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## Medium Speed Engine Power Plants

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## Agenda & Discussion Topic



*"The Medium Speed Power Plant market has seen tough last two years due to the global market situation however electric power demand is increasing and the MSE technology sees more demand to replace old conventional fossil power plants in Europe, in North America and other parts of the world, due to their high efficiency and flexibility"*

Today we will discuss :

### Today's Agenda

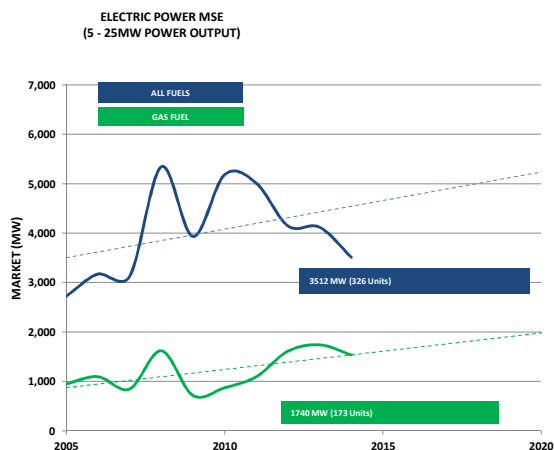
- Medium Speed Engine Power Plant Market and fuel Trends
- Cat Power Plants Overview
  - MSE common Applications
  - MSE as Prime Mover
- Cat MSE Product Portfolio
- Standardised Design
- References

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## MSE Power Plant Market & Fuel Type

**GAS**



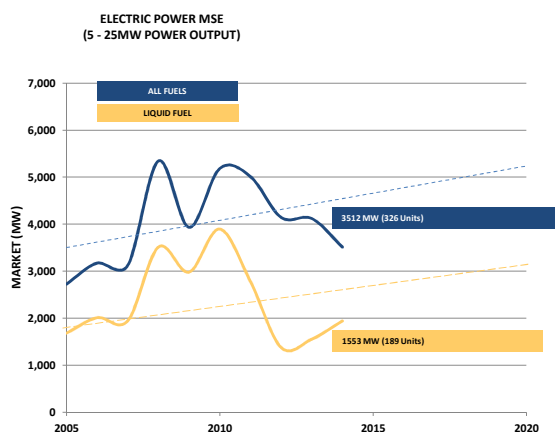
Diesel & Gas Turbine Power Generation Order Survey Data is source for '05 - '14 Data.

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## MSE Power Plant Market & Fuel Type

**Liquid Fuels**



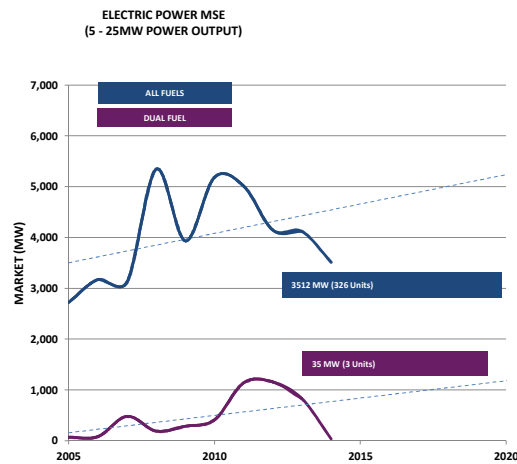
Diesel & Gas Turbine Power Generation Order Survey Data is source for '05 - '14 Data.

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## MSE Power Plant Market & Fuel Type

Dual  
Fuel



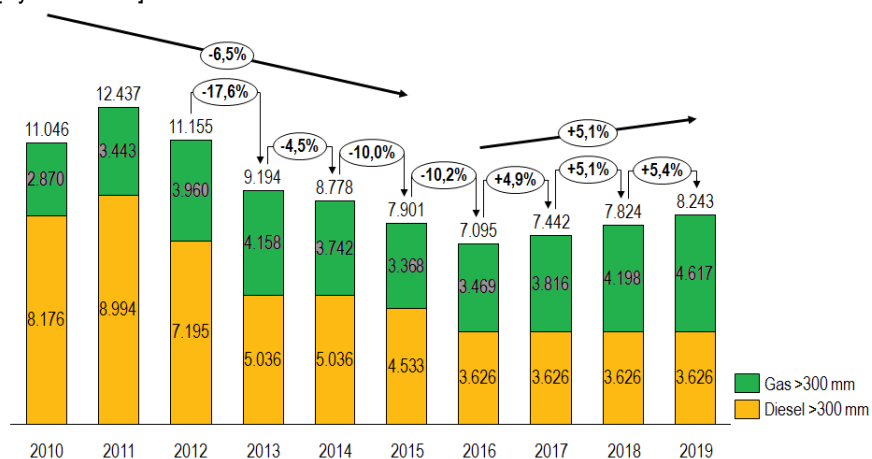
Diesel & Gas Turbine Power Generation Order Survey Data is source for '05 - '14 Data.

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## VDMA Large Engine Forecast

[Cylinder Units]



VDMA October 2015 (VDMA: German engineering association, Figures from engine parts suppliers & manufacturers)

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## Global MSE market



Despite all challenges, Caterpillar Power Plants expect a growth of Medium speed engine power plants market in near future due to many advantages vs. Conventional fossil power plants e.g.

- many > 100 MW gas projects in Germany to replace conventional fossil power plants
- Wind-following projects in USA where Medium Speed Engines replace gas turbine power plants
- Dual Fuel projects in the Middle East and other regions due to fuel flexibility advantage
- More Gas availability thanks to new LNG terminals e.g. Pakistan
- Etc...

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## CES Partner's success is CES success



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**Cat Power  
Plants Overview**







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## Cat Power Plants Overview

- A team within Caterpillar Energy Solutions (CES), Cat Power Plants is a leading supplier of medium speed reciprocating engine power plants for both interconnected (parallel to grid) and captive power (island mode) applications
- Plants' output: From 2 to over 200 MWe
- Contracting flexibility: Equipment Supply Contract (ESC), Engineered Equipment (EEQ), Design Engineering Services Agreements (DESA) and participation in Engineering, Procurement & Construction (EPC) projects
- Fuel flexibility: Dual Fuel, Heavy Fuel Oil, Diesel, Natural gas, Renewables and various blends of each.
- Operations & Maintenance Capabilities: Structured to meet customers specific requirements.

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## MSE – Common Applications

Single or multi-engine plants can be strategically located to feed into the distribution system (i.e. grid support). Scalable, modular design allows for efficient future plant expansion:

- Peaking / Intermediate base load
- Wind following (firming-up)
- Industrial CHP
- Combined cycle

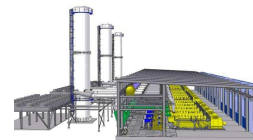


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## MSE - Common Applications



- **Peaking / Intermediate Base load**
  - Single or multi-engine power plants can be strategically located to feed into the distribution system (i.e. grid support). Modular design allows for efficient future power plant expansion
- **Wind Load**
  - Extremely flexible dispatch control and fast load response. Use of renewable fuels provides a “green” complement to installed wind capacity.
- **Industrial CHP**
  - Total plant efficiencies can exceed 90%. Easily integrated into existing infrastructure. Popular choice amongst mining, textile, cement and many other industrial segments.
- **Combined Cycle**
  - Traditional heat recovery steam generator (HRSG) and steam turbines or organic Rankine cycle (ORG) can be used to improve plant efficiency.

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## Medium Speed Engine as Prime Mover

Example : Captive Power Plants for Cement Companies  
High efficient and flexible Power Generation  
with very low water consumption

Tabuk Cement Company : 30MW, 4x16CM32 , KSA

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## Medium Speed Engine as Prime Mover

Example for Providing ancillary services  
and wind-following

Mid-Kansas Electric Company, LLC: 116 MW, 12xG20CM34, USA

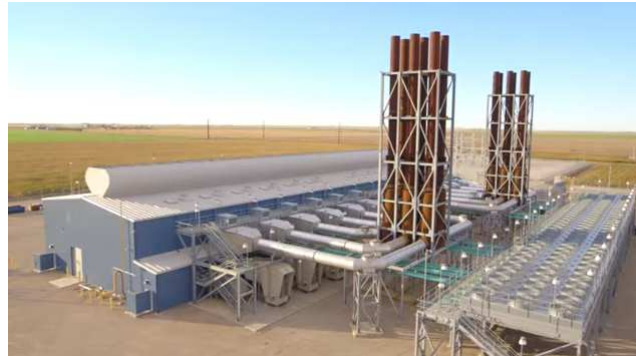
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## Cat® Natural Gas Generator Sets Deliver Flexible Power for Kansas Utility

<https://youtu.be/mpl4cA7-nSc>

<http://www.catpowerplants.com/ReferencesAndVideo>

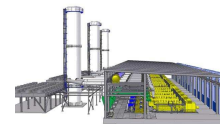


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## MSE : Perfect to provide Ancillary Services

- **Regulation:** Our power plants can:
  - Respond rapidly to requests for up and down movements
  - Track fluctuations in system load and correct for unintended changes in generator output
  - Ramp load up from 0% to 100% and back down in less than 3 minutes
  - Run at low load factors (as low as 25%)
- **Spinning Reserve:** Once synchronized to the grid, plants can increase output almost immediately in response to major generation or transmission outages
- **Non-Spinning Reserve:** With CM standard starting air system, our plants can go from 0% to 100% in less than 7 minutes (Gensets can be started unlimited times at no additional operating costs).
- **Replacement Reserve:** Generator sets can run for as little as a few minutes to as many hours as needed to restore spinning and non-spinning reserves to their pre-contingency status.



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## MSE: Perfect to provide Ancillary Services

- **Voltage/Frequency Support:** Cat Power Plants can be used to maintain transmission system voltage and frequency within required range



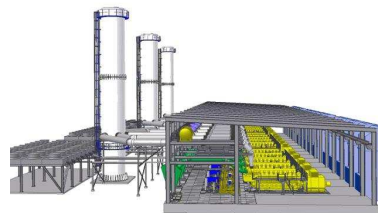
- **Black Start :** Can be started without support from the grid. Sufficient real and reactive capability/control to energize parts of the transmission system allowing for the start of other generation units.

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## Main Advantages of MS Reciprocating Engines (vs. Turbines):

- Higher efficiency in simple cycle (42+%, net of parasitic loads. HR~8,800 BTU/kWh, HHV)
  - Lower heat rate de-rating
  - With temperature
  - With elevation
  - In partial load
- Lower water consumption
- Lower time to start, synchronize and reach full load
- Lower shaft risk
- Unlimited starts at no additional costs



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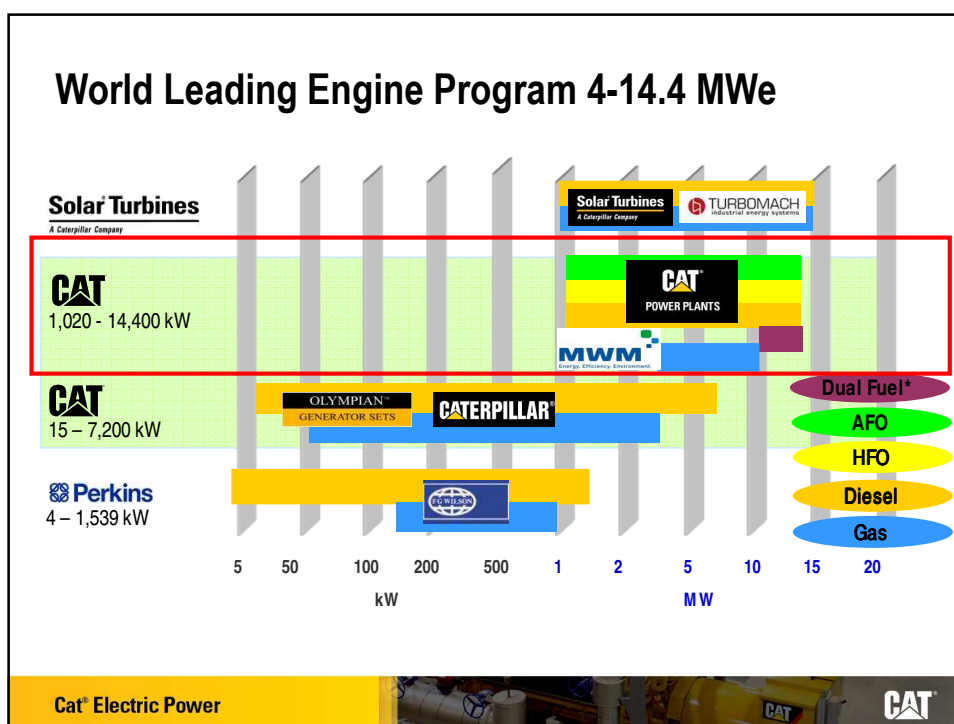
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**Cat Power Plants Products**



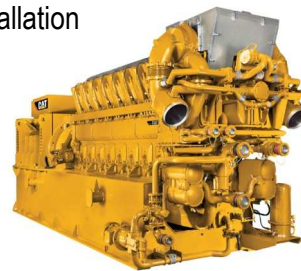
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## Products: CG260-16

- Workhorse, highly reliable with many references all over the world
- Low lube oil consumption
- Increased exhaust gas energy utilization
- Different gas types and fluctuating gas qualities
- Slim engine dimensions guarantee low installation costs
- High specific power-weight ratio
- Small weight and dimensions ensure easy transportation, even to remote places



CG260-16 (4.5 Mwe, 44.6 %)

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## Products: GCM and CM

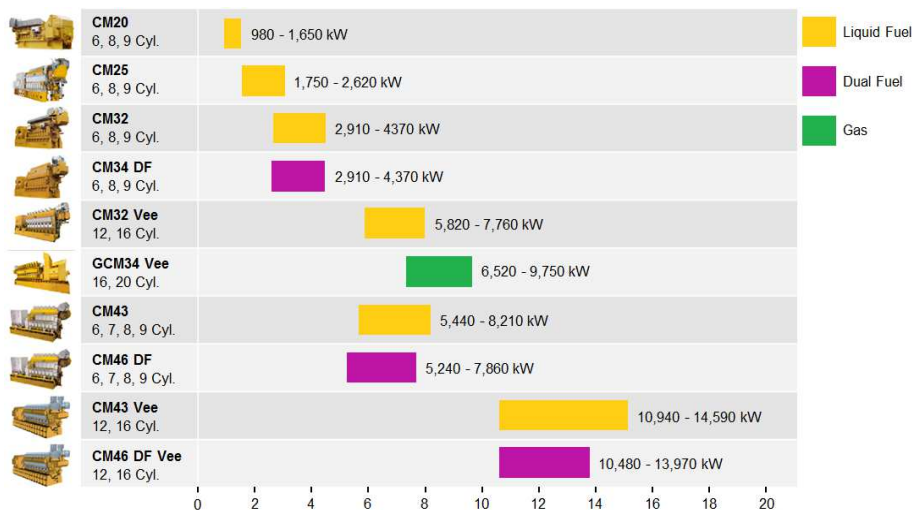
- ongoing projects for improving performance
- optimization of cost structure for increasing competitiveness
- development of capabilities to increase the scope of supply
- preparation of marketing material
- at the moment bulk of gas projects to be covered by CG260, GCM can be offered for selected projects



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## CM Medium Speed Engines



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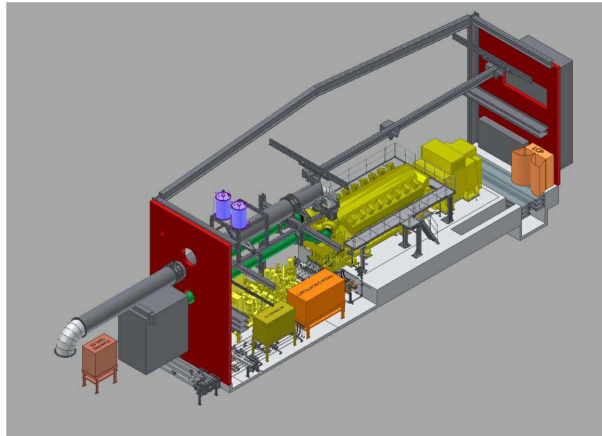
Standardised  
Design



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## Standardised Power Plant



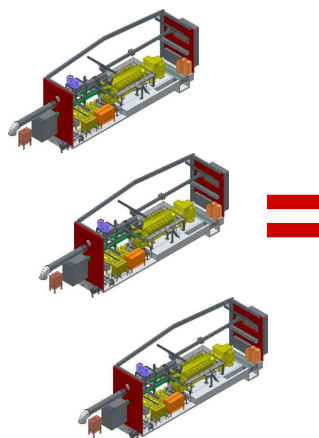
### Standard Power Train

- Pre-Engineered Modules & Interconnect facilitate standard:
  - Engineering & Deliverables
  - Sales and Product Support information
  - Application & Installation
  - Ease of Installation
  - Quality improvement

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## Standardised Power Plant



CM/GCM - Standard Power Plant

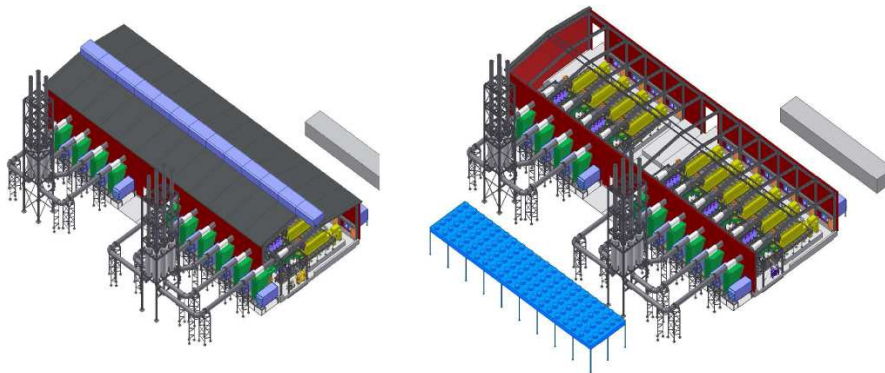
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## Standardised Power Plants

### 10 x G20CM34 Configuration – 100 MW



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## CAT Modular Power Plant – Decentralized power supply system



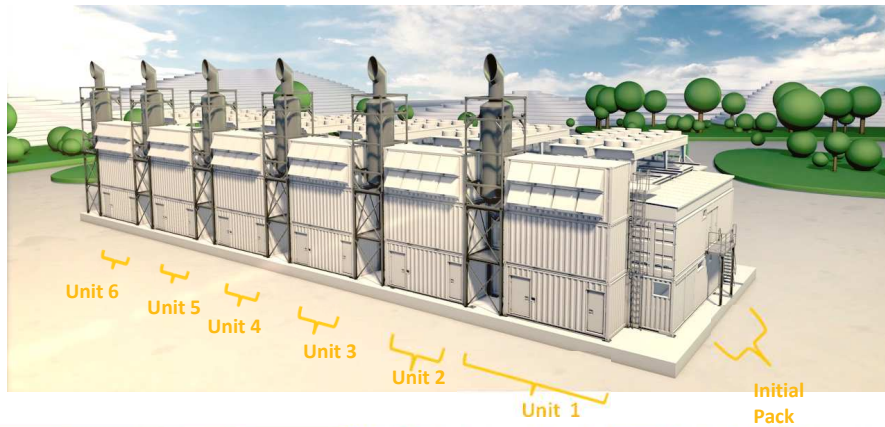
- Location-independent complete system
- All components are perfectly matched and prepared
- Quick mounting without any welding
- Efficiency in a new, compact design

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## Flexible scalability in any location

- MPP can be expanded step by step to include up to six units
- Delivering a rated output of up to 25.8 MWel
- Mobile power generation with a total efficiency of over 86%

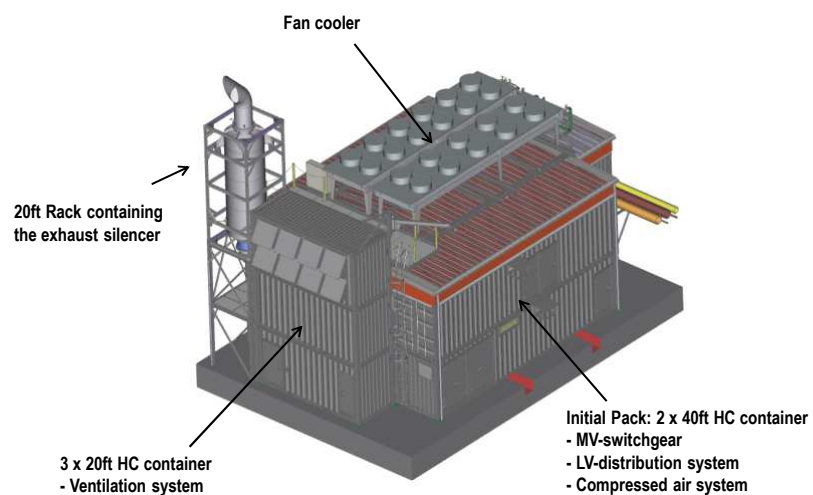


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## MPP Single Unit

Front View

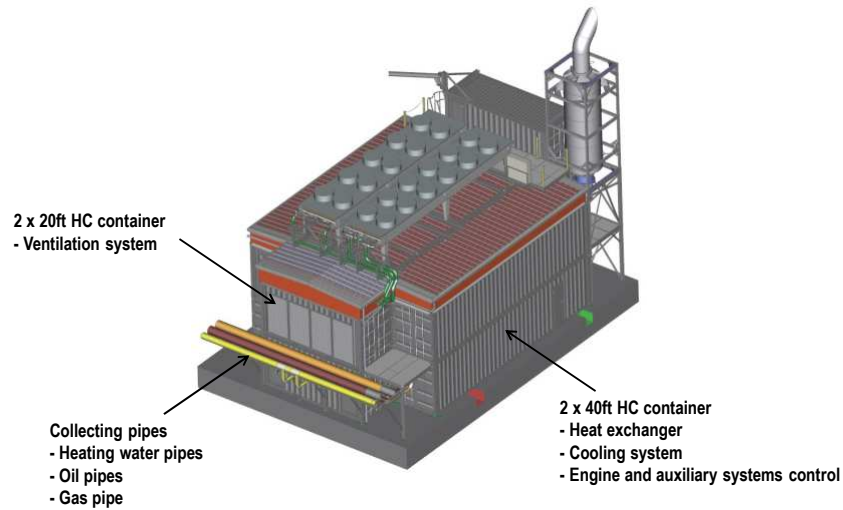


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## MPP Single Unit

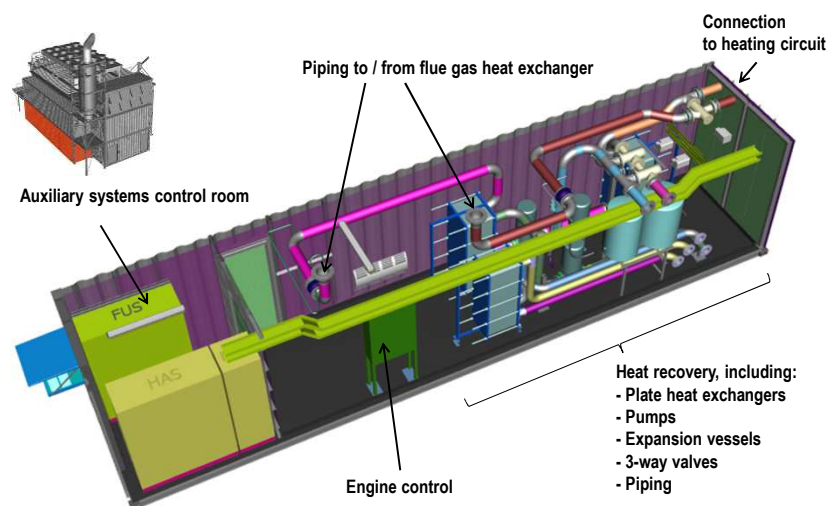
Back View



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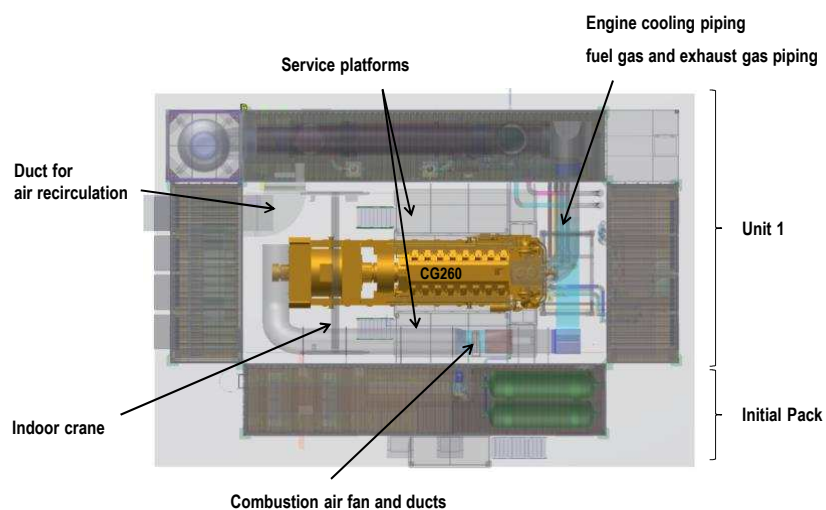
## Auxiliary Systems Container



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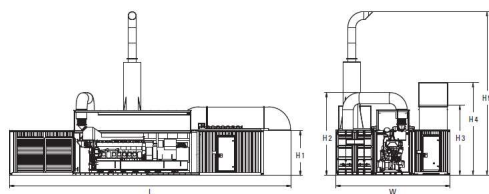
## Internal Layout



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## CM20 Power Box – compact solutions > 1 – 5 MWe



Length (mm)	Width (mm)	Height 1 (mm)	Height 2 (mm)	Height 3 (mm)	Height 4 (mm)	Height 5 (mm)
18,100	7,300	2,900	5,300	4,500	6,000	10,500

Dimensions are approximate values and subject to project specifics.

### Transport dimensions

	Length (mm)	Width (mm)	Height (mm)
Engine container	12,192	2,438	3,300
Auxiliary container	12,192	2,438	2,896

Type	Power kW	Power kW <sub>h</sub> <sup>a</sup>	rpm	Hz	Fuel consumption g/kWh <sup>b,c</sup>
9CM20C	1,530	1,489	900	60	187
9CM20C	1,710	1,642	1,000	50	190
8CM20C	1,360	1,308	900	60	187
8CM20C	1,520	1,459	1,000	50	190
6CM20C	1,020	979	900	60	187
6CM20C	1,140	1,074	1,000	50	190

<sup>a</sup> based on 98% efficiency and 0.8 Power Factor  
<sup>b</sup> According to ISO 9486-1  
<sup>c</sup> Fuel based on Cat Grade 68 specification limit values

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**References**








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## Peace River Power Center


**Canada, Genalta Power**




- 5 x CG260-16
- 20 Mwel
- Modular Power Plant
- Natural Gas
- Commercial Operation: 2015



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## Werk Globalfoundries Inc.

### Dresden, Germany

The Energy Supply Center II, consisting of nine CG260-16 can provide uninterruptedly 35 MW<sub>el</sub> and 38 MW<sub>th</sub> used for heating and for refrigeration.



- 9 x CG260-16
- 35 MW el plant output
- Tri-generation
- Natural gas
- Commercial Operation: 2007

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## Mid-Kansas Electric Company, LLC

### Rubart Station, Ulysses, Kansas, USA

Providing ancillary services and wind following



- 12 x G20CM34 @ 9.2 MWe each
- 116 MW plant output (ISO)
- Largest Caterpillar natural gas plant in the world
- Caterpillar provided:
  - Gensets and major aux equipment
  - Emissions control equipment
  - Supervisory and commissioning
- COD – June 2014

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## City of Geneva

### Geneva, Illinois – USA

Clean, efficient, reliable power for the city



- Municipal Utility
- 29MW plant employed to control peak electric system demands reducing the city's dependence on power delivered to Geneva
- Natural Gas
- 5 x G16CM34 @ 5.9 MWe each
- Caterpillar provided:
  - Caterpillar manufactured switchgear & controls
  - Engineering
  - Commissioning and Start-Up support
  - Maintenance
- Commercial Operation - 2004

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## Basin Creek

### Basin Creek, Montana - USA

Balancing the wind power



- Local utility
- Altitude 1600 m
- Natural Gas
- 50MW plant employed to help balance the ups and downs of the wind power
- 9 x G16CM34 @ 5.9 MW each
- Caterpillar provided:
  - EPC
  - Maintenance & Repair Contract
- Commercial Operation – Jan 2006

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## Basin Creek

### Southern Minnesota Municipal Power Agency Fairmont, Minnesota - USA

Replacing retired coal plant Offers ancillary services to MISO



- 25 MWe net plant output
- 4 x G16CM34 @ 6.3 MW each
- Natural Gas
- Caterpillar provided:
  - Gensets and major aux equipment
  - Emissions control equipment
  - Supervisory and commissioning
- Commercial Operation – Jun 2014

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## Alberta Newsprint Company

### Whitecourt, Alberta – Canada

Powering an industrial business and providing ancillary services



- 10 x G16CM34 @ 6.5 MW each
- 65MW plant employed to power the existing paper mill
- Offers ancillary services to the Alberta grid
- Caterpillar provided:
  - Engineering
  - Project Management
  - Commissioning and Start-Up support
  - Full EPC
- Commercial Operation – Jul 2014

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## Alberta Newsprint Company

Duba – Kingdom of Saudi Arabia  
Captive Power Plant



- 30 Mwe (site conditions)
- 4 x 16CM32
- Heavy Fuel Oil
- Caterpillar Components:
  - Engineering
  - Project Management
  - Commissioning and Start-Up support
  - Full EPC
- Commercial Operation – Jan 2016

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## Acorn

Jhulda – Bangladesh  
Acorn Infrastructure Services Ltd



- Independent Power Plant Producer
- 100 MW power plant
- Heavy Fuel Oil
- 8 x 16CM46
- Caterpillar delivered:
  - Engineering
  - All major equipment & controls
  - Installation Supervision
  - Commissioning and Start-Up support
  - O&M
- Commercial Operation – 2012

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## Monte Rio Power Corporation

Dominican Republic  
Power Generation



- 13 x 9CM43 @ 7.86 MWe each
- Heavy Fuel Oil
- Caterpillar / Dealer Components:
  - Finance
  - Equity
  - Project Engineering
  - Commissioning
  - Construction Management
  - Operations & Maintenance
- Commercial – Jan 2003

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## More Info

<http://www.catpowerplants.com>

<http://www.mwm.net>

<http://marine.cat.com/>

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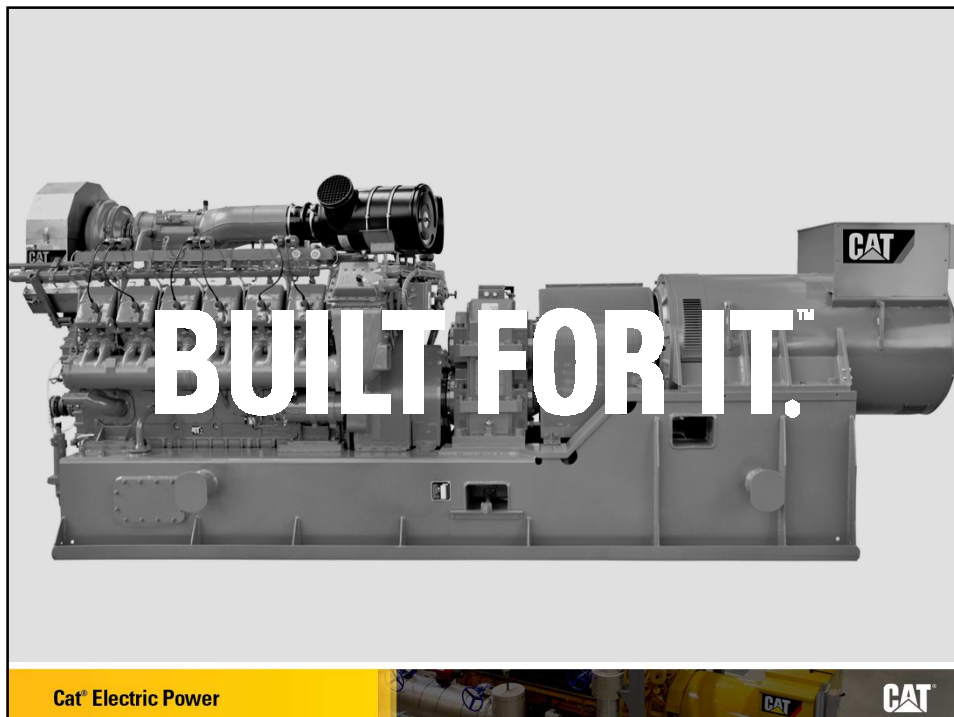




## Thank You

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