






# Waukesha Tech Update

February 2017

# GE's Distributed Power business

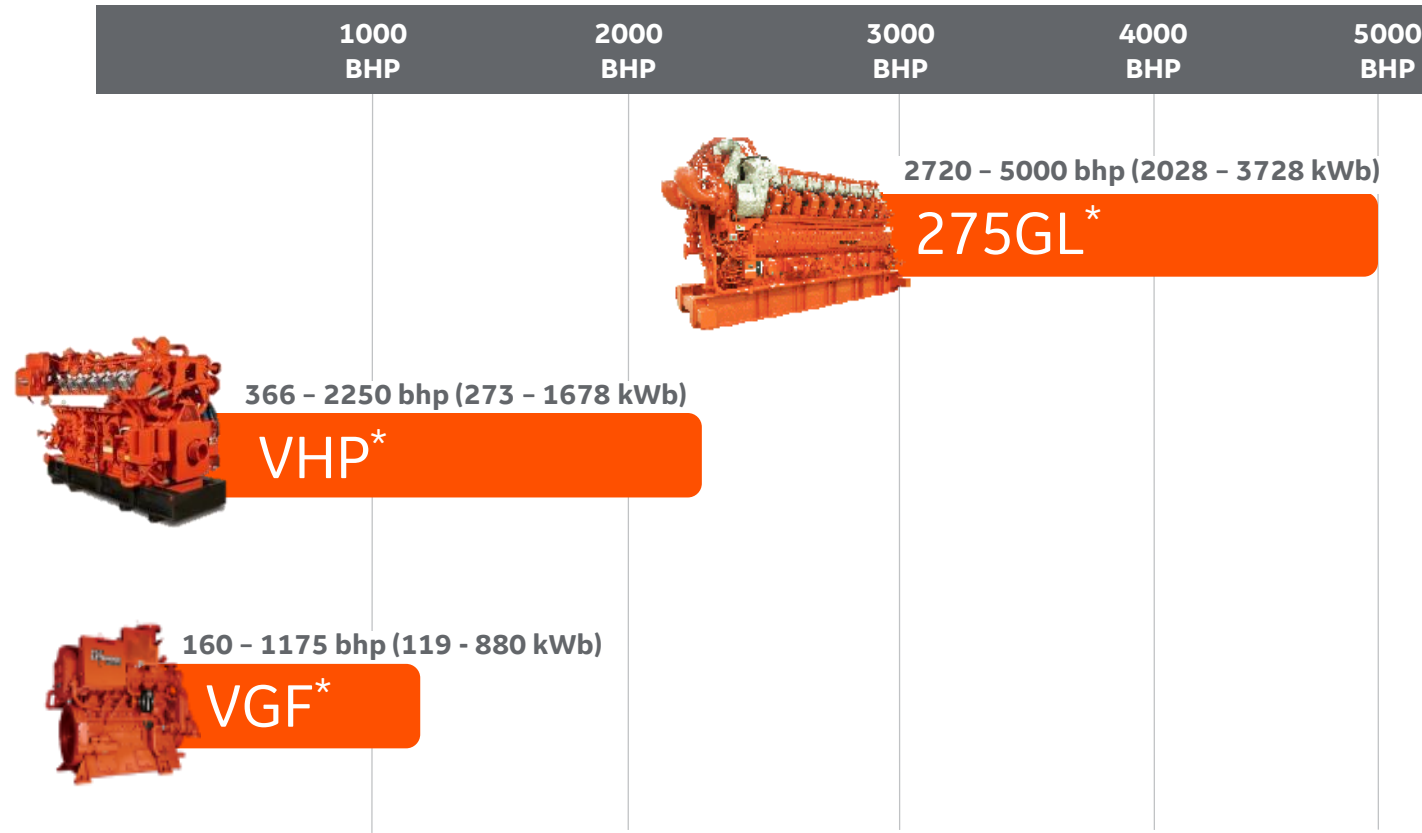
	Jenbacher Gas Engines	Waukesha Gas Engines	Stationary Diesel Engines
<b>Technology</b>	 Gas engines (0.3-10 MW)	 Gas engines (0.2-3.6 MW)	 616 Diesel engine (2.6-2.8 MW)
<b>Target Segments</b>	✓ Power Gen	✓ Oil & Gas ✓ Power Gen	✓ Power Gen
<b>Benefits</b>	<ul style="list-style-type: none"><li>• Electrical efficiency</li><li>• High total efficiency</li><li>• Application diversity</li><li>• Fuel flexibility</li><li>• Advanced monitoring and diagnostics</li></ul>	<ul style="list-style-type: none"><li>• Hot/high BTU fuels capability</li><li>• High altitude and ambient capability</li><li>• Fast load acceptance</li><li>• Durability/reliability</li></ul>	<ul style="list-style-type: none"><li>• Maintenance friendly engine design</li><li>• High fuel efficiency</li><li>• Solution flexibility</li><li>• High degree of availability (up to 99%)</li></ul>

**The broadest gas-fired portfolio ... 220 kW to 10.4 MW**



# Waukesha Product Portfolio

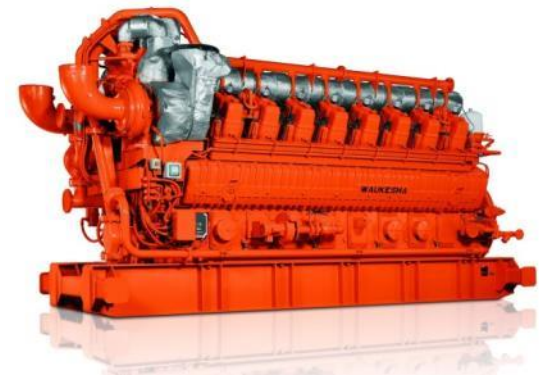
Waukesha gas engines' comprehensive product portfolio offers multiple configurations available in both lean-burn and rich-burn combustion systems to meet specific application requirements.



\*Trademark of General Electric Company



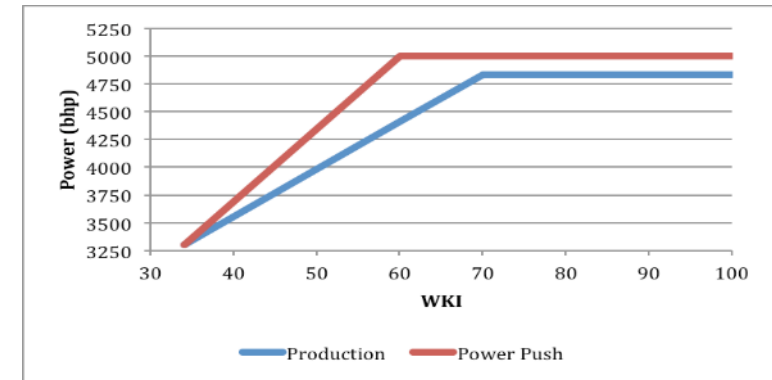
# 275GL+ Product Improvements



## Performance improvement

		12V	16V
Power (bhp)		3,750	5,000
BSFC (BTU/bhp-hr)		6,494	6,499 – 6,550
Start of derate	Altitude (ft. @ 100F)	3,500	3,000
	Fuel quality (WKI - BTU/ft <sup>3</sup> )	70	60
Fuel flexibility	BTU range (BTU/ft <sup>3</sup> )	600 – 2,300	600 – 2,300
Emissions	NO <sub>x</sub> (g/hp-hr)	0.5	0.5
	CO (g/hp-hr)	1.7	1.6
	HC (g/hp-hr)	6.0	5.60

## Fuel flexibility improvement



• 16V275GL+ curve shown

## New power vs. altitude/temp. map

Inlet Air Temp (°F)	Altitude (ft)					
	2,000	3,000	4,000	5,000	6,000	7,000
60	100	100	98.5	93.9	90.2	87.2
80	100	100	96.6	92.8	89.7	86.8
100	100	100	96.5	93	89.2	85.3
110	100	99.7	95.4	91.2	87.4	83.7
120	100	98.7	95	90.9	85.9	81
130	100	97.4	93.3	88.8	84	79.2

• 16V275GL+ table shown



# The new VGF F18SE and H24SE

## New controls suite for VGF

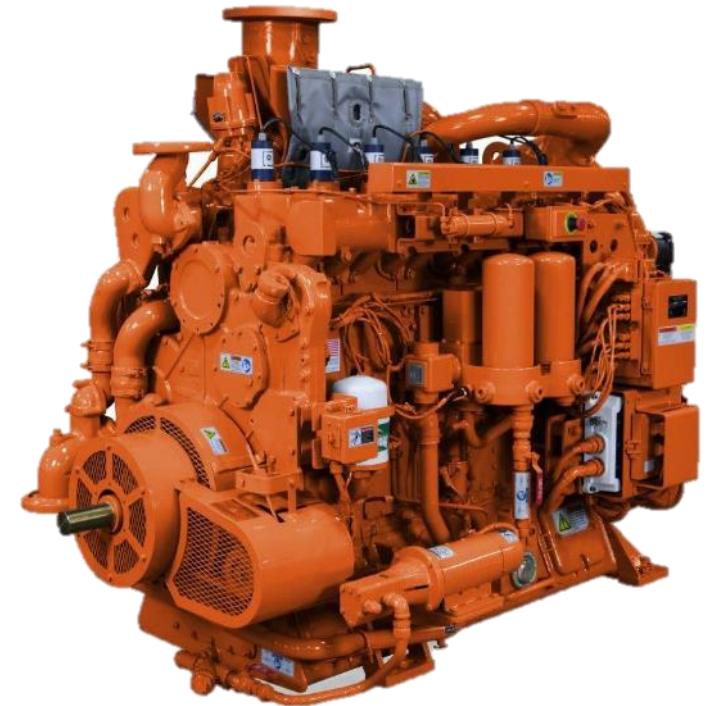
- Application of proven ESM controls
- Use of emPact AFR w/ GE-branded TWC availability for 0.15 & 0.5 gr/BHP-hr NOx capability from the OEM – lowest on the market

## Product Enhancements

- Dual-fuel autoswitching capability for both field gas and propane operation
- OFPG genset with new ECP, TWC, silencer, tail-boarding skid, & radiator
- Controls, AFR2, cylinder heads, oil cooler, oil filtration, crankcase breather –shared technology from other engines

## Mobile capability & emissions cert.

- EPA mobile & stationary certification
- Fuels from 850-2350 Btu/scft and from 1400-1800RPM for mobile compression



**Most technically advanced controls & robust design in its class...competing against truck engines...poised for growth in new markets!**



# ESM2 System

Available on VHP F3514GSI, F3524GSI, L5794GSI, L7042GSI S4 and L7044GSI

## Engine Control Unit

- New ECU, additional functionality
- Incorporates AFR2 functionality in single ECU
- Smaller packaging, new location



## Hardware Updates

- New Power Distribution Box (PDB)
  - Improved diagnostics communication
- Smart Thermocouple Unit (STU)
  - CAN thermocouple interface to ESM2
- APM Analytics w/MyPlant integration

## Additional Performance Monitoring

- Additional engine protection incorporated:
  - Crankcase pressure
  - Exhaust port temperatures
  - Main bearing temperatures
  - Oil filter differential pressure (pre filter added)
- Boost pressure sensors
  - throttle reserve monitored

## Customer Interface

- Standard HMI
  - 12" Touchscreen (15" & 19" Options)
  - Multiple screens for operators
  - Integrated Diagnostics
    - Data logging
    - Fault history
    - Troubleshooting (E-Help)
    - O&M Manual
- ECU Calibration & Code updates
  - remote download capability through laptop interface



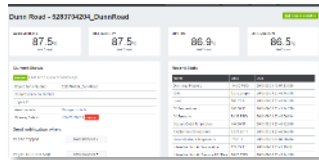
# Asset Performance Management suite

Standard with 275GL+ and VHP - Optional with VGF-SE

## Machine & Equipment Health system

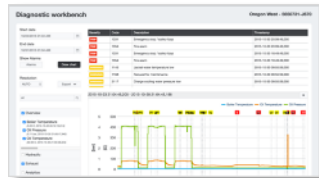
## Add-on advanced analytics

### Asset status dashboards



- Reliability, availability, uptime, utilization & gas through-put metrics
- 200+ tags/asset in near-real time
- Fleet map, alarms and alerts summary

### Diagnostic workbench/charts



- Advanced data trending
- Troubleshooting/diagnostics

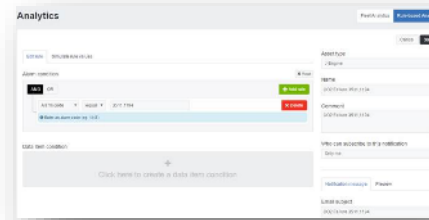
### Mobile App



- Key insights at fingertips anytime, anywhere

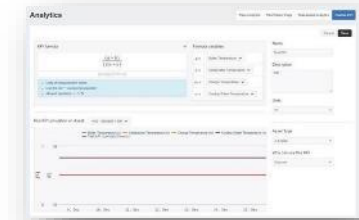
### Rule-based analytics

Based on user-defined threshold



### Custom KPIs

Based on user-defined equations



### Physics based analytics

for asset condition & component life prediction

Cluster	Analytics	Value Drivers			
For Field Validation only from end Jan'17		Efficiency/Opex	Throughput (mmscfd)	Emissions	Availability/Reliability
Remaining Useful Life	Oil Remaining Useful Life	High	High	Low	High
Engine Condition	IMAP Differential	High	Low	High	High
	Oil Pressure Monitoring	Low	Low	Low	High
Compressor Condition	Gas Compressor P <sub>S</sub> vs P <sub>D</sub>	High	High	Low	High
Package Info	Operating Hours (OPH) per Start	Low	Low	Low	High
	Starts per Week	Low	Low	Low	High

Limited availability

Impact on Value Driver

High

Medium

Low



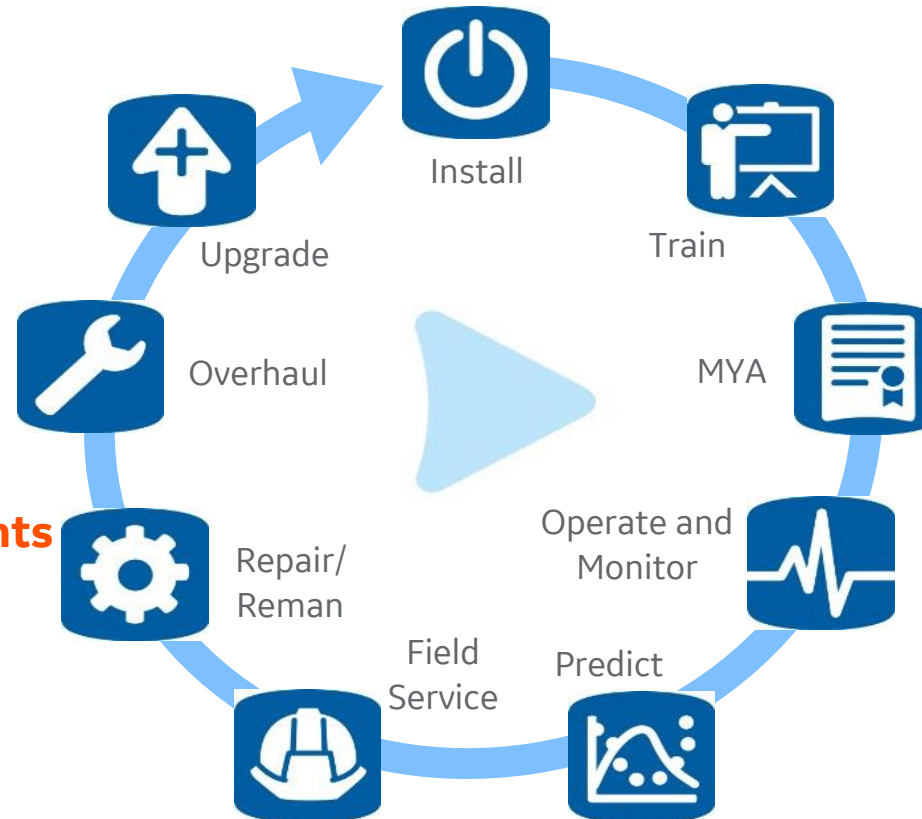
# GE conversion, modification and upgrade (CM&U) programs

## 1 CM&U Programs

- Introduced ~2 years
- Improvements in
  - Reliability
  - Performance
  - Emissions
  - Efficiency

## 2 reUp\* ... reman components

- Reduce lifecycle cost and improve reliability with genuine GE reUp parts solutions



## 3 Multiyear agreements on service and replacement parts

## 4 Asset Performance Management

- Digital product connectivity
- Pivotal development point
- Reduce costs and improve availability with analytics

A full lifecycle approach to improve product performance and extend useful life

\* Trademark of General Electric Company





