OUR CUSTOMERS’ GOALS. OUR COMMITMENT.

ADVANCED POWER

Suresh Reddy
Chief Engineer, Electric Power Conversion
Caterpillar Inc.

NREL Off-Road Decarbonization Workshop
March 2022
Power drives our customers’ work.

Innovation and integration drive ours.

Whatever our customers’ goals — lower GHG emissions, energy flexibility, business sustainability — we provide the advanced power that keeps them working.
Low Carbon Intensity Fuels
Enable increased use of reduced-carbon options and hydrogen blends.

Fuel Cells
Use renewable hydrogen fuel as a scalable source of electric power.

Electric & Hybrid Powertrains
Employ an electric drive transmission with power components.

Batteries
Power the work with stored electrical energy.

Microgrids
Integrate renewable energy sources into electric power systems.

Multiple Solutions
Made to Match the Work

Making established power sources even more efficient and fuel-flexible

Pairing established power sources with new technologies in a hybrid format

Replacing established power sources with stand-alone new technologies

Delivering reman, repair, rebuild, retrofit and repower services

CATERPILLAR®
HIGH-EFFICIENCY INTEGRATED COGENERATION

ADVANCED POWER

COMBINED HEAT & POWER WITH GAS GENERATOR SETS
Turbines provide stable base load for increased renewables

Compressor sets allow transportation and storage of hydrogen in existing pipelines

Increased turbine operation on hydrogen lowers GHG emissions

Enable increased use of reduced-carbon options and hydrogen blends.
Combined Heat & Power Demonstration

Research funding awarded by the U.S. Department of Energy* for flexible natural gas and hydrogen combined heat and power (CHP) system project.

1.5MW Fuel Cell Demonstration

Research funding awarded by the U.S. Department of Energy* for a renewable hydrogen fuel cell system for data center power.

WORKSITE MICROGRID SOLUTIONS

GRID STABILIZATION SOLUTIONS
Caterpillar: Non-Confidential

LAND DRILLING ENERGY STORAGE SYSTEMS

Power the work with stored electrical energy.

G3512 Natural Gas Generator + Energy Storage System

- Allows use of available natural gas vs. trucked-in diesel
- Lowers carbon intensity of operation
- Reduces fuel consumption
TROLLEY ASSIST MINING EQUIPMENT

BATTERY-ELECTRIC MINING EQUIPMENT
<table>
<thead>
<tr>
<th>Electric Medium Excavator</th>
<th>Certarus MOU</th>
<th>CarbonPoint Solutions Acquisition</th>
<th>Microsoft Swedish Data Center</th>
<th>Hydrogen-Fueled Generators</th>
<th>Microsoft, Ballard Hydrogen Fuel Cell</th>
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<tbody>
<tr>
<td>Zero exhaust emissions excavator developed with Cat® dealer PON</td>
<td>Creating collaboration for a lower carbon future</td>
<td>Creating solutions for a lower-carbon future</td>
<td>Cat® standby power capable of running on renewable liquid fuel</td>
<td>Cat generators capable of operating on 100% hydrogen</td>
<td>Power system incorporating large-format hydrogen fuel cells for data center backup power</td>
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**CHEVRON HYDROGEN COLLABORATION**

- **Exploring hydrogen as alternative fuel; locomotive prototype**
- **EMD Joule® will be tested in rail yards to identify locomotives’ capabilities and challenge**

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**UNION PACIFIC RAILROAD**

**Nouveau Monde Graphite**

- **Zero-emission mine site with Cat machines**

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**NEW MONDE GRAPHITE**

- **Zero-emissions autonomous mining trucks**

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**RIO TINTO**

- **Fully connected, automated, zero carbon emitting, end-to-end mining system**

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**NEWMONT**

- **Battery-powered mining trucks**

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**BHP**

- **Battery-electric locomotives**

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**ADVANCED POWER**
INDUSTRY CHALLENGES

- Differing worksite energy requirements – supply, delivery, distribution, management
- Reliable infrastructure to site and across site – renewable electricity, low carbon intensity fuels
- Collaboration to ensure productive operations – customers, utilities, manufacturers, regulators