One powerful future.

Technology Utilization:
Sustainable Power Generation with CMM Gas

Caterpillar Business Development Manager
Gaseous Low Energy Fuels
Electric Power Division

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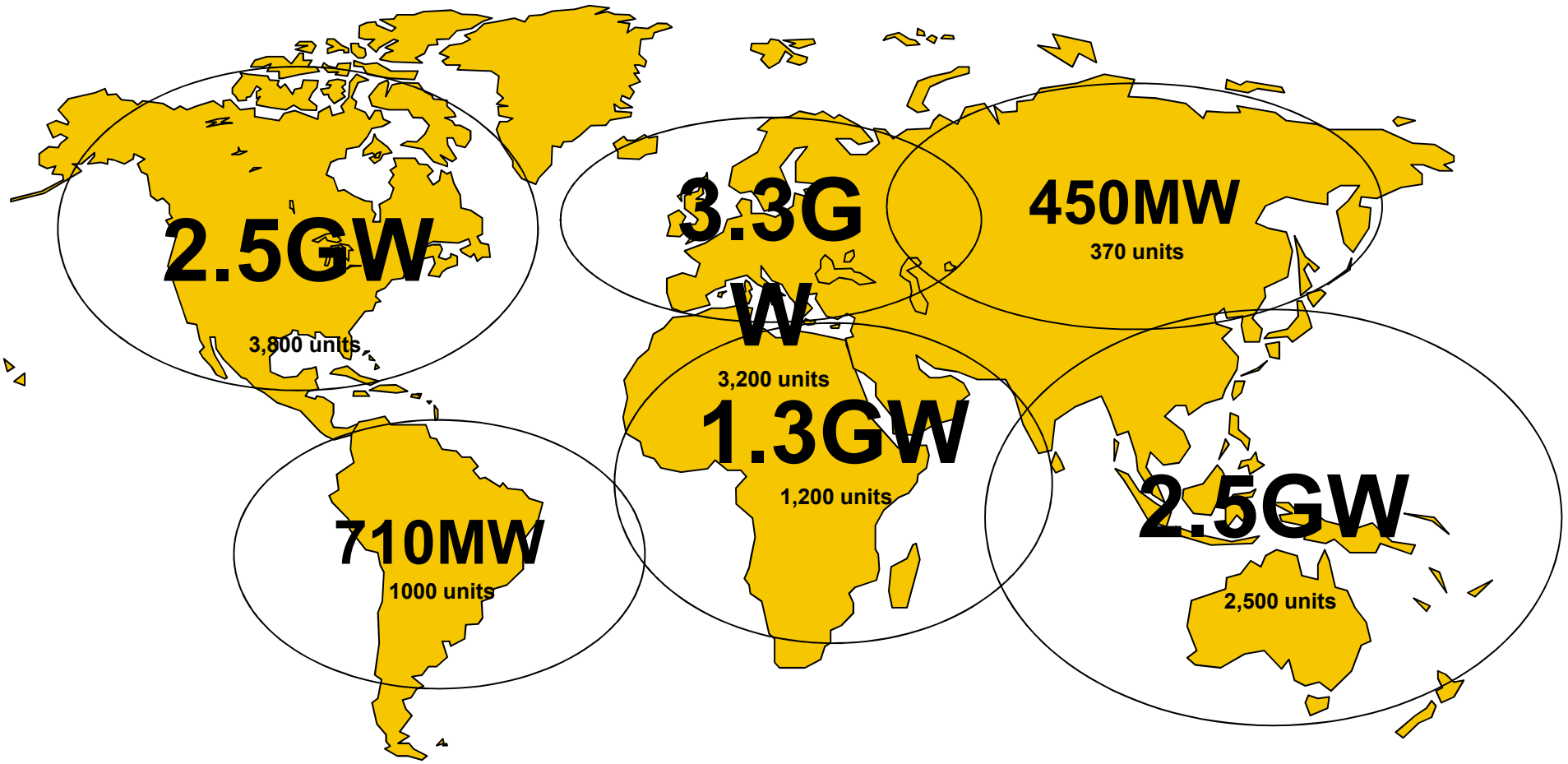
Outline

- Introduction to Caterpillar.
- CBM, CMM Utilization.
- Project Experiences.
- Why Sustainable Power Generation from CMM?
- Overview of Jincheng CMM claster.

11GW Gas Gensets (15 Years Population)



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Product Support

- One of the best dealer distribution networks in the world.
- Fast Repair and Reduced Downtime.
  - Critical for Plant Economics.
  - Cannot be Compensated with Higher Efficiency.
- Worldwide Logistics
  - **Parts Supply within 24 hours**
- Service Contracts
  - Extended Service Agreements
  - Fleet Management

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Coal Mine Methane

CATERPILLAR®

TODAY'S WORK. TOMORROW'S WORLD.™

Project Example - North America Compression

Over 1000 Caterpillar Gas Engines in Coal Bed Methane Compression

Coal gas projects account for 7.5% natural gas in USA

Appin & Tower Coal Seam Methane Project

- BHP Appin & Tower coal mines are located in New South Wales. Two hours from Sydney.
- Construction commenced in July 1995
- Full capacity of 94 MW was achieved in September 1996
- Combined engine hours to date of 7,990,000

Caterpillar Coal Mine Methane Solutions

Energy Developments Limited
BHP Billiton's Appin and Tower Coal Mines
New South Wales, Australia

- 96 megawatts electricity
  - 94 Cat 1,030 kW generator sets
  - 600,000 m^3 per day of methane consumed
  - VAM feed to power plant
  - 3.4 M T CO_2 equivalent reduction /year
- 15 years of operation,
  - Over 100,000 operating hours
  - Major overhauls at 60,000 hours
  - Combined engine hours to date of >8,000,000

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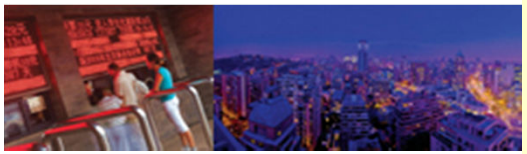

WORLD FIRST CMM ENERGY INNOVATION

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German Creek Project

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Caterpillar Coal Mine Methane Solutions

German Creek, Australia

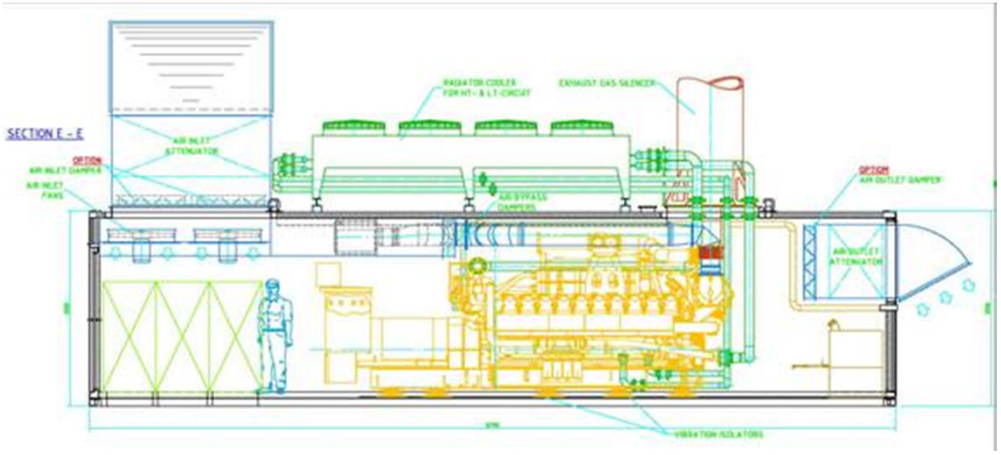
- Anglo Mining Company Simple Cycle 32 MW (16x G3520C) Power Plant
- NO_X Limit of 500 mg/Nm^3
- 690 V to 22 kV to 66 kV

German Creek CMM Power Station

Caterpillar Coal Mine Methane Solutions

South Park
South Yorkshire, England

- 24 MW (12 X G3520C) Power Plant
  - 2x units at 6 locations
- NO_X Limit of 500 mg/Nm ^{3}
- Parallel to the grid
- Operational November 2005
  - Over 40,000 hours of operation
- Application: Abandoned Coal Mine Methane
- Gas supplied by Anglo coal
- Modular solutions designed for quick installation and location flexibility.



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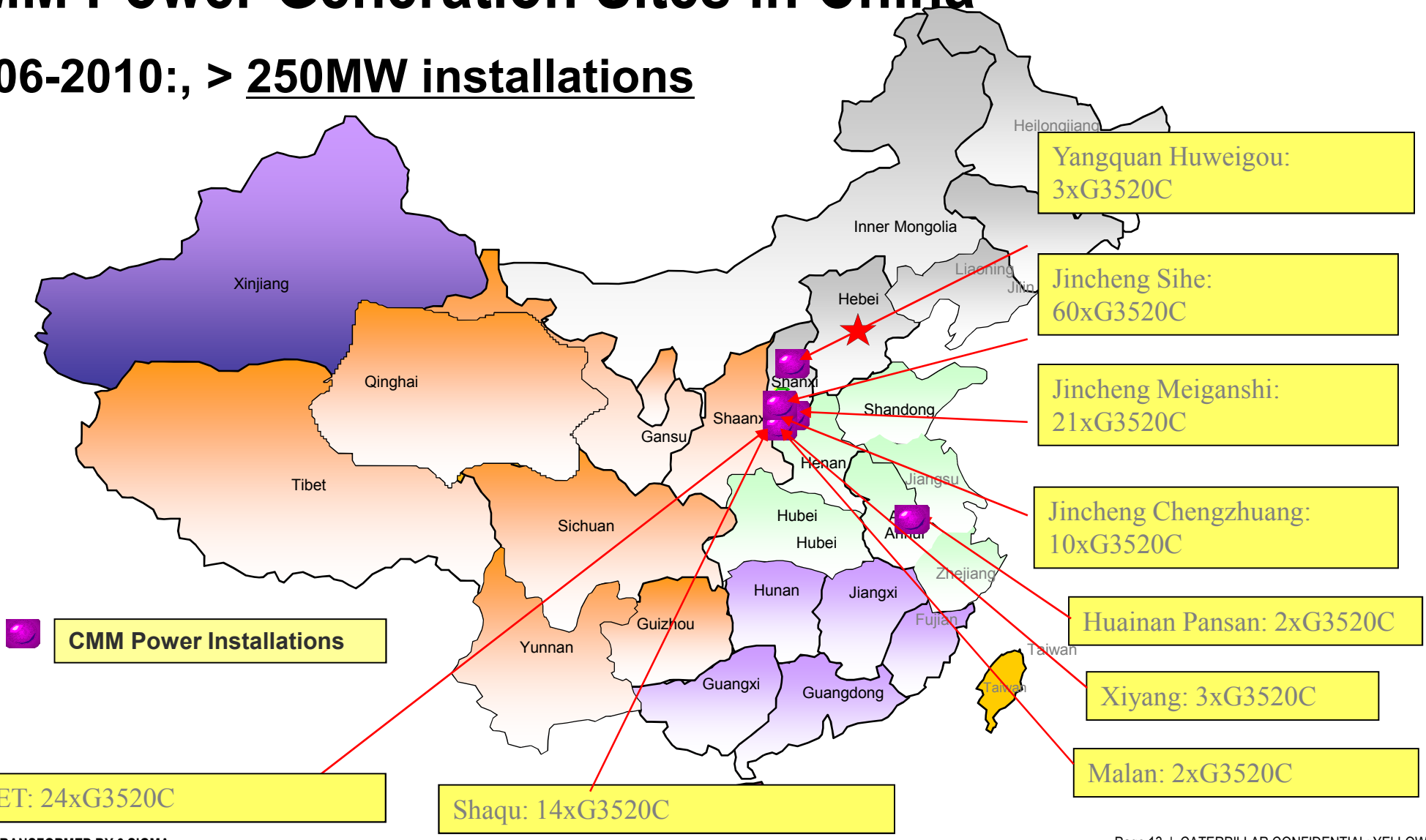
Project Example – 4 MW at Manvers UK

CMM Power Generation Sites in China

One powerful future.

2006-2010:, > 250MW installations



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Project Overview

- Power plant Capacity: 120 MW
- Power Sold to Electricity Company: 840,000 MWhr/y
- Heat Recovery in Winter: 233,600 GJ
- Carbon Credits: 2.5 MMTCE to the World Bank's Prototype Carbon Fund

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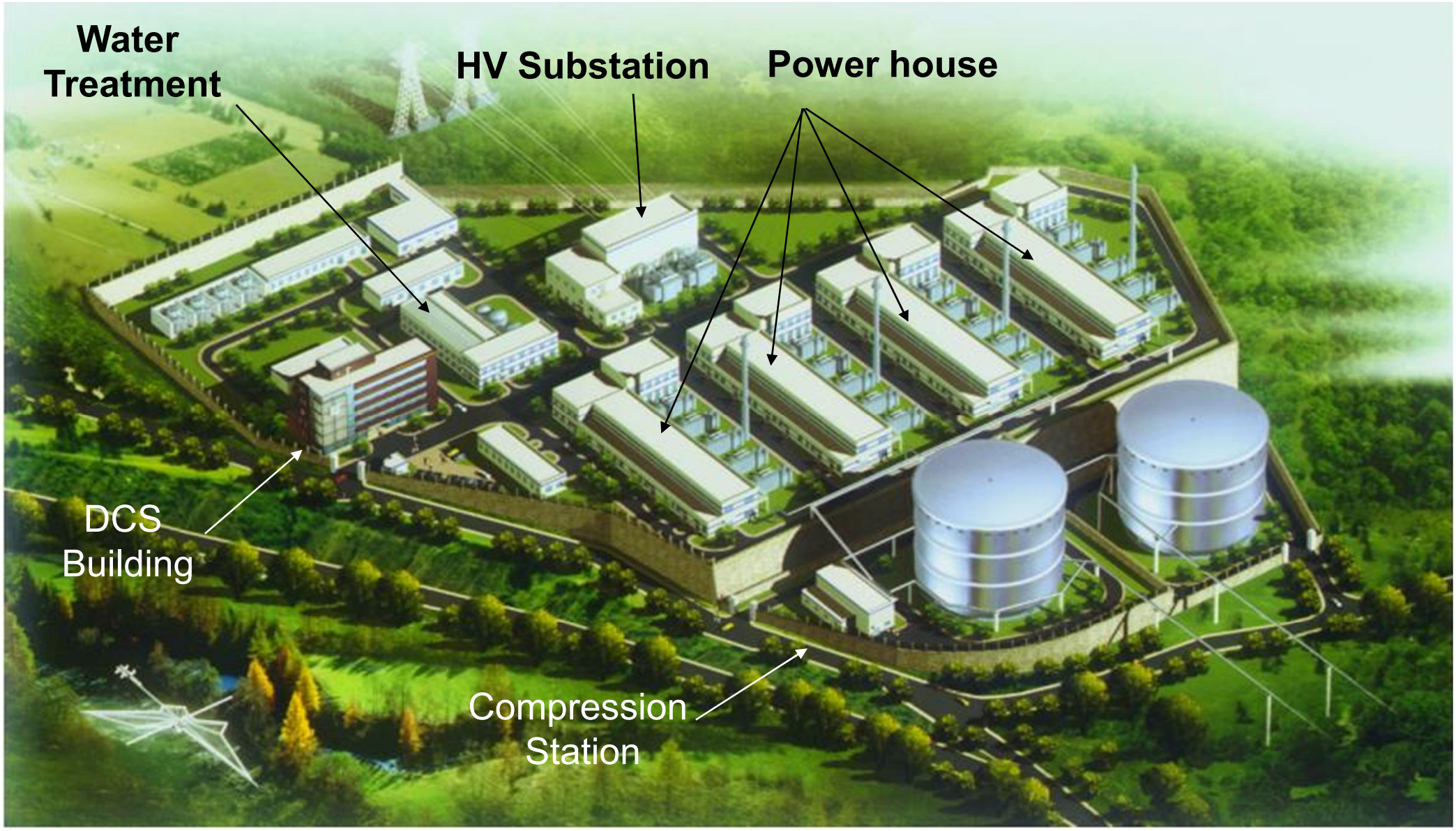

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Project Scope

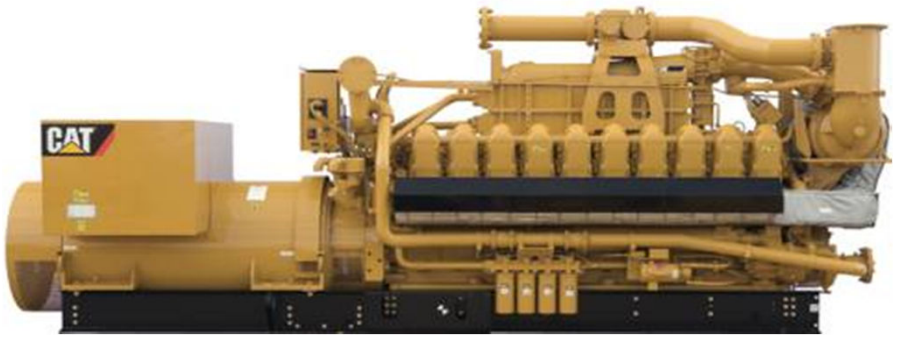
- 120 MW of 24/7 Continuous Electric Power and Steam Generation
  - Divided into 4 power houses of 30 MW Each
  - 60 x CAT 1.8 MW G3520C CMM Gas Engines
  - 16.5 Tons/hr of Superheated Steam Generation at 2.5 MPa and 400°C
  - 4 x 3 MW Steam Turbines and/or 10 MW of Hot Water for Winter Heating
  - 10.5 kV, 50 Hz Operation
  - Standard Grid Parallel
  - Full Load System Thermal Efficiency of 80%

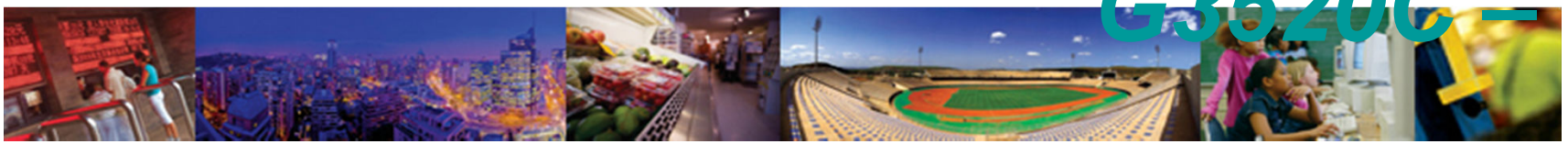
Technology Selection Criteria

- Gas pressure requirement
  - High speed Engines 1 – 2 MW require 300-1000 mbar
  - Medium Speed Engines 3 – 6 MW range need 2 – 3 bar
  - Turbines (6 MW and above) need around 25 bar
    - Higher pressure requires more complex compression equipment.
    - More power needed just to boost compression.
    - Wasted Energy consumption affects overall efficiencies.
    - More safety concerns.

Caterpillar Gas Engines

- Key Technology Strengths
  - Robust core components based on more than 50 years of gas engine production experience
  - Reliable and prove design
  - Stable performance (±1% deviation in kW)
  - **High efficiency (40 + %) in balance with high uptime and low Owning &Operating Cost.**
  - Low emission (250/500 mg/Nm 3)
  - Tolerant to ambient changes
  - Tolerant to fuel changes





G3520C – CMM

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JINCHENG SIHE
120MW
Power Plant

Jincheng CMM Power Generation Updates

- A total of three CMM power plants: 1) 120MW, 2) 42MW, and 3) 20MW in three locations with **91 x G3520C CMM units**
- In 2010, three CMM power plants generated a total of **1.28B eKW-hr** at an average of **89% availability**
- In 2010, **45** out of the 91 x G3520C units has undergone **scheduled Top End Overhaul.**
- The customer is satisfied with the overall performance of the G3520C CMM generator sets.

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Thank You!

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