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Panel Session: Supplier Perspective on the Future of CHP

Introduction to the Panel

Moderator:
Richard Sweetser
President
Exergy Partners Corporation

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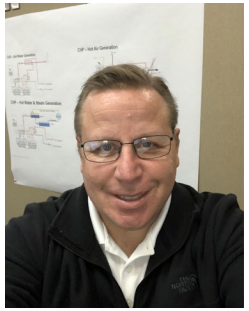
The Panel

Aaron Tasin
Vice President Sales

Mr. Aaron Tasin is the Vice President of Sales for 2G Energy, Inc., an engine manufacturer, and CHP system packager. He has been involved in the energy industry for over 20 years spanning service, project management, business development, and executive management. Over that period, he has been involved with well over 200 projects where engines or gas turbines were installed for CHP, Biogas, or Landfill projects. Prior to joining 2G Energy, he held positions with Wartsila, GE Distributed Power, and Capstone Turbine. Mr. Tasin has a BS degree in Marine Systems Engineering from the U.S. Merchant Marine Academy at Kings Point, NY, as well as a US Coast Guard Engineer License; an EIT in the State of NY; is on the executive committee of the CHP Alliance, and is on the CHP leadership team of the Energy Solutions Center.



John Hibler
Large Electric Power Standard
Engineering Manager

John graduated from Purdue University in Aeronautical Engineering and started with Caterpillar straight out of college and has been with Caterpillar for 24 years. 90% of his career has been working with natural gas engines between 500 kW to 10 MW. John has held positions in design, performance and testing, application and installation, project management, and power plant engineering. John has worked at Caterpillar's engine manufacturing plants in Lafayette, Indiana and Mannheim Germany. John is currently the Standard Solutions Engineering Manager with a focus on CHP.

Chris Lyons
Manager, Power Generation

Chris Lyons has over 40 years experience in the energy field working in a variety of positions from plant construction and commissioning, to design engineering and sales and marketing. Chris has a BS in Chemical Engineering from the University of Rhode Island. Chris is currently Manager, Strategic Growth and Special Projects for Solar Turbines based in San Diego. In this job Chris is responsible for developing and promoting new markets and applications using alternative fuels including technologies to improve efficiencies and reduce carbon emissions. With Solar's commitment to the development of new markets, Chris has several resources available, including combustion engineering, package design engineering and a host of other technical resources located within the company.

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Panel Session Objectives

Each panelists will have five slides and ten minutes to:

1. Present their company.
2. Describe their company's role in CHP markets in the US.
3. Outline the challenges their CHP equipment faces today.
4. Outline the challenges their CHP equipment faces in the future.
5. Explain what their company is doing to future proof their CHP product lines.

Assuming everybody is timely we will have a few minutes for Q&A at the end.

Panel Session: Supplier Perspective on the Future of CHP

2G Energy, Inc.

- Founded 1995 – Global Headquarters in Heek, Germany with $300 million annual revenue
- U.S. Operations started in 2011 with offices in St. Augustine, FL and Rockville, MD with $30 million annual revenue
- Distributors in Idaho, Tennessee, and Texas
- 25 direct employees in U.S.
- Strong focus on R&D
- 10 national and international subsidiaries
- Over 120 CHP plants in the US and over 6,000 CHP plants in more than 50 countries worldwide

Aaron Tasin
Vice President Sales

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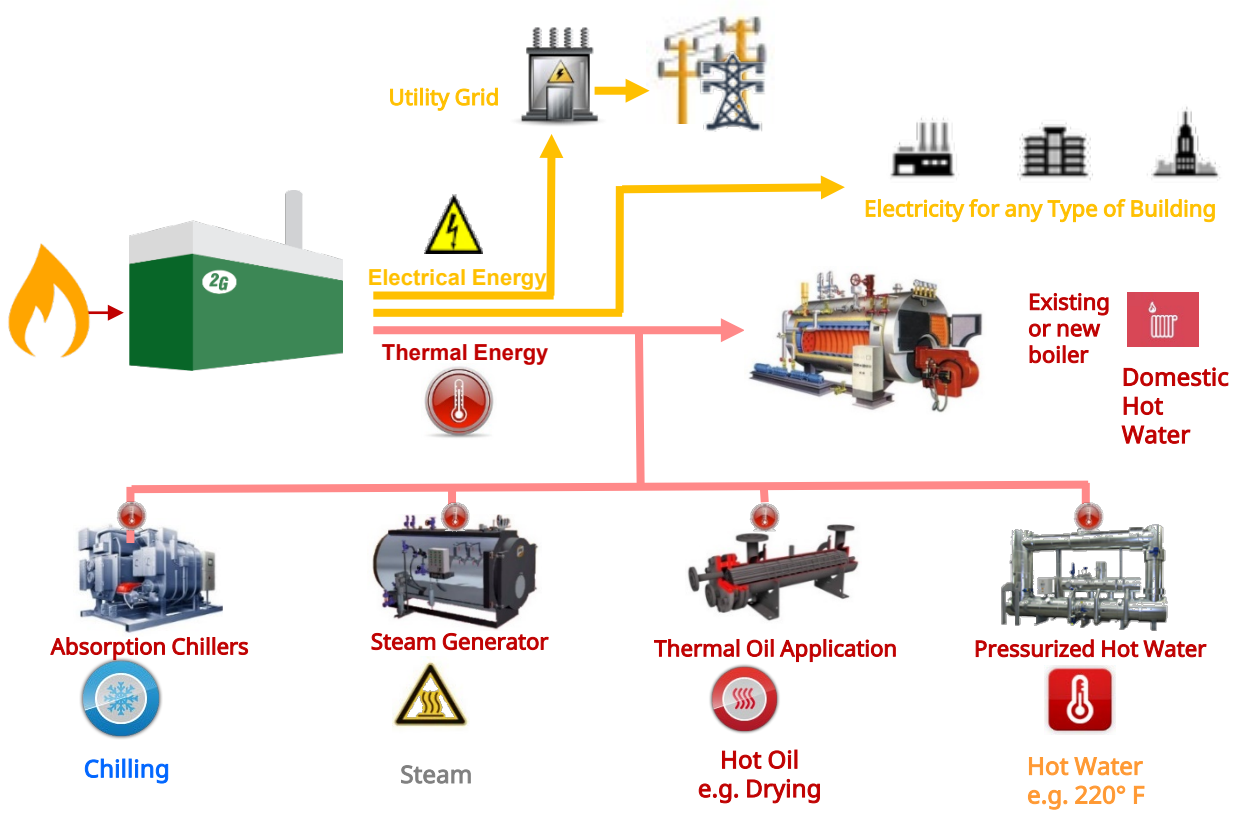
2G Energy's role in the CHP market in the US

- Provide a pre-manufactured CHP solution ready for installation at customer location ("DOE eCatalog") that is:
  - Highly efficient
  - Cost effective
  - Easy Implementation
  - Meets or exceeds all emission and efficiency requirements for the location where it is to be installed
- Include all CHP options possible for the customer so they can utilize the waste heat in the most efficient way possible
  - Hot water
  - Steam
  - Cold Water
  - Organic Rankine Cycle



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Challenges 2G's CHP equipment faces today

- Lack of general knowledge that CHP is an option for their facility
  - "CHP" is still thought of as California Highway Patrol
- Interconnection with Grid is time consuming and not a certainty (like it is in Europe)
- Standby rates charged in lieu of demand charges hurt economics
- Utilities try to convince customer that CHP is not in their best interest
- Paybacks are often >4 years, which for private sector decision makers is "too long"
- Clean burning, low emission Natural Gas is getting a bad name in the best markets (NY, CA)
  - Some locals have gas bans in place for new connections

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What 2G is doing to future-proof its CHP products

- 2G has a significant portion of revenue directed to R&D, which in the last few years has designed:
  - Engine capable of operating on 100% hydrogen
  - Designed own emission control system (SCR) to reduce cost for the end product
  - Designed own Organic Rankine Cycle
  - Designed smaller kW, highly efficient engines capable of running on biogas
  - Designed condensing heat exchangers matched up with the smaller engine range
  - Working with Microgrid companies for easy integration of CHP into their microgrid design

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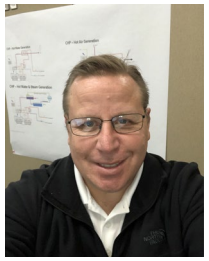
Panel Session: Supplier Perspective on the Future of CHP

Caterpillar

For more than 90 years, Caterpillar Inc. has been making sustainable progress possible and driving positive change on every continent. Customers turn to Caterpillar to help them develop infrastructure, energy and natural resource assets. Caterpillar Solutions is focused on delivering highly efficient and environmentally friendly solutions for decentralized energy generation and combined heat and power (CHP). Caterpillar builds generator sets and Packaged CHP systems worldwide and will design, assemble, test, and service all of the balance of plant equipment including complete microgrids. Caterpillar offers financing and long-term service agreements to meet customer's needs. Caterpillar Solutions focus is on the 400 kW – 10 MW power range generator sets and Packaged CHP systems. Caterpillar has three main facilities that package CHP systems.



John Hibler
Large Electric Power Standard Engineering Manager
Caterpillar
3701 State Rd 26 East
Lafayette, IN 47905
Phone: 765.4482562
Email: Hibler_John_P@cat.com
www.cat.com/en_US/by-industry/electric-power/electric-power-industries/cogen-chp.html

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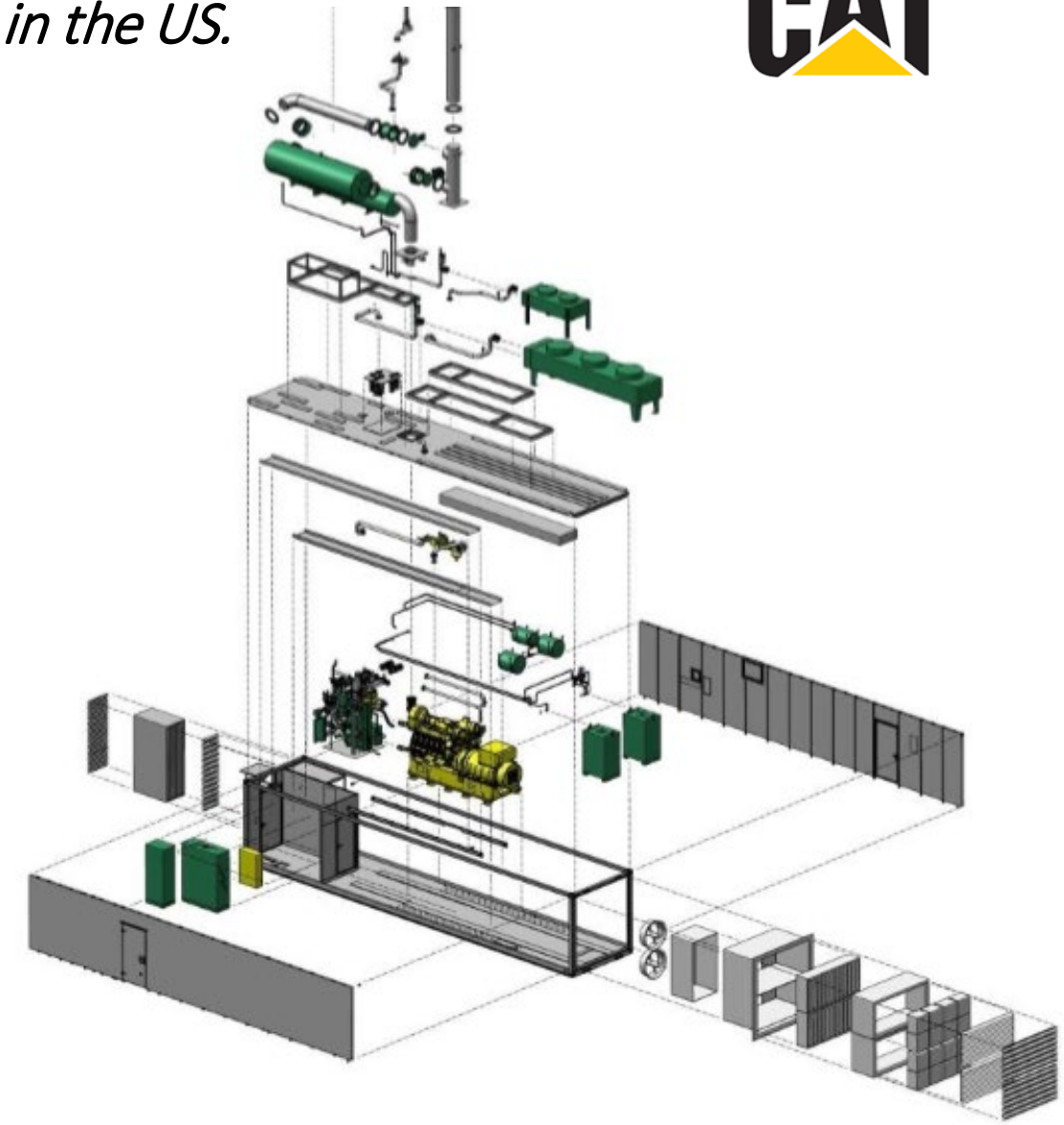
Caterpillar's role in CHP market in the US.

- Maximizing utilization of the overall efficiency of a system (up to 95%)
- CHP BOP Solution from 400 – 10000 kWe
- "Standard" CHP solutions in a container
  400 - 2500 kWe
- Manufacturing facilities in Griffin, GA and Mannheim
- Natural gas and Low Energy fuel solutions.
- Multiple CHP configurations



Challenges Caterpillar's CHP equipment faces today

- Challenges
  - standardized interconnections, air permits, emissions requirements, and resiliency policies
  - State, local, and utilities regulations
- Lower emission levels that require additional BOP equipment and longer payback periods
- Lack of general knowledge and awareness of CHP technologies and benefits
- Lack of expertise in Sales and Service people in the industry.
- Lack of financial incentives or tax rebates
- Electrical and thermal loads do not match up
  - Seasonal Cooling
  - Thermal loads needed at different times than electrical
  - Limited or no thermal loads needed.

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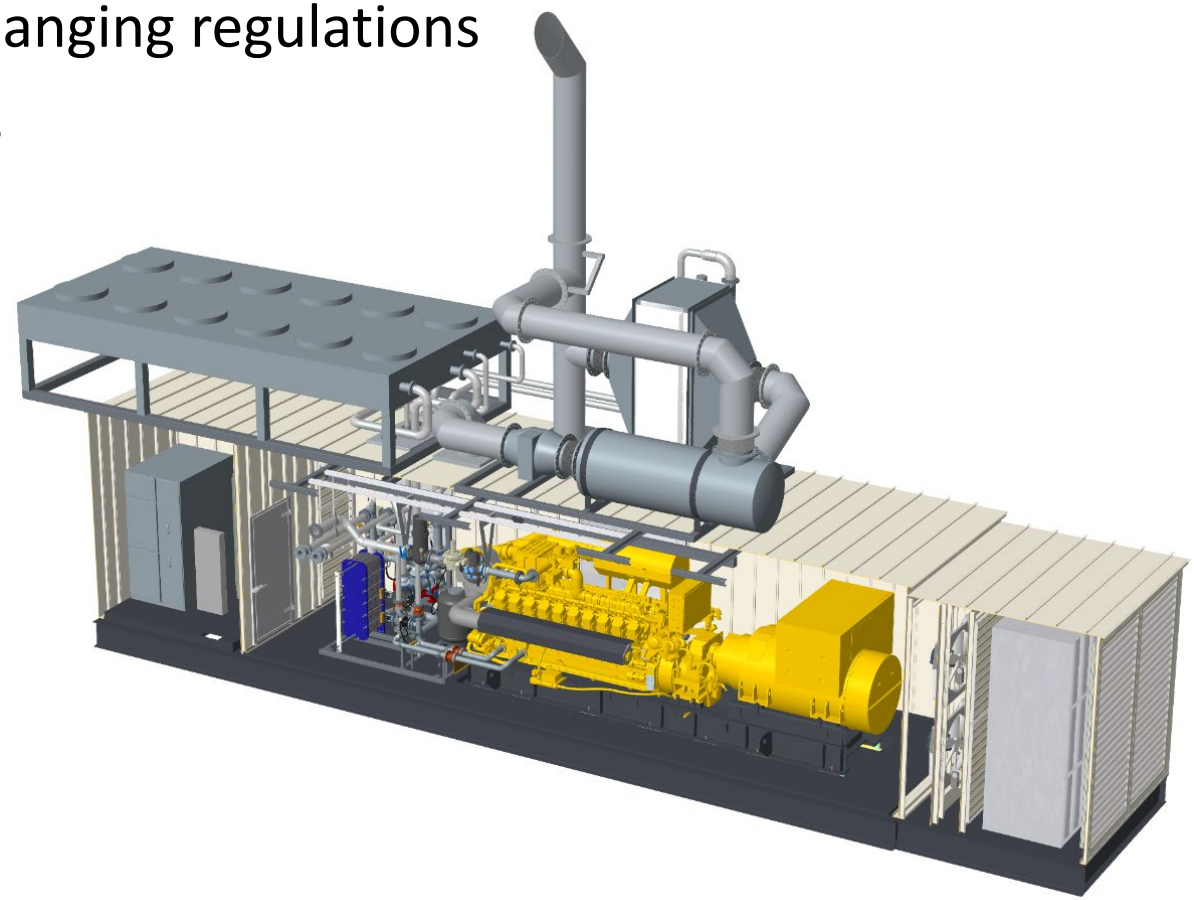
Challenges Caterpillar's CHP equipment faces in the future

CAT

- Government policies and regulations on fossil fuels
- The cost of BOP to meet new and ever-changing regulations
- Resilience to extreme weather conditions
- Alternate fuels such as Hydrogen
- Integrated and advance plant controls

Grey Hydrogen	Blue Hydrogen	Green Hydrogen
Uses natural gas to produce Hydrogen and CO_2	Uses natural gas to produce Hydrogen and CO_2	Uses water to produce hydrogen by electrolysis
CO_2 emitted into the atmosphere	CO_2 stored and used on site or shipped elswhere	No CO_2 produced



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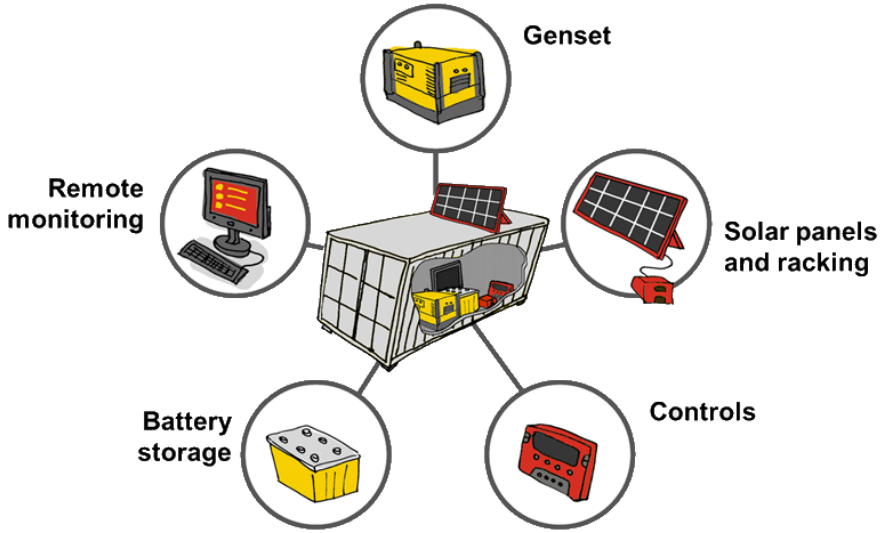
What Caterpillar is doing to future-proof its CHP products

- Increasing Electrical and Thermal efficiencies.
- Adding CHP solutions performance data to all of Caterpillar Sales and Service tools
- Training classes directly related to Sales and Servicing of CHP BOP equipment.
- Integration of hybrid solution with “standard” CHP solutions.
- Further reduction of Green House Gas emissions



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Solar® Turbines
A Caterpillar Company

Solar Turbines offers complete gas turbine power plant solutions, tailored to your power and heat/cooling requirements. We are a leading producer of industrial gas turbines and turbo machinery packages. These turbine driven generator sets are designed for base load electricity, combined heat and power, combined cycle, dispersed power, and peak shaving applications. Besides the electric power, these units can produce hot air, hot water, and steam, which can then be used in the production process for drying or heating purposes. The units are designed to operate in harsh mining environments and are capable of operating on a variety of liquid and gaseous fuels, as well as dual fuel (diesel & gas).

Chris Lyons
Manager, Power Generation
Solar Turbines
Administrative Headquarters
San Diego, California
Phone: 858.694.6586
Email: Lyons_Chris_D@solarturbines.com
www.solarturbines.com/en_US/index.html

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Solar's role in CHP market in the US

Solar Turbines
A Caterpillar Company

- Market leading supplier of combustion turbine generators sets from 1 MWe to 23 MWe
- Extensive service organization to support operation and maintenance of these units
- Can support balance of plant supply and financing

World's Largest Manufacturer of Industrial Gas Turbines (1 to 23 MW)

Subsidiary of Caterpillar Inc.
Since 1981

16,000+
Gas Turbines Sold

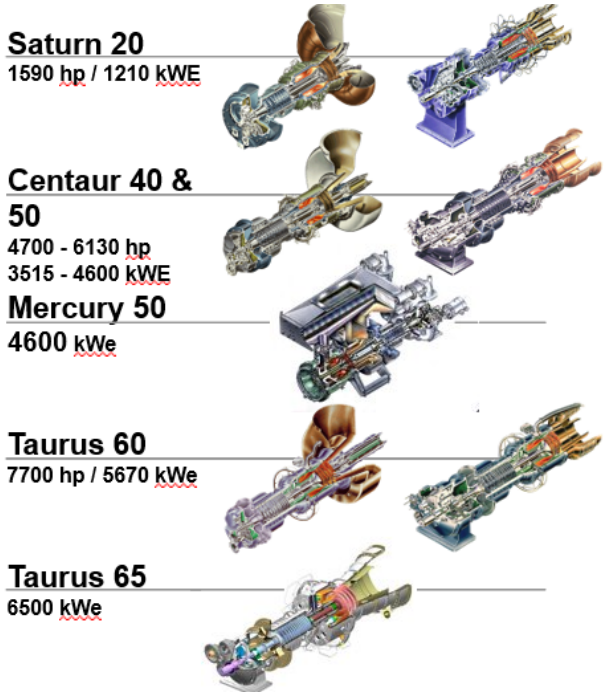
6,500+
Gas Compressors Sold

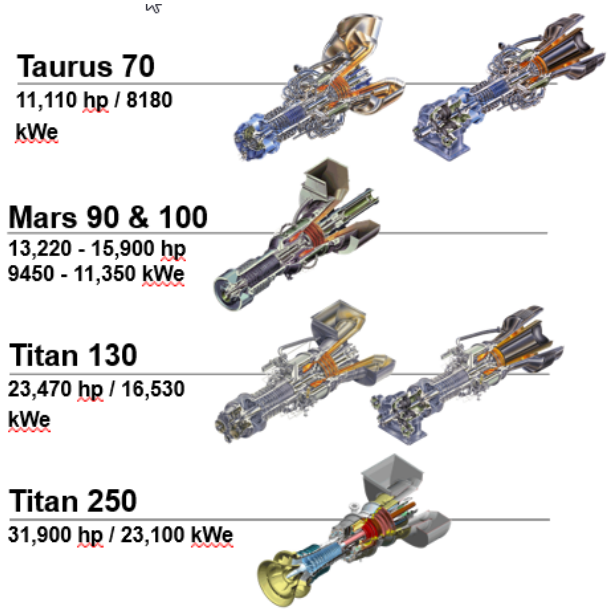
Installations in
100+
Countries

Direct
End-to-End
Sales and Service

65
Sales and Service Locations

Global Workforce
8,000+
Employees





Updated Apr 2019

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Challenges Solar's CHP equipment faces today

Solar® Turbines
A Caterpillar Company

- Energy Transition / Fuel transition: How natural gas is being perceived
- Low natural gas prices, while great also lowers energy operating cost, so improving cost is a lower priority
- No clear regulated electric utility strategy to deploy CHP
- COVID19 is having a short term effect on capital investments, delaying projects
- Uncertainty on future carbon pricing
- Future USA requirements on carbon, will we be net zero by 2050?
- In Europe it is Grid Code Compliance, will impact USA as well
- Plus all of the usual challenges (utility standby charges, interconnection cost, capital prioritization, etc., etc.)

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Challenges Solar's CHP equipment faces in the future

Solar® Turbines
A Caterpillar Company

- Fuel Flexibility – capable of operating on various carbon neutral fuels
- Low Emission – Enhancing emission capability to reduce overall emission.
- Flexible power – Meeting power demand in high concentration of renewable power in grid, and capable of handling grid interruption from renewable energies.
- Public perception of fossil fueled technologies
- State mandates to be all Green Energy

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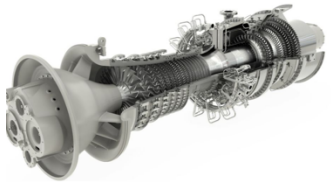
What Solar is doing to future-proof its CHP products

Solar® Turbines
A Caterpillar Company

- Expanding low carbon fuel capabilities
- Standardizing and providing expanded package features
- Developing carbon capture capabilities
- Working on lower thermal heat to power systems to improve efficiencies
- Providing expanded digital controls to better integrate with renewable energy and to optimize carbon footprint
- Compliance with Grid Code, frequency and response times
- Faster starting times
- Power Boost to meet short term peak demands/prices

Solar Turbines DLE H2 Roadmap



2018 - 2020
- Up to 20% H2 Technology with NOx below 15ppm
- LEL Methods Development
- Screening viable solution up to 100% H2: TRL 1-2

2021 - 2022
- Legacy system qualification up to 20% H2
- 100%H2: New platform design (ATP): TRL 3

Flame stabilization method development (Oscillations, Flashback)

Flame Detection technology development

2023 - 2024
- 100% H2 Single Injector Scaled Rig Testing (ATP);
- DSTF
- TRL 4-5

Flame measurements to calibrate numerical models

2024 - 2026
- 100% H2 NPI Development
- First Engine Test
- TRL6-7

2027 - 2028
- 100% H2 NPI Productionization
- TRL 8

2029 - 2030
- 100% H2 Field Evaluation
- TRL 9

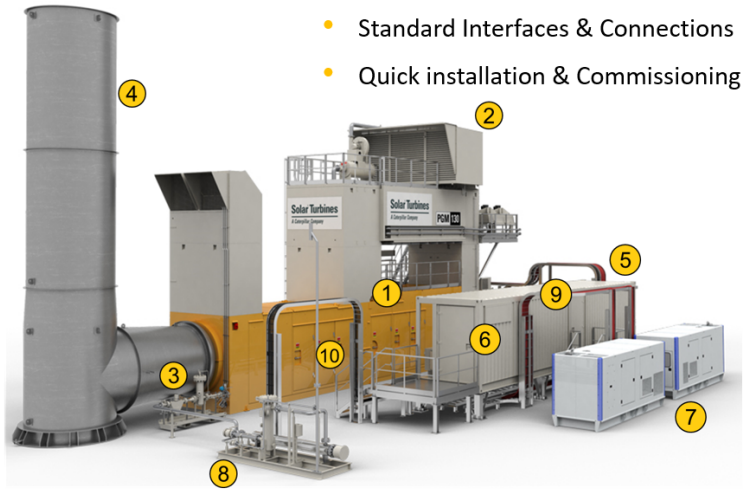
Hydrogen H_2

Modular Power Plant (MPP)

Power Generation Module	
1	Enclosed Package
2	Air Filtration & Ventilation Module
3	Off-Skid Gas Fuel Module

BOP Modules	
4	Exhaust Module (Exhaust Duct)
5	Electrical Equipment Module (EEM)
6	Service Air Module
7	Black Start Module
8	Fuel Gas Conditioning Skid (FGCS)
9	Plant Supervisory Console (SCADA)
10	Interconnections

- Modular
- Compact Footprint
- Standard Interfaces & Connections
- Quick installation & Commissioning



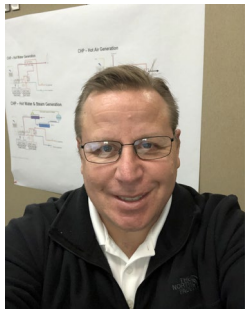
PGM designed with BoP integration in mind...

Question for the Panel

Moderator

Richard Sweetser
President

Aaron Tasin
Vice President Sales



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