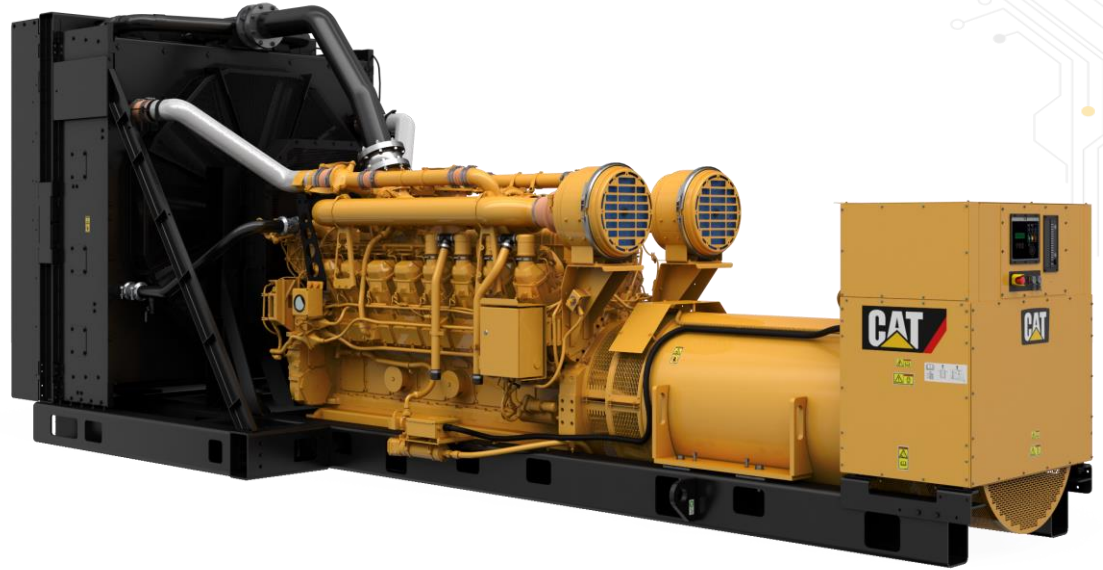




7 x 24 Exchange Northwest Chapter

Chris Barton, N C Power Systems
Chris Blazeovich, N C Power Systems
Rick Walkup, Cat Electric Power



N C POWER SYSTEMS



N C Power Systems – Locally Owned Since 1994



- 1926 – N C Named Caterpillar Dealer for Alaska and Yukon Territories
- 1957 – N C Becomes Caterpillar Dealer for Western Washington
- 1986 – N C Acquires Central Washington Caterpillar Dealership
- 1994 – John J. Harnish (HGI) Acquires N C Power Systems



Our Value & Focus

- Focus on Helping Customers Manage Risk Through Project Management & Engineering
- Want to be Easy to Do Business – Responsive, Flexible, Customer Focused (work on meeting time to market on product needs and investment)
- Investing in Customer Uptime – Technicians, Parts Stocking, & Mobile Generator Fleet



An Investment in Uptime



-  **Power Systems Locations**
-  **Resident Technicians Support**

- **Data Center Technician Coverage**
 - 5 Quincy / Wenatchee Technicians
 - 1 Moses Lake Resident Technician
 - 3 Western Washington Technicians





3516E

3000-3500 kVA 50Hz

3000 ekW 60Hz



3500 engine platform introduced

Improved fuel system & structural capability

Improved air system & aftercooler capability

3500B Series Introduced (meets Tier 1)

Improved injection / combustion / control systems

Displacement increased by 13%

3500C Series Introduced (meets Tier 2)

Improved combustion / control systems / air to air aftercooling

3500E Series Introduced (Tier 4 - some applications)

Improved core structure for increased peak cylinder pressure

3500 Power Density Extension

Increased fuel system delivery, improved air systems efficiency

1980 75kW / Cylinder

1986 93kW / Cylinder

1988 113kW / Cylinder

1996 131kW / Cylinder

1999

2006 154kW / Cylinder

2016 188kW / Cylinder

2019+ >200kW / Cylinder



3516E HPD Standby and Mission Critical Genset



- Standby and Mission Critical ratings:
 - 3.0 ekW, 60Hz T2
- 78.1L displacement
- Air to Air aftercooled
- NFPA-110, 10 sec start time
- MEUI-C fuel system
- Performance
 - ISO 8528-5 G3 load acceptance
 - Accepts 100% block load in one step
 - 2 steps to 100% within ISO 8528-5 G2
- Full power up to 55degC @ 300m

Cat® 3516E Diesel Generator Sets



Bore – mm (in)	170 (6.69)
Stroke – mm (in)	215 (8.46)
Displacement – L (ft³)	78.1 (4766)
Compression Ratio	14.0:1
Aspiration	TA
Fuel System	EUJ
Governor Type	ADEM™ AS

Image shown may not reflect actual configuration

Standby 60 Hz kW (VA)	Mission Critical 60 Hz kW (VA)	Prime 60 Hz kW (VA)	Emissions Performance
3000 (3750)	3000 (3750)	2725 (3406)	U.S. EPA Certified for Emergency Stationary Applications (Tier 2)

Standard Features

Cat® Diesel Engine

- Meets U.S. EPA Stationary Emergency Use Only (Tier 2) emissions standards
- Reliable performance proven in thousands of applications worldwide
- Dual element air cleaner
- Dual electric starting motors

Generator Set Package

- Accepts 100% block load in one step and meets NFPA 110 loading requirements
- Conforms to ISO 8528-5 G3 load acceptance requirements
- Reliability verified through torsional vibration, fuel consumption, oil consumption, transient performance, and endurance testing

Alternators

- Superior motor starting capability minimizes need for oversizing generator
- Designed to match performance and output characteristics of Cat diesel engines

Cooling System

- Cooling systems available to operate in ambient temperatures up to 50°C (122°F)
- Tied to ensure proper generator set cooling

EMCP 4 Control Panels

- EMCP 4.2B
- User-friendly interface and navigation
- Scalable system to meet a wide range of installation requirements
- Expansion modules and site specific programming for specific customer requirements

Warranty

- 24 months/1800-hour warranty for standby ratings
- Extended service protection is available to provide extended coverage options

Worldwide Product Support

- Cat dealers have over 1,800 dealer branch stores operating in 200 countries
- Your local Cat dealer provides extensive post-sale support, including maintenance and repair agreements

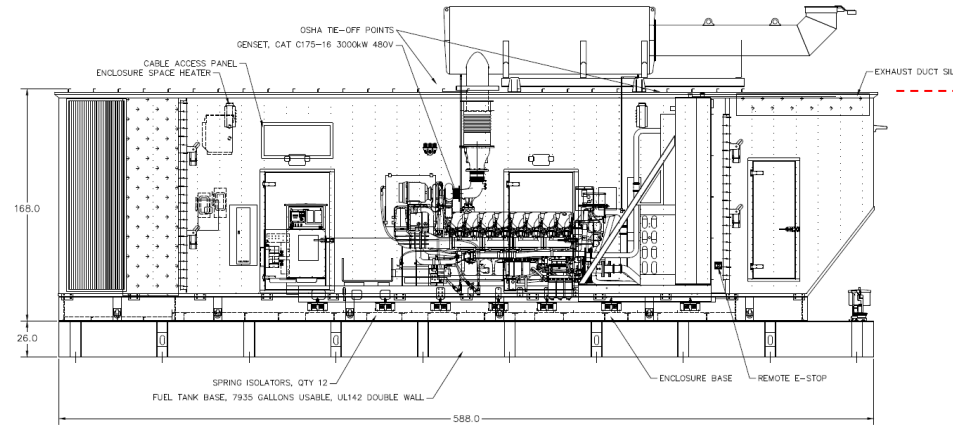
Financing

- Caterpillar offers an array of financial products to help you succeed through financial service excellence
- Options include loans, finance lease, operating lease, working capital, and revolving line of credit
- Contact your local Cat dealer for availability in your region

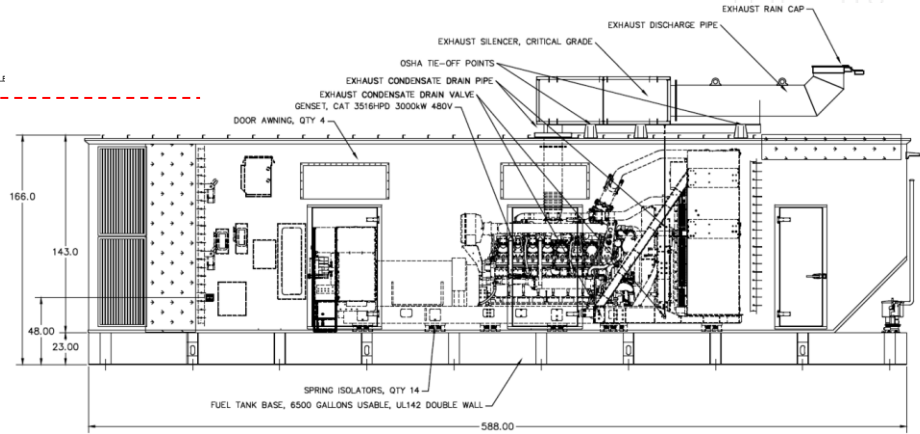
LEH22570-01 Page 1 of 4



Dimensions (60Hz)



C175-16 with standard ambient price list radiator



3516E with AF98 High Ambient price list radiator

Shorter radiator: allows to integrate fuel tank in enclosure design in one single piece, while meeting maximum US road transportation height

- \$40k material cost saving (structural base)
- \$10k+ additional saving in transportation, on site work & crantage



CAT CONNECT FOR ELECTRIC POWER: Cat RAM

Caterpillar's connectivity solution of Remote Asset Monitoring (Cat RAM) with **Cat® Connect** turns data into insights and insights into profits



Customer Benefits:

- Decreasing Owning & Operating costs
- Minimizing downtime
- Peace of mind with Ready to Run
- Real time streaming data & insights

Intermediate

Parameters: 1/minute

Alarms: 1/second

• Alarms/Events

• **Run Status**

• **Fuel Consumption**

• **kWhr**

• kVarhr

• SMH

• Fuel Level

• Battery Voltage

• Location

• Engine Speed

• Oil Pressure

• Jacket Water Temp

• **Engine Percent Load**

• Gen Phase A AC RMS Current

• Gen Phase B AC RMS Current

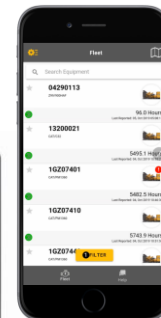
• Gen Phase C AC RMS Current

• Gen Average AC L-L AC Voltage (234)

- Gen Phase A L-N AC Voltage (234)
- Gen Phase B L-N AC Voltage (234)
- Gen Phase C L-N AC Voltage (234)
- Gen Total Real Power
- Def Level (0)
- Total kVA (234)
- Gen Ave Frequency
- % kW – 1%
- Power Factor (calculated)
- kVAR (calculated)
- New Natural Gas Engine Parameters
- Generator Rated Frequency
- Engine Speed Desired
- Engine Fuel Valve Position
- Engine Throttle Actuator Position
- Engine Turbo Comp Bypass Valve Position
- Engine Actual Ignition Timing
- Engine Coolant Pressure
- Engine Coolant Pressure2
- Engine Intake Manifold Temperature
- Engine Fuel Valve Diff Pressure
- Engine Intake Manifold Pressure

Mobile App

Fleet View



Asset View



Customers log into **My.Cat.Com** as the single portal to view all digital services including their connectivity data. These digital services can include:

- Custom Reports
- Inspections
- Scheduled Oil Sampling
- Operation & Maintenance manuals
- Ordering Parts
- Requesting Service
- Connectivity Data with **Remote Asset Monitoring**



Emissions Reporting Support

- Intermediate Data Options Include
 - 39 Genset & Electrical Parameters
- Including Key Parameters:
 - ✓ Run Time / Duration
 - ✓ Load
 - ✓ Fuel
- Automatically generated alerts and reports
- Custom Reports Available



Product Link Elite: End-to-End Security Architecture

Defense In Depth Security Safeguards



Product Link Device Security:

- Cryptographically verified secure boot
- Application verification to protect against device software tampering
- Secure device software update using signature based authentication

Remote Connection Security:

- HTTPS & mutual authenticated bidirectional communication
- AES 128 encrypted unidirectional communication
- Device initiated outbound connection only
- Device does not respond to general internet traffic

Web Application Security:

- HTTPS/TLS secured web application interface
- User authentication with role based access controls
- Web application security scans

Generator Set Controller,
Compressor Panels,
Transmissions, Pumps,
3rd Party PLCs



Engine



Product Link



Ethernet



Customer Site
Network



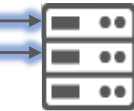
Customer
Firewall



Internet



Caterpillar
Firewall



Caterpillar Servers
and Databases



Caterpillar
Firewall



Internet



Web Application



Users

Customer Firewall:

- Customer's may need to adjust their firewall rules to allow the outbound connection.

Caterpillar IT Infrastructure Security:

- Intrusion detection and prevention solutions
- Network segmentation with multi-layer security protections
- Physical and Logical data center security
- Incident response and disaster recovery plans





H₂



Hydrogen-based Caterpillar Power Generation Solutions

May 2021 – Rick Walkup

Why...

- Customers are becoming increasingly focused on decarbonization and greenhouse gas (GHG) reduction
- Investors are also evaluating companies on their Environment, Social and Corporate Governance (ESG) progress
- Governments are driving ie. EU goal to achieve additional ~30% reduction of GHG in the next 10 years (2020-2030)
- Hydrogen production from renewable sources solves supply/demand mismatch and yields decarbonized energy



Renewable Energy Growth & Storage Need

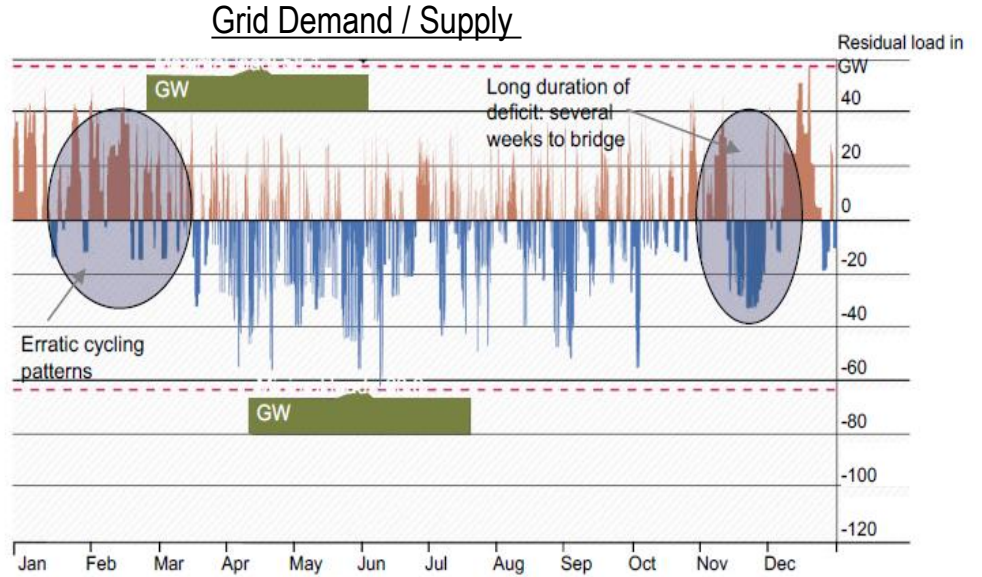
Increased penetration by variable renewables (wind, solar) creates storage issues due to demand / supply mismatch

Leveraging surplus energy for H₂ Production

- **Long term**
Seasonal / weather variability
- **Large scale**
Hundreds of TWh (terra-watt hours)

➔ DEFICIT
i.e. load > feed in from variable renewables
-84.7 TWh

➔ SURPLUS
i.e. load < feed in from variable renewables 82.7 TWh



Note: Residual load with load management i.e. re-scheduling the charging of electric vehicles or the use of air-conditioning.
Source: Fraunhofer IWES for Umwelt Bundes Amt (2010).



Types / “Colors” of Hydrogen

96% of current hydrogen production is made from natural gas, oil, and coal



No GHG benefit

Gray: traditional steam methane reforming: most prevalent today, lowest cost

Brown: gasification of coal (ie lignite)



Carbon capture provides opportunity for GHG benefit

Blue: steam methane (or coal) reforming combined with CCS (Carbon Capture Systems): scale steppingstone

Turquoise: molten metal pyrolysis producing solid carbon

Pink: water electrolysis using nuclear electricity



Carbon free

Green: water electrolysis via renewable electricity (wind/solar): cost depends upon electrolyzer and renewable electricity advances



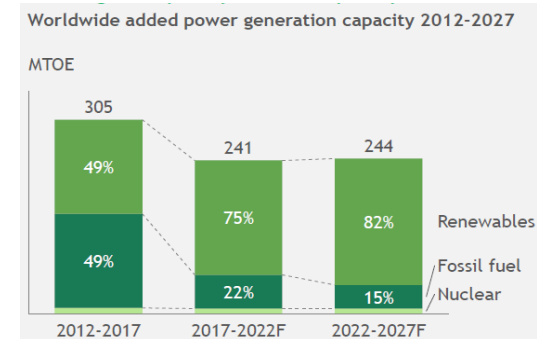
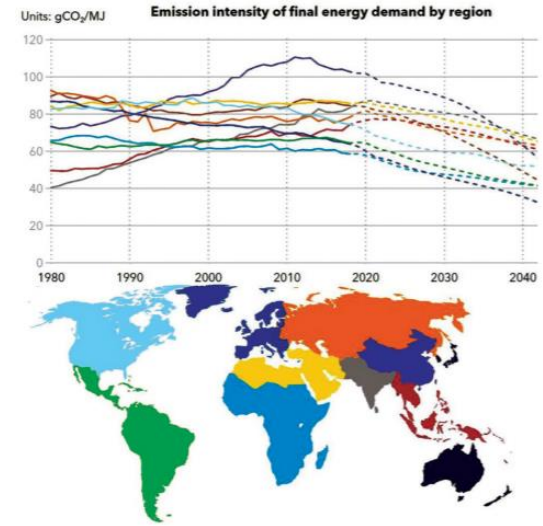
When

Renewable power growth is underway, which is fundamental for “green” H₂

- Electricity consumption is expected to double by 2050 (from 2020), and capacity additions have shifted heavily toward renewables in last 10 years
- Renewables anticipated to become a cheaper source of central power generation than coal and gas in most regions by 2030

Three H₂ “pace setters”

- Safety
- Scale (Infrastructure, Electrolysis/CCS) – technology and cost
- Policy – investment and supportive framework



Source: Boston Consulting Group



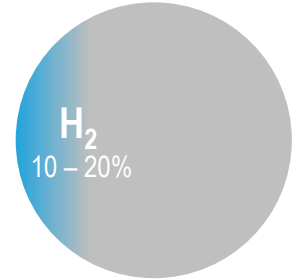
Likely Path for Hydrogen Utilization

Two distinct and parallel business cases:



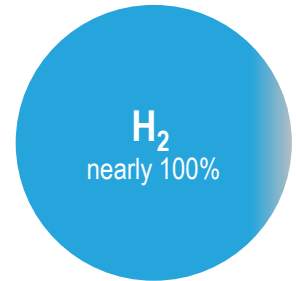
1. Hydrogen blending: 10 – 20% H₂ (vol) mixed with natural gas

- Uses installed storage and distribution capacity of existing natural gas grid
- Concerns: variability of blend (renewable), proximity to blending location, limitation on household use (water heaters, etc.) beyond 20%
- Cat/MWM gensets can utilize these hydrogen/natural gas blends with limited or no impact on ratings and performance



2. 100% H₂ or nearly 100% at dedicated locations where H₂ is a product of a production process

- Requires specialized gensets and infrastructure
- Developed in parallel with growth in H₂ transportation use








20 Years of Hydrogen-Fueled Electric Power Experience

- Caterpillar currently sells production engines with 5%-10% hydrogen mixed with methane (by volume) and customer projects up to 20% hydrogen mixed with methane.
- Additionally, Caterpillar has many years of experience (150,000+ operating hours) with specialized customer projects running fuels that contain up to 60% hydrogen (by volume) produced from coke oven gas and producer gas from wood chip gasification.
- Caterpillar experience has shown no impact to maintenance schedules and durability when operating on hydrogen.
- Caterpillar continues to do research on alternative fuels like hydrogen/methane mixtures and 100% hydrogen in internal combustion engines.



Caterpillar Products – Hydrogen Capability



Product		Power Range	Standard Product	Project Approval	Experience
	CG132B	0.4 – 1.0 eMW	0 – 10% H ₂	> 10% H ₂	80% H ₂
	CG170/CG170B	1.2 – 2.3 eMW	0 – 10% H ₂	> 10% H ₂	10% H ₂
	G3500	1.0 – 2.5 eMW	0 – 5% H ₂	> 5% H ₂	40% H ₂
	CG260	3.3 – 4.5 eMW	0 – 10% H ₂	> 10% H ₂	60% H ₂
	GCM34	6.0 – 10 eMW	0 – 10% H ₂	> 10% H ₂	10% H ₂



Today's Take-Aways

- Renewable Hydrogen is one of several fuels our customers are considering to help reduce their carbon footprint.
- Caterpillar currently offers reciprocating engines and turbines capable of running on hydrogen and hydrogen blends.
- Many factors influence if and when hydrogen achieves critical mass -- infrastructure, cost, regulations, safety, storage, packaging, governmental policy and incentives, etc.
- Caterpillar continues to invest in hydrogen technology and is well positioned to serve customers as the timing and dynamics of renewable hydrogen production, distribution and storage gain speed.





LET'S DO THE WORK.™

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