# SUSTAINABLE POWERTRAIN 2021
# BIOMETHANE & SMART GRIDS: THE "ECO-CHP"

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Caterpillar Electric Power Division

CATERPILLAR®

# This is Caterpillar

*Based on Year-end 2020 Data*

**4M+**
Cat® Products at Work Around the World**
***Includes discontinued products.*

**~1M**
Connected Assets

**2020 Consolidated Sales & Revenues**
**$41.7B**

**61%**
Sales & Revenues Outside the U.S.

**21 Brands**

**161**
Cat Dealers in **192 countries**

**97,300**
**Global Employees**
*(Full-time employment)*

**Our Values in Action**


## OUR SOLUTIONS HELP OUR CUSTOMERS BUILD A BETTER WORLD.

### PRODUCT LINES

- Construction Equipment
- Mining Equipment
- Diesel & Natural Gas Engines
- Industrial Gas Turbines
- Diesel-Electric Locomotives

CATERPILLAR FOUNDATION

**~$810M**
Invested in global communities since 1952

**~150**
Primary Locations

**~25** Countries

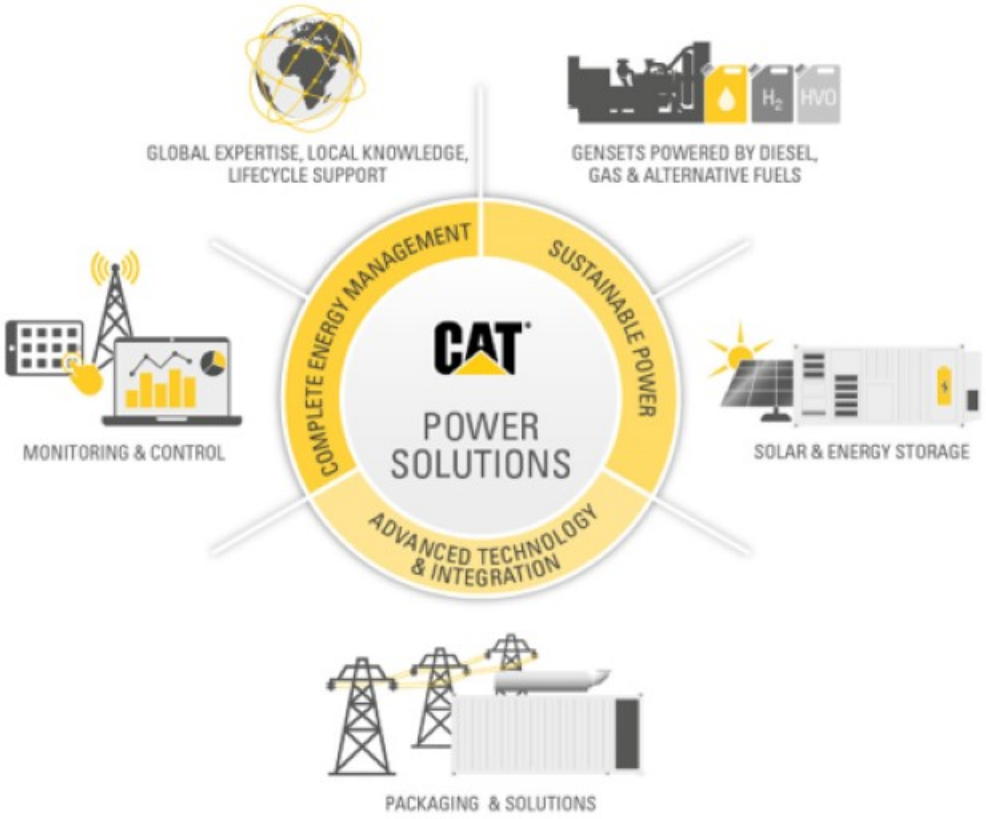
Focused on **Sustainability & Innovation**

Caterpillar.com



CATERPILLAR

# Caterpillar Electric Power: Sustainable Product Design & Beyond




Partner with customers, optimising power systems for efficiency, reliability, sustainability and emissions reduction.

- Reducing environmental impact & optimising efficiency of existing product
- Innovating & diversifying product offering
- Packaging and Integration
- Monitoring, control and whole-life dealer support

# Electric Power – Connected Across the Lifecycle

**Expanded Solutions Offerings**

Full Range of System Offerings
Design Experts
Online Tools
Application Expertise
Tailored Services
Engineered Solutions

**Customer**

Concept | Design | Installation | Lifetime Support

**Aftermarket Services**

Customer Value Agreements
Cat Connect & Extended Service Cover
Total Cost of Ownership
Parts and Service
Facility Upgrades
Expert Advisors


**Our Dealer Network**

# Available TODAY: Low Emissions, Efficient & Sustainable

## Diesel Oxidation Catalyst

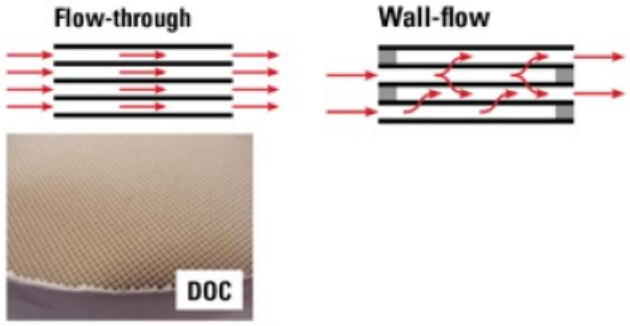
- Flow through catalyst
- Controls
  - CO, HC, NOx, SOF

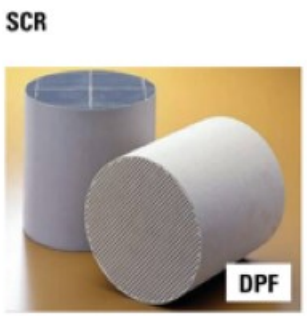
## Diesel Particulate Filter

- Wall flow device

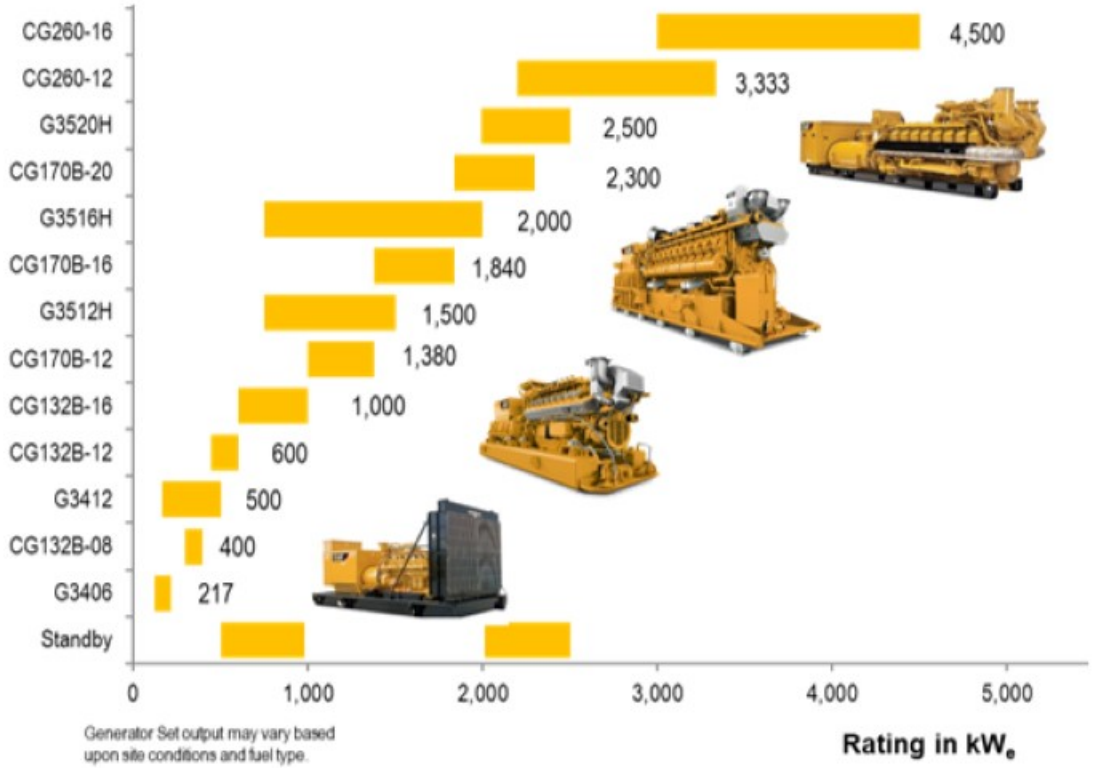
## Selective Catalytic Reduction (SCR)

- Flow through catalyst
- Converts NOx to $N_2$ and $H_2O$

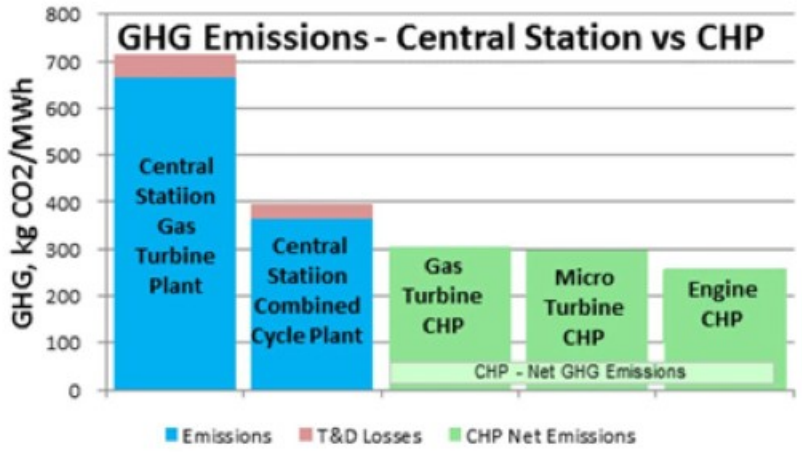



## Gas Product Range



# Combined Heat & Power (Cogeneration)


## Reduces Emissions, Increases Efficiency, Saves Money, Adds Resiliency

## Any Industry Can Benefit

- District Heating and Cooling
- Landfills & Wastewater Treatment
- Greenhouses & Farms
- Municipalities & Utilities
- Manufacturing (Textiles, Pharma, and Food Processing)

## Reduced Emissions

- Displacement of fossil fuels

## An Economic Solution

- Efficiency up to 90% allows for a payback period of 3-5 years before generating profit

## An Energy-resilient Solution

- CHP Installation can run on island mode, providing mission critical standby power during grid outages

# Renewable Fuel Options


**Biofuel, Hydrogenated Vegetable Oil (HVO), and Synthetic Fuels**

- Reducing fossil fuel reliance and emissions of carbon and NOx

**Biogas**

- Converting harmful waste gases to electrical and thermal energy
- Landfill and digester gas

**Hydrogen**

- 20+years of experience
- Products operating on blended $H_2$
- Ongoing research & development

# Biofuel, Hydrogenated Vegetable Oil (HVO), and Synthetic Fuels

**Renewable Liquid Fuels**

- Drop-in replacement for traditional diesel
- Supply is increasing

**Customer Types**

- Standby customers who want a low-carbon footprint solution with proven reliability with little investment.

# Biogas & Biomethane

**Waste To Energy Drivers**

- Consumer awareness
- Legislation
- Zero emissions targets

**Biomethane Drivers**

- Automotive & power generation sectors
- Demand for bio-based fuel for power generation plants

**Biomethane Inhibitors**

- Cost - initial investment, installation & operating

**Waste To Energy Global Market Projections**

**"Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions"**

**Climate & Clean Air Coalition (CCAC) & UN Environment Programme**

Waste to Energy cited as targeted measure for:

- Waste Sector – Water Treatment (Residential & Commercial)
- Fossil Fuels Sector
- Agriculture Sector

# Customer Examples

**Bettencourt Dairies**
Idaho, USA

- 9,000 Cows
- Power for facility & 2MW for local grid
- Thermal energy to AD plant
- 200,000 gallons of manure processed
- 2 Cat G3520C Gas Generators

**Waste Water Treatment Plant**
Egypt

- 2.5m cubic meters wastewater per day
- Five CG260-16 (3200ekW/unit), biogas-fuelled with heat recovery system
- 16MW electrical energy, 10MW thermal
- 87% Total efficiency

# Customer Examples

**Agriculture Sector**

***Homestead Dairy, Indiana, USA***

- Milking 3,500 cows + 300 dry cows
- Biomass waste-to-energy facility to convert the manure into electric power & reduce odour
- Two Cat G3512A generator sets + heat recovery applied to AD plant
- +1MW Power (1,000 homes)
- Dewatered solids from the digesters = clean bedding.
- Liquid nutrient by-product is used to fertilize the farm fields.

# Hydrogen


- **Over 20years experience in $H_2$ fueled engines**
- **$H_2$@Scale Initiative**
  US Department of Energy Research Funding
  - $H_2$ Fuel Cell System for Data Center Power
  - Flexible NG and $H_2$ Combined Heat & Power System

# Gas Product Range


## Available for various gas types

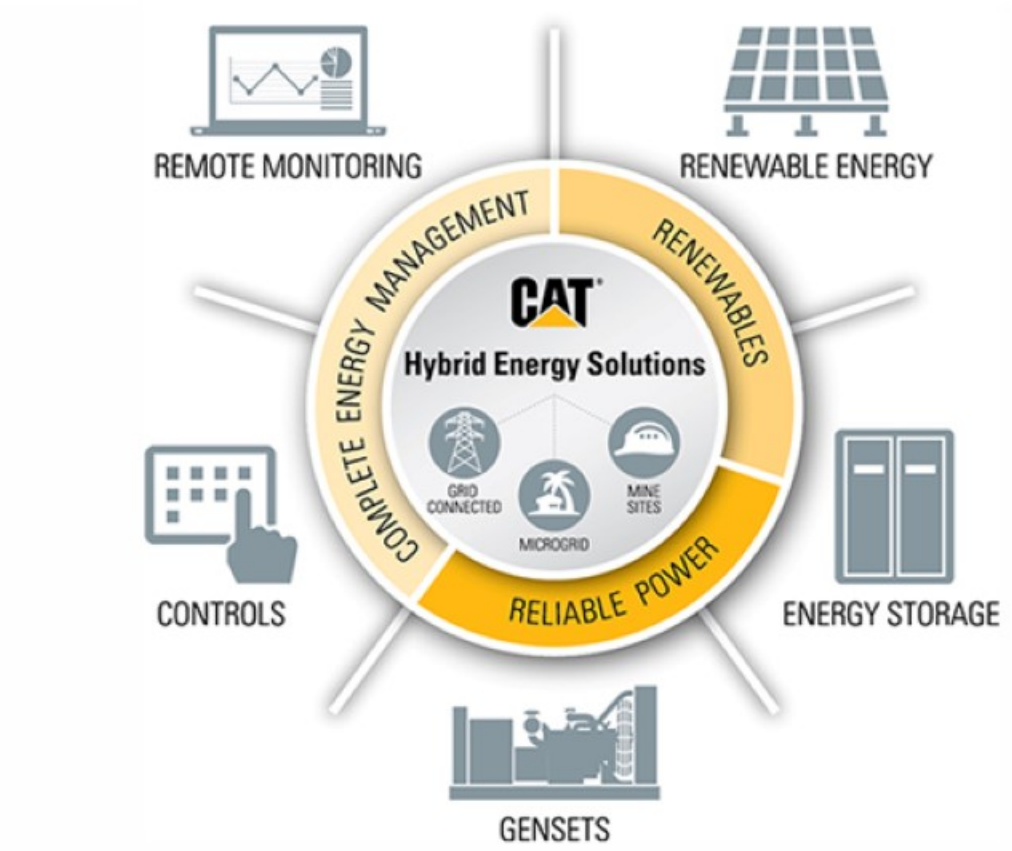

Grid code compliant product available

# Electric Power Hybrid

## Lower Total Cost of Ownership

- Engine power + solar power + energy storage + advanced controls
- Reduced Energy Costs
- Better Power Quality
- Reduced Emissions
- Improved Power Resiliency

## Hybrid options to meet customer requirements



# Microgrid Opportunities: Solar PV + Battery + Genset


**Achieve cost, reliability, and emissions goals**

**Applications**

- Decarbonize total energy supply
- Large solar farms
- On-site or adjacent to data centers

**Hybridization with Energy Storage**

- Energy storage for time-shifting solar energy from day to night

**Zero/Limited On-site Emissions**

- PV + battery for zero emissions
- Gensets for firm power & limited emissions

# Customer Story


## PROJECT BACKGROUND

- Greenfield off-grid agriculture project
- Remote desert location

## CATERPILLAR'S SOLUTION

- 5 x Cat Diesel gensets
- 2.7MWp of ground mount Cat solar PVT117
- Cat ESS 375kW, 290kWh
- Cat Master Microgrid Controller (MMC)
- Cat Connect

## BENEFITS

- Saving 1.4M liters of diesel each year.

# Caterpillar's Commitment

**From making the products more sustainable to recycling products to reduce waste to working in our communities to improve quality of life—sustainability is not new for our company.**

The next step in our sustainability journey includes:

- Partnering with our customers to achieve their goals for reducing or neutralizing their carbon emissions and the impact of their operations on the environment (local and global)
- Reducing emissions – road map of product conversion technology
- Socializing Caterpillar sustainability goals