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WHERE THE WORLD TURNS FOR POWER

Sustainable Energy Development
Coal Mine Methane in China

Overview of a 120 MW Coal Mine Methane Cogeneration Power Project in PRC

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Road Map for the Presentation

- Introduction
- Selection Criteria and Product Capability
- Project Challenges
- Commercial Opportunity
- Summary

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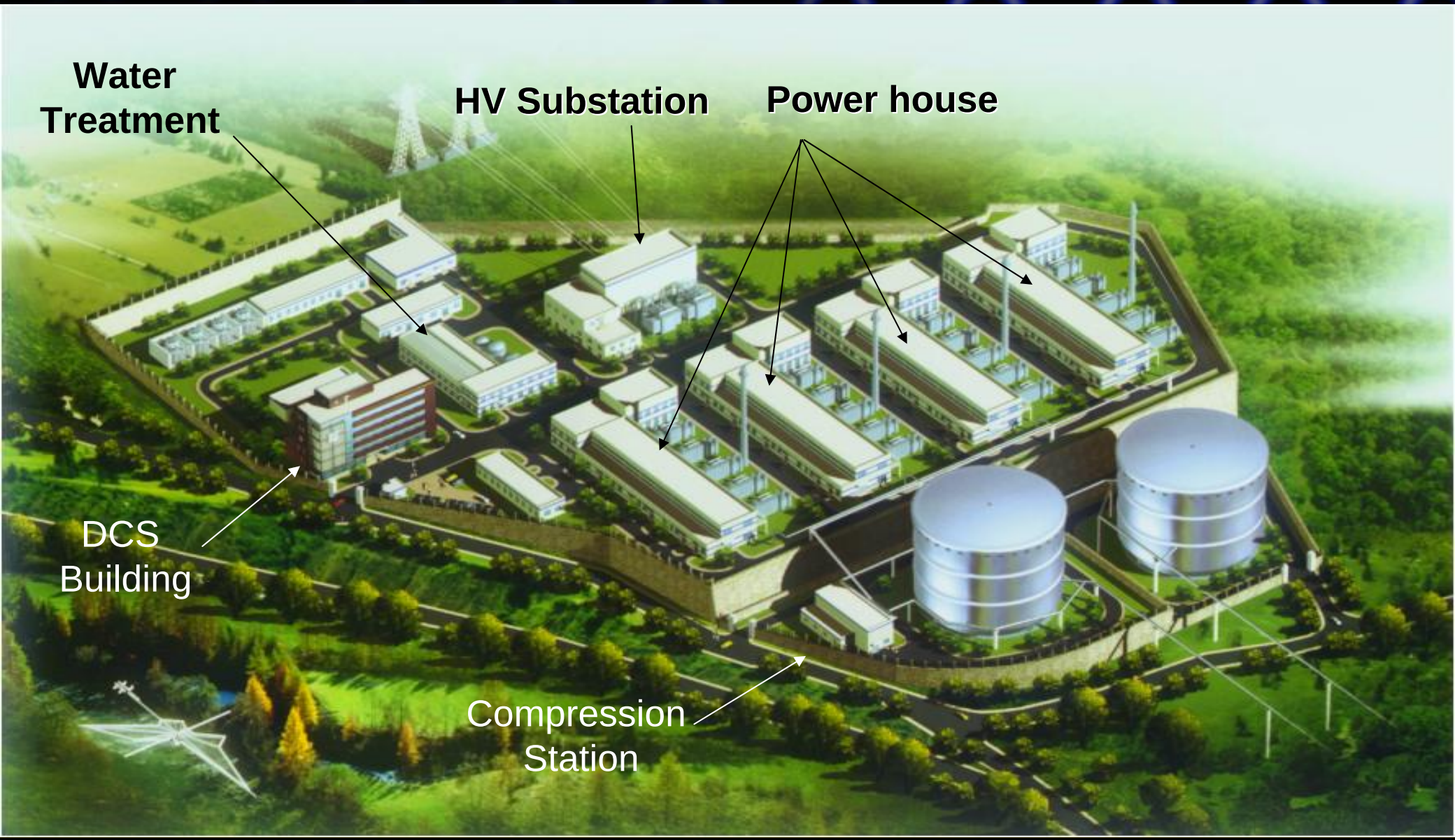
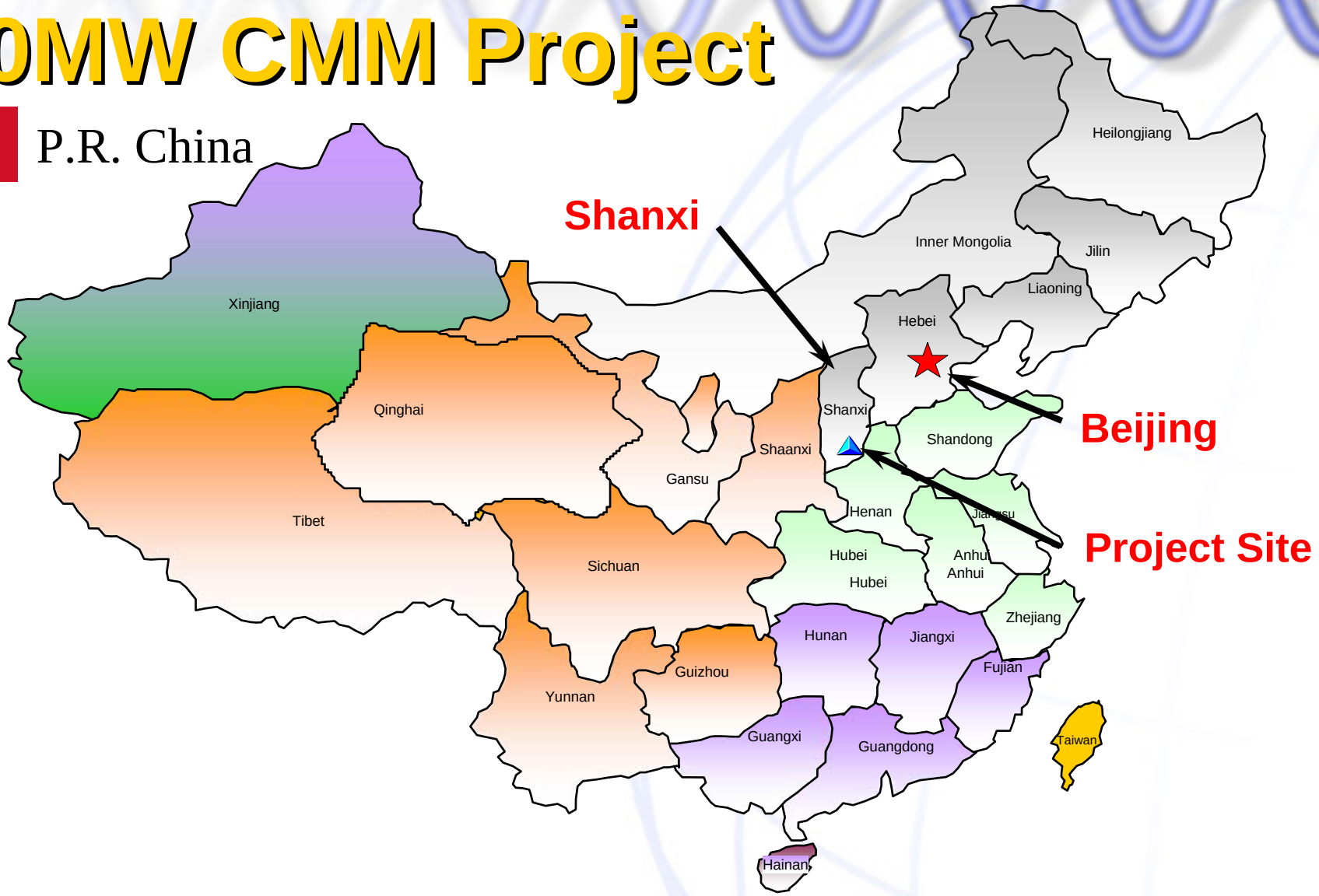

Water Treatment
HV Substation
Power house
DCS Building
Compression Station

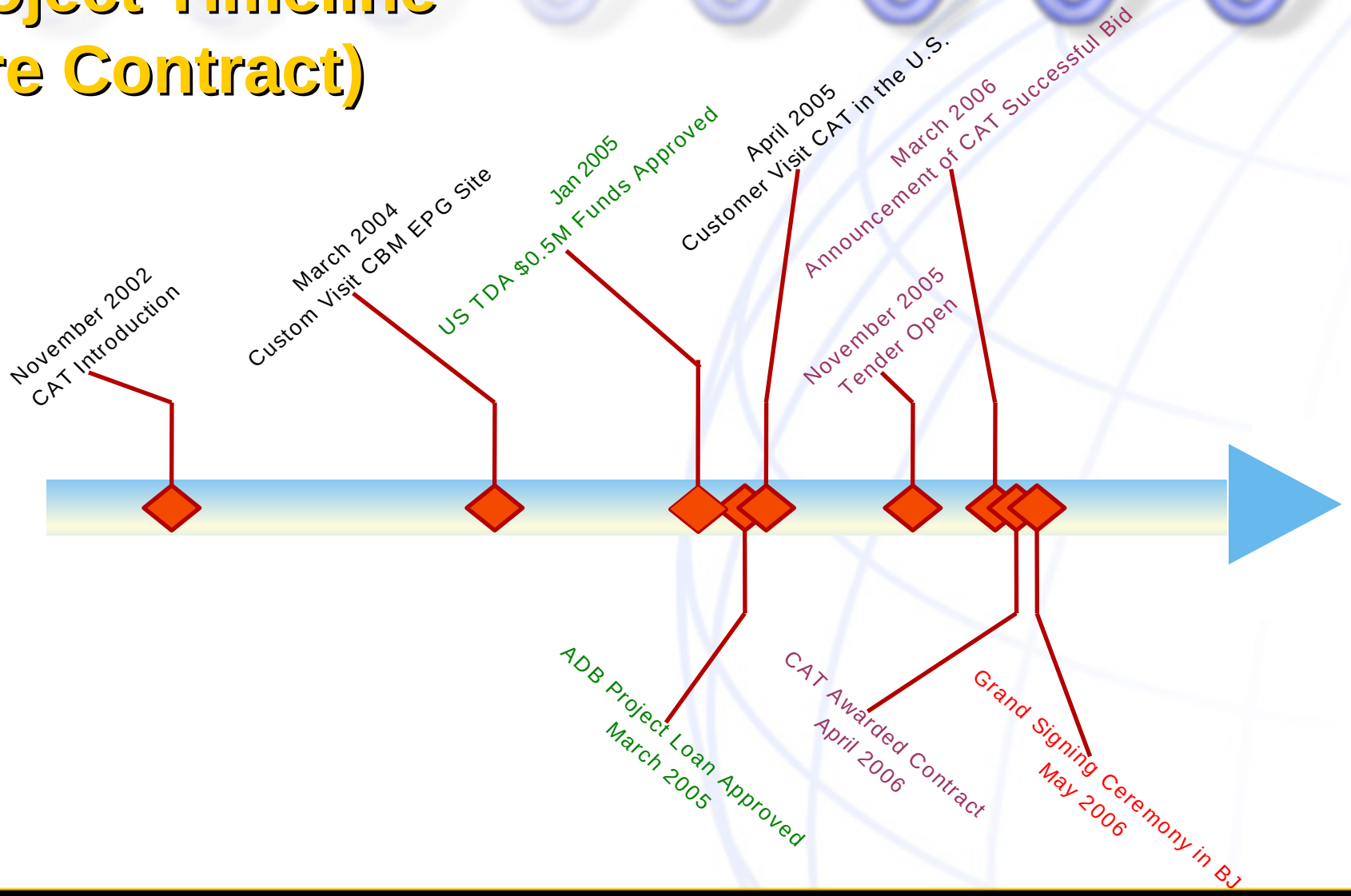
120MW CMM Project

P.R. China

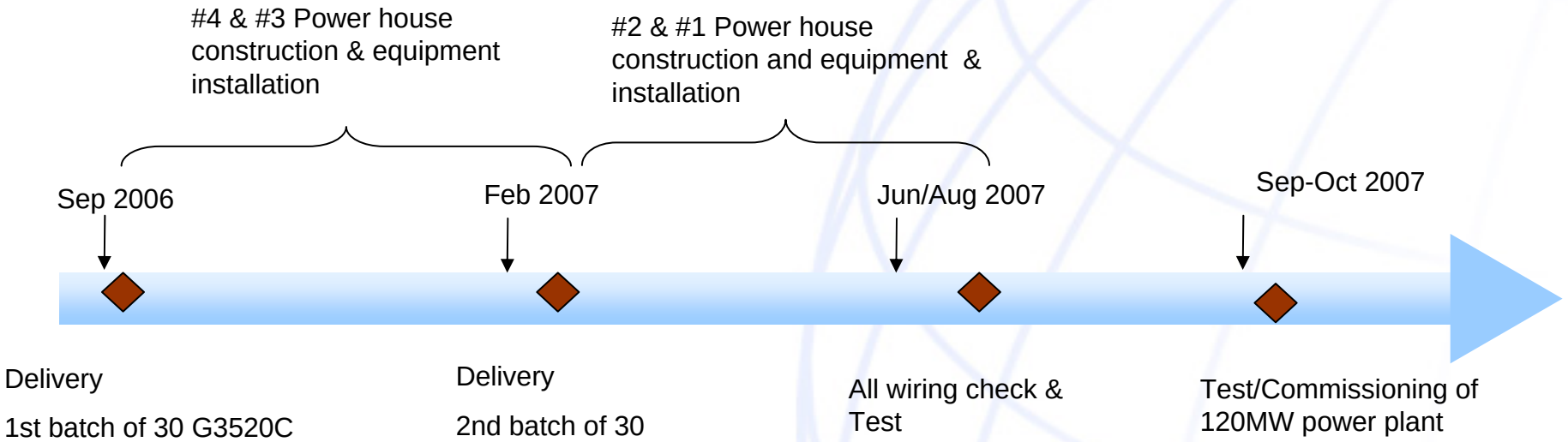


HISTORICAL MOMENT
MAY 18 , 2006
GRAND SIGNING CEREMONY
GREAT HALL OF THE PEOPLE
TIANANMEN SQUARE

Project Timeline (Pre Contract)

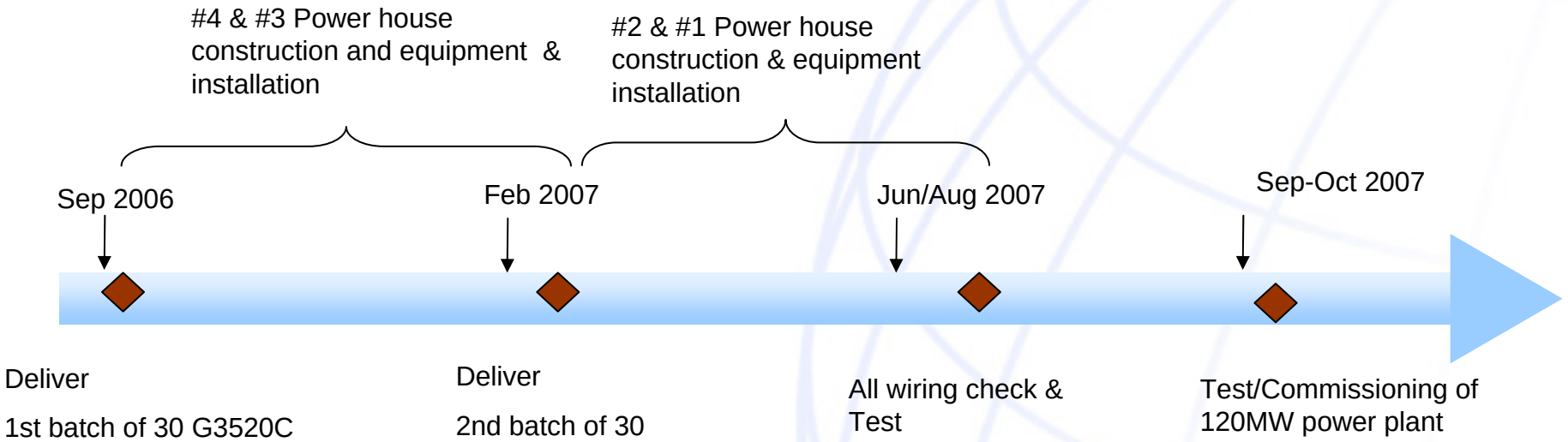


Project Timeline(Post Contract)

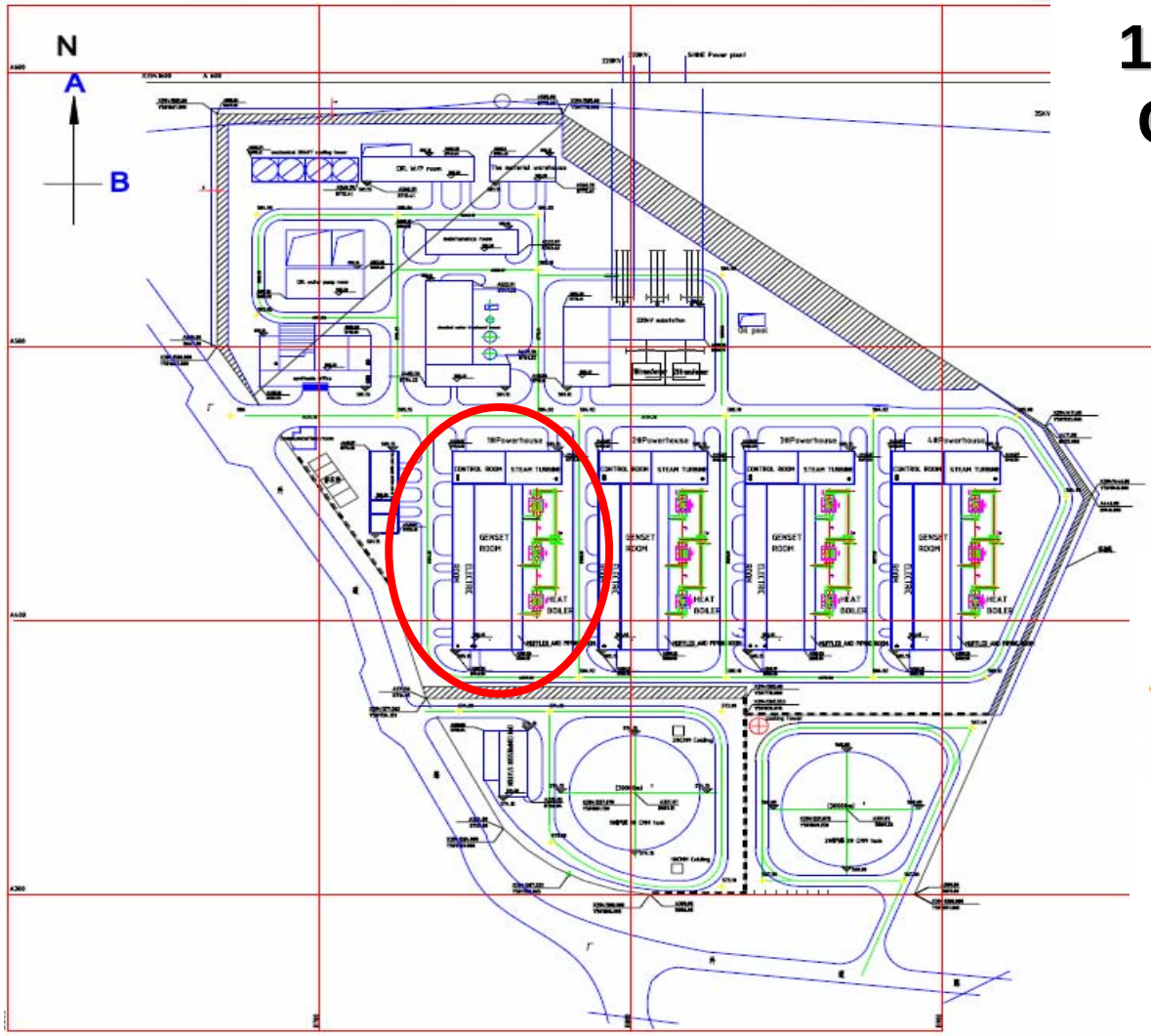


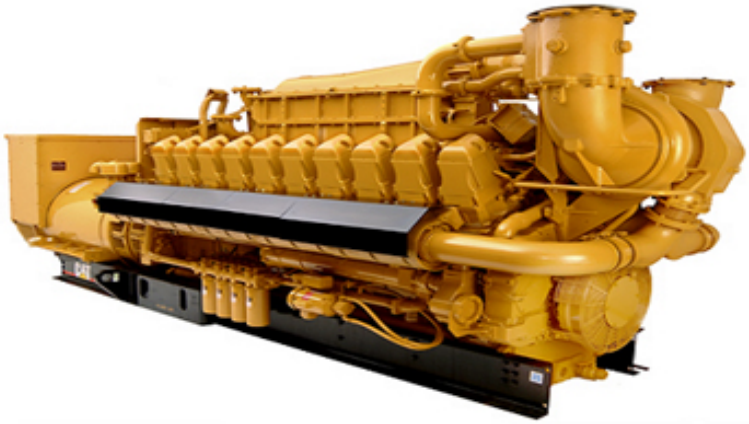
Phase 1 - First 30 packages
Phase 2 - Second 30 packages

Project Timeline(Post Contract)



120 MW Coal Mine Methane Cogeneration Power Plant





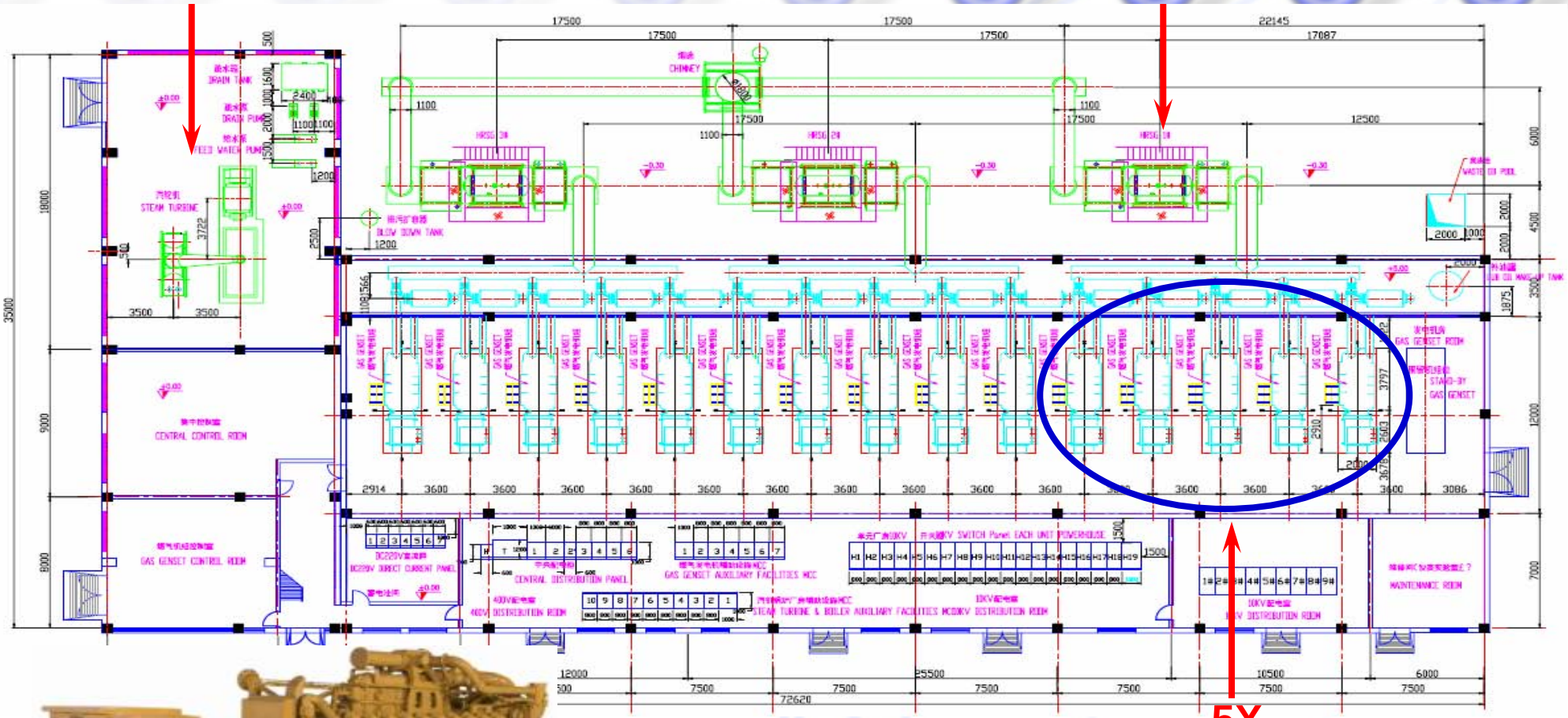
Project Scope

- 120 MW of 24/7 Continuous Electric Power and Steam Generation
  - Divided into 4 Bank of 30 MW Each
  - 60X CAT 1.8 MW G3520C CMM Gas Engines
  - 16.5 Tons/hr of Superheated Steam Generation at 2.5 MPa and 400°C
  - 4X 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%

- Equipment Suppliers
  - Caterpillar (Gas Generator Sets, Switch Gear, Gas Train)
  - Shanghai Electric Company (Balance of Plant)

3 MW Steam Turbine

HRSG



G3520C

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Typical Fuel Properties

Component	Symbol	Units	Pipeline Natural Gas	CBM	CMM*
Methane	CH_4	vol %	92.3	85.9	**40.0**
Ethane	C_2H_6	vol %	2.5	3.8	---
Hydrogen Sulfide	H_2S	vol %	---	---	---
Oxygen	O_2	vol %	---	2.1	12.6
Nitrogen	N_2	vol %	3.5	8.2	46.8
Others	---	vol %	1.8	0.0	0.6
Lower Heating Value	LHV	MJ/Nm^3	33.2	32.5	**13.4**
Caterpillar Methane Number	MN	---	80	86	100

*** Represents one particular site**

Selection Criteria

- **Gas pressure requirement**
  - Why is it important?
    - Well pressure is in the order of 50-100 mbar
    - Compression equipment needed to boost the pressure
    - Volumes required are high due to the low LHV
  - High speed Engines 1 – 2 MW require 300-1000 mbar (16 HP/ MW Compressor power)
  - Medium Speed Engines 3 – 6 MW range need 2 – 3 bar (50 HP/ MW Compressor power)
  - Turbines (6 MW and above) need around 25 bar (130 HP/ MW Compressor power)
  - Higher pressure calls for more elaborate compression equipment
    - More power needed just to boost compression
    - Wasted Energy consumption affects overall efficiencies
    - More safety concerns

Selection Criteria

- **Availability of Gas**
  - Depends on the type and characteristics of the mine
  - Limited by the extractability and process of mining
  - Wide fluctuations in volume is a real possibility

Selection Criteria

- **Ability to tolerate fuel swings**
  - Depends on the type of gas available in the region
  - **Calls for a faster response of the Engine**
  - **Calls for better air fuel ratio control**

Selection Criteria

- **Utility Connection Point Voltage**
  - Depends on the size of the power plant and load in the region
  - Depends upon the availability of the transmission line nearby
  - Depends on the location of the unit
- **Higher the connection point voltage the better the Stability**
- **Local plant load usually integrated with the Utility**

Gas Generator Set selected

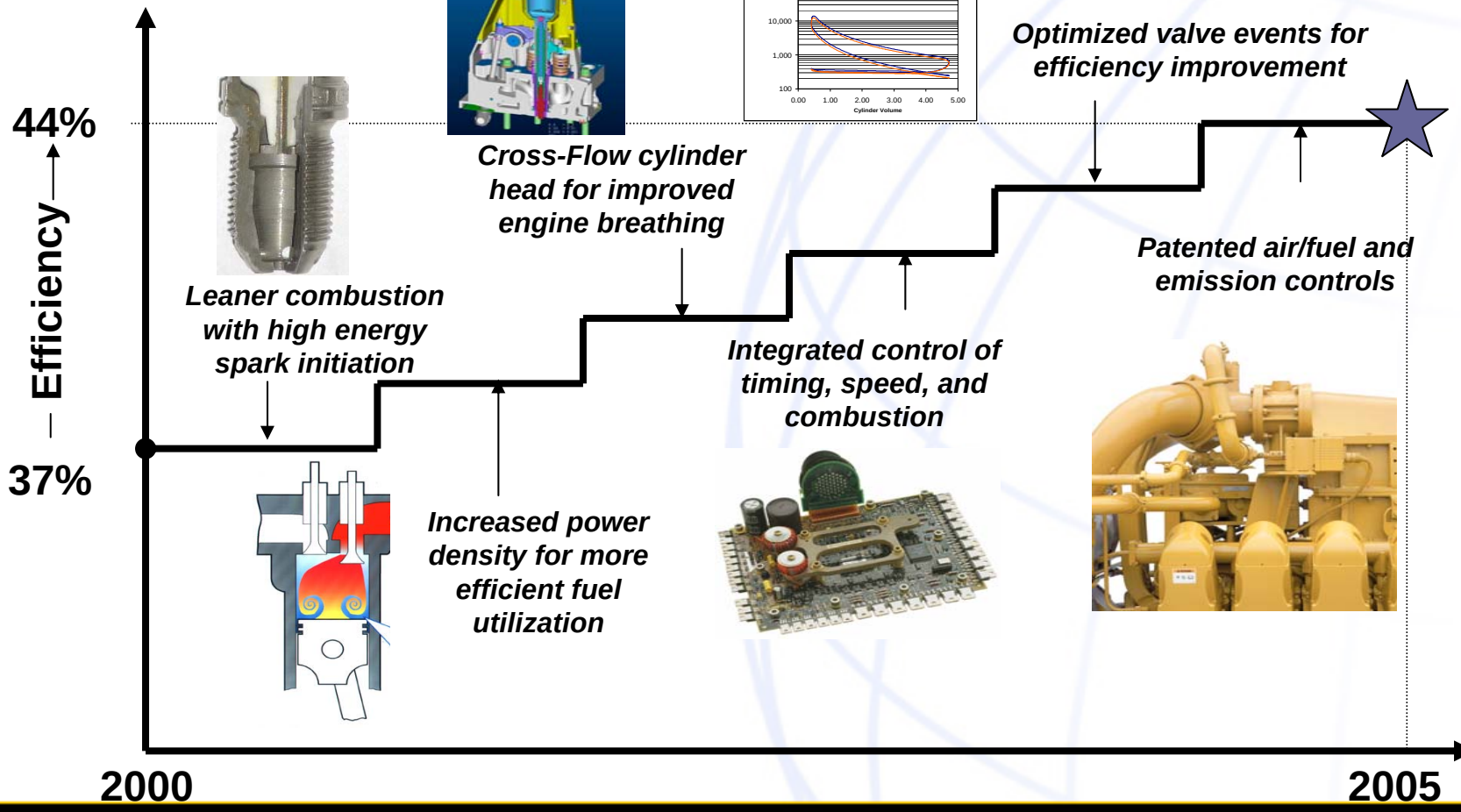
- **From all the selection criteria, the following emerge:**
  - Require Engines operating with lower gas pressures
  - Due to volume variation multiple units required
  - Require have High Voltage Generation
  - Ability to response quickly to fuel swings

Engine Technology Development

- Basic Requirements
  - Safety
  - Reliability
  - Efficiency
  - Low Emissions
  - Product Support

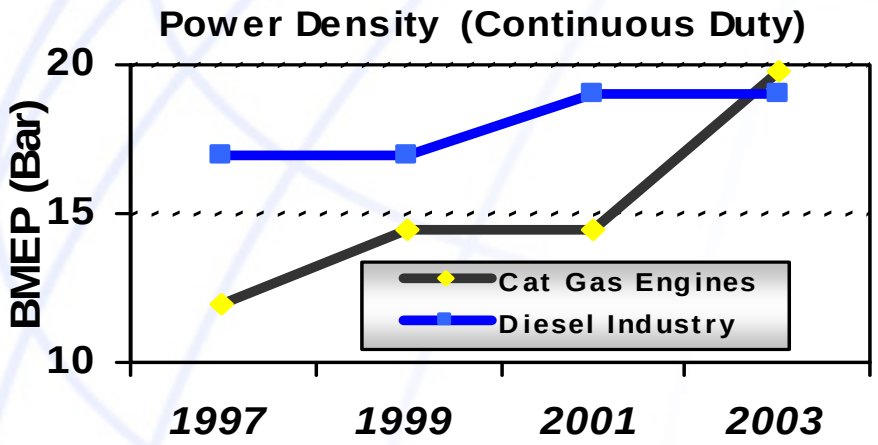
Voice of the Customer!

Efficiency Improvements



Engine Emission Enhancement

- **Power Density Impact**
  - New Gas Engines Have Higher Power Density Than Comparable Diesel Engines at Continuous Ratings
- **Efficiency Impact**
  - 7 Points More Efficient
- **Emissions Impact**
  - 75% Reduction in NO_X



Product Support

- 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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Key Project Challenges

#1 - Phase 1 - G3520C Generator Set & Aux. – Five months after Contract

Action:-

- Strong Support from Caterpillar. Top priority for Sustainable Development Project
- Key project managers – Factory, Regional & local level
- Daily/weekly meeting on progress
- Advance Logistic arrangement
- Working closely with customer and importation company.

#2 - Learning Experience

- First in the country – Large scale coal mine methane power plant development

  - Design Concept
  - Contracting
  - Project management

#3 – Complexity in Project Management

- 9 Bid Packages
- Need experience project manager to organize and pull the work together
- Critical Path analysis

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Power Project Benefits

- **Commercial**
  - Largest CMM Power Plant in the World
- **Social & Environmental**
  - Electric Power for Township
  - Energy Efficiency Program – Cogeneration
  - Removal of Hazardous Gas – Mine Safety
  - Reduction of Greenhouse Gas – Environmental (CDM Program in Place)
- **Corporate Governance**
  - Improve Bilateral Trade between USA and China

Vital Statistics

- **Power Generated and Sold to Utility**
  - 840,000 MW-hr/yr
- **Heat Recovery in Winter**
  - 233,600 GJ
- **Carbon Credit**
  - 4.5 MMTCE to the World Bank's Prototype Carbon Fund

Project Finance (USD240M)

- Bank Loans(74%)
  - Asian Development Bank
  - Japan Bank for International Cooperation
  - Industrial Commercial Bank of China
- Equity Capital (26%)
  - Coal Mining Group
  - Provincial Government
  - Municipal Government
- Grants
  - USTDA Grant on project management (USD 450K)

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Sustainable Green Electricity from Coal Gas in China

- Safety Concerns – A Local Priority
  - Effective Drainage
- Security Concerns – A National Priority
  - Energy Price's Volatility
- Environmental Concerns – A Global Priority
  - Increasing Global Warming awareness worldwide


2007/07/01


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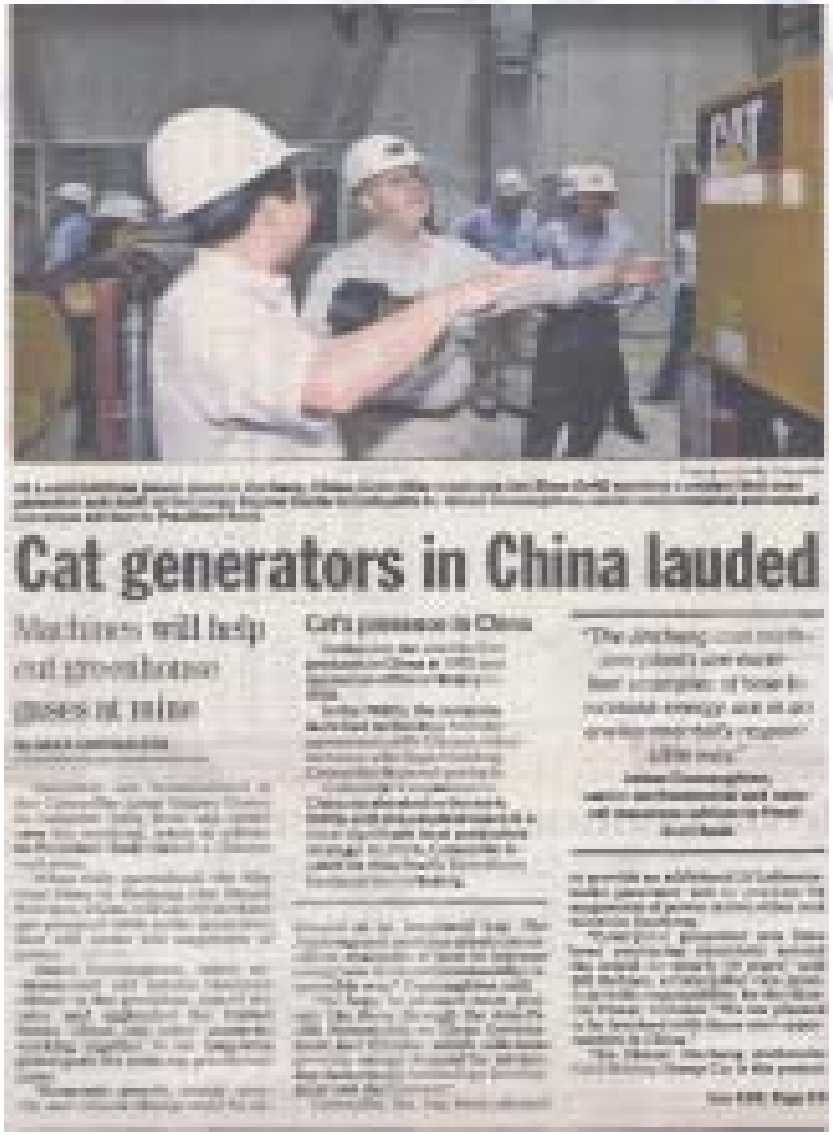

Cat generators in China lauded

Machines will help cut greenhouse gases at mine

Cat's presence in China

James Connaugton
Chief Council of Environment Quality
White House

Visited

Jincheng 120mW
Power Plant in

August 2007

Thank You