGERIA

- SONCAP

SERVICEABILITY

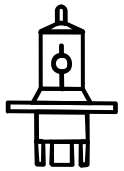
2,000 hrs – minimum interval

40,000 hrs – mid-life overhaul

80,000 hrs – full overhaul

$ **Faster return on investment, keeping operation and maintenance costs low**

SERVICEABILITY



Easy engine air filter inspection and replacement

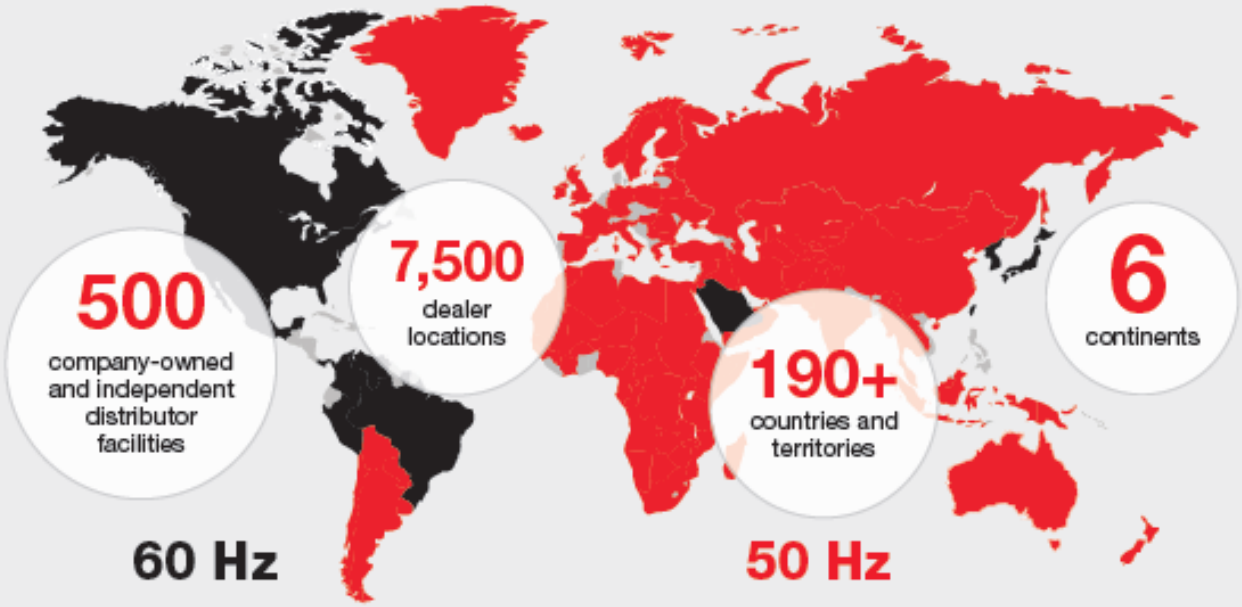
Long life re-gapable spark plugs, 6000 hours life with 2000 hours re-gap on pipeline natural gas

Top end service improvements

Corrosion resistant bearings allowing for 20k/40k hours top and bottom end change intervals on very aggressive fuels

Auto lubrication (re-greasing) as standard on alternator

TAKING SERVICE AND SUPPORT TO EXTREMES.



ENGINEERED TO WORK, NO MATTER THE CONDITIONS YOU FACE.

HSK78G

Q+A


Cummins