

Sustainable Energy Development Coal Mine Methane in China

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

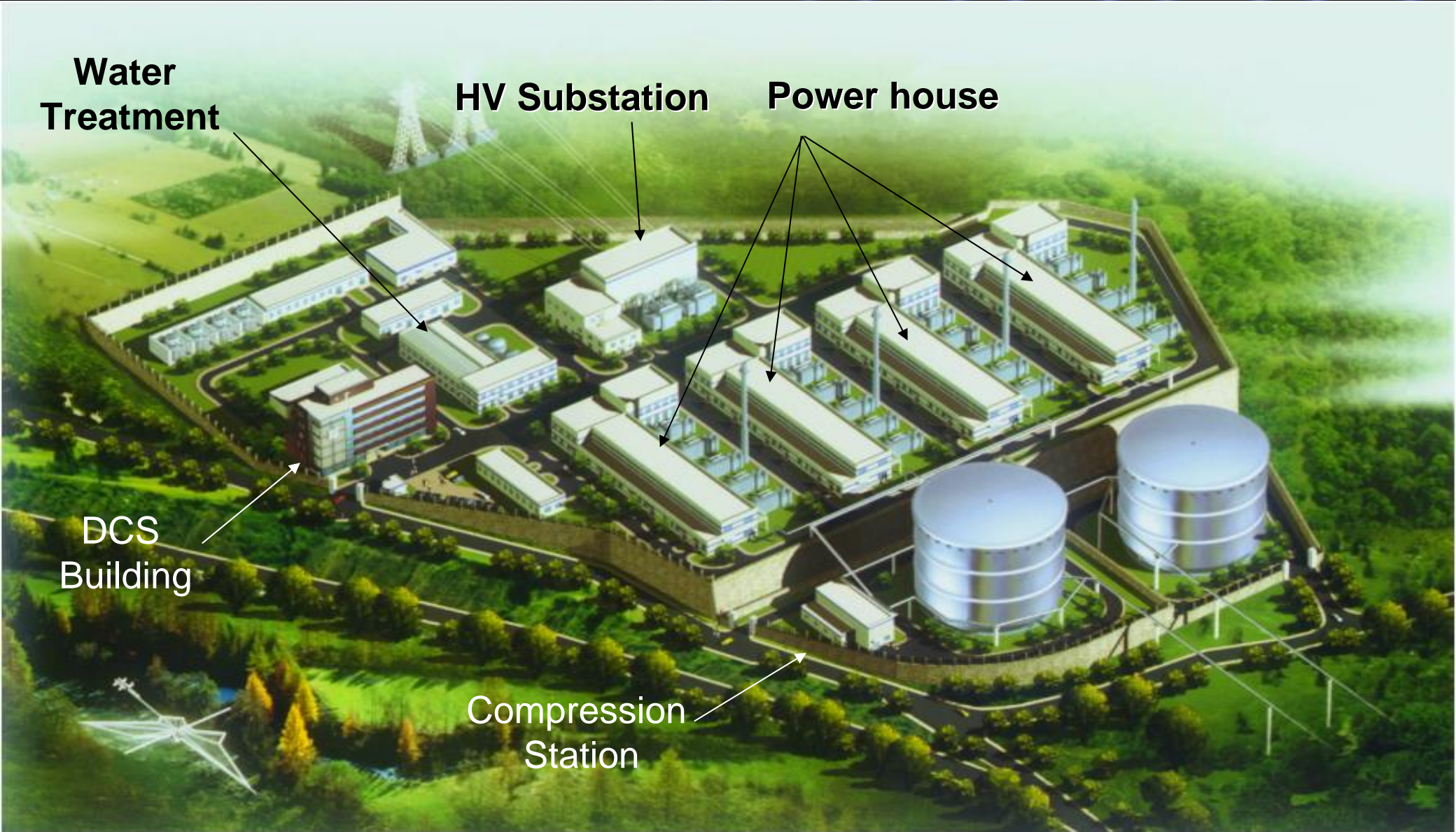
**Thomas Teo
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Electric Power Division
Greater China Region**

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

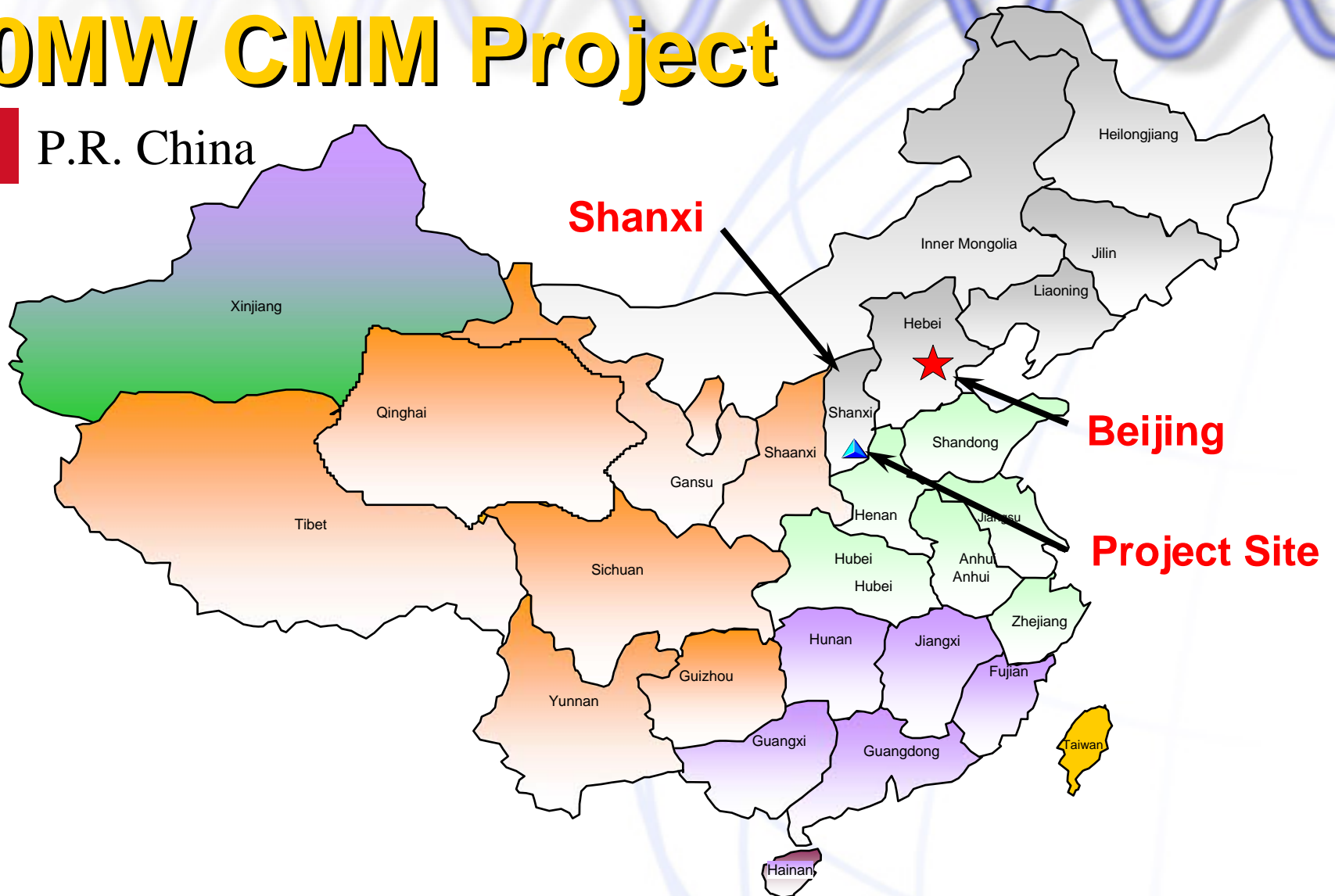
DCS Building

Compression Station

120MW CMM Project



P.R. China

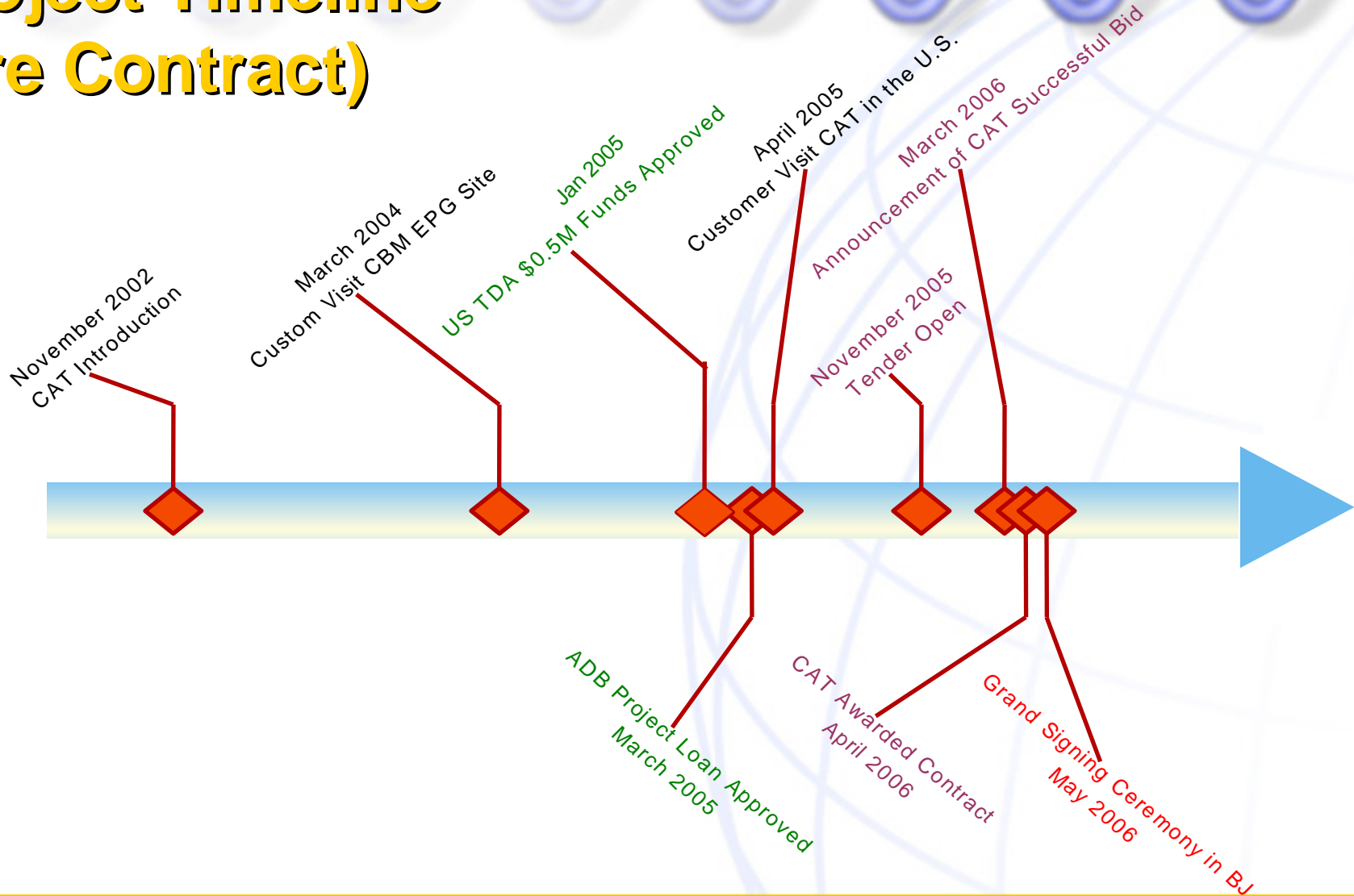




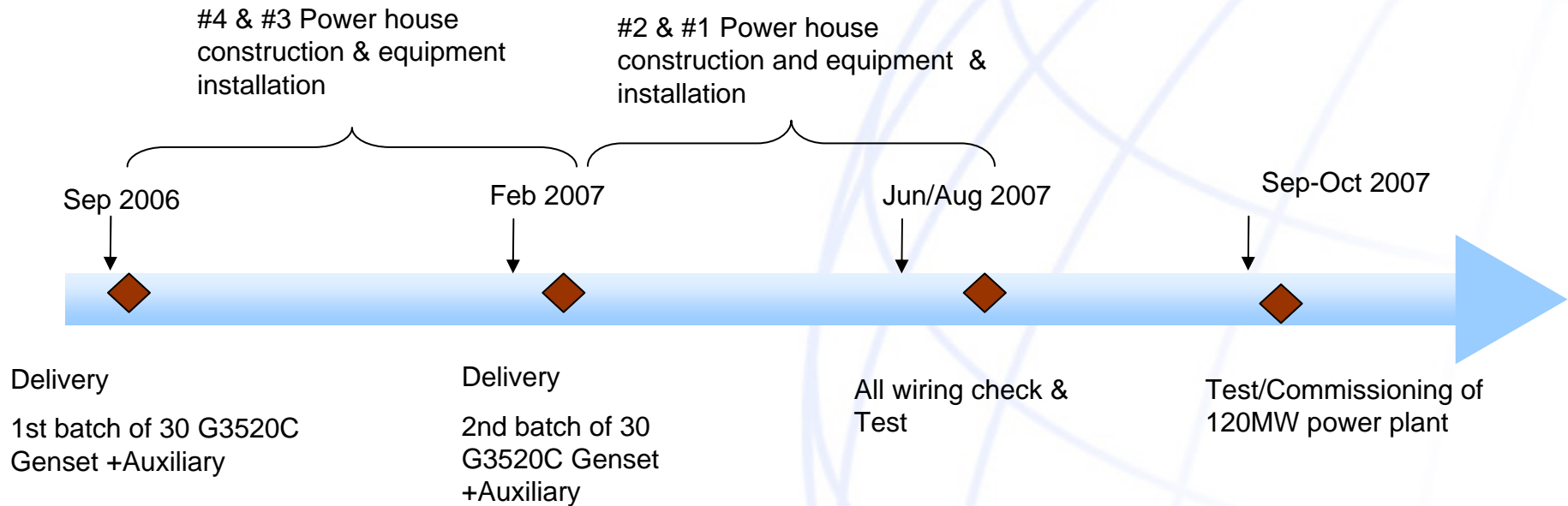
HISTORICAL MOMENT
MAY 18 , 2006
GRAND SIGNING CEREMONY
GREAT HALL OF THE PEOPLE
TIANANMEN SQUARE



Project Timeline (Pre Contract)

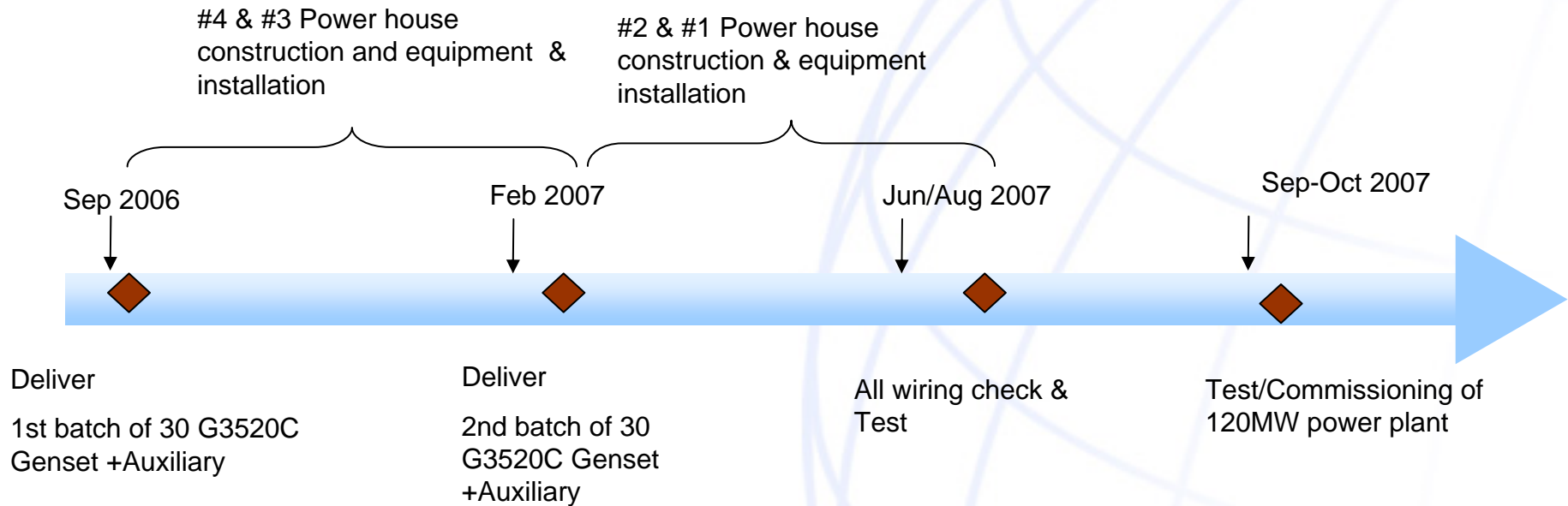


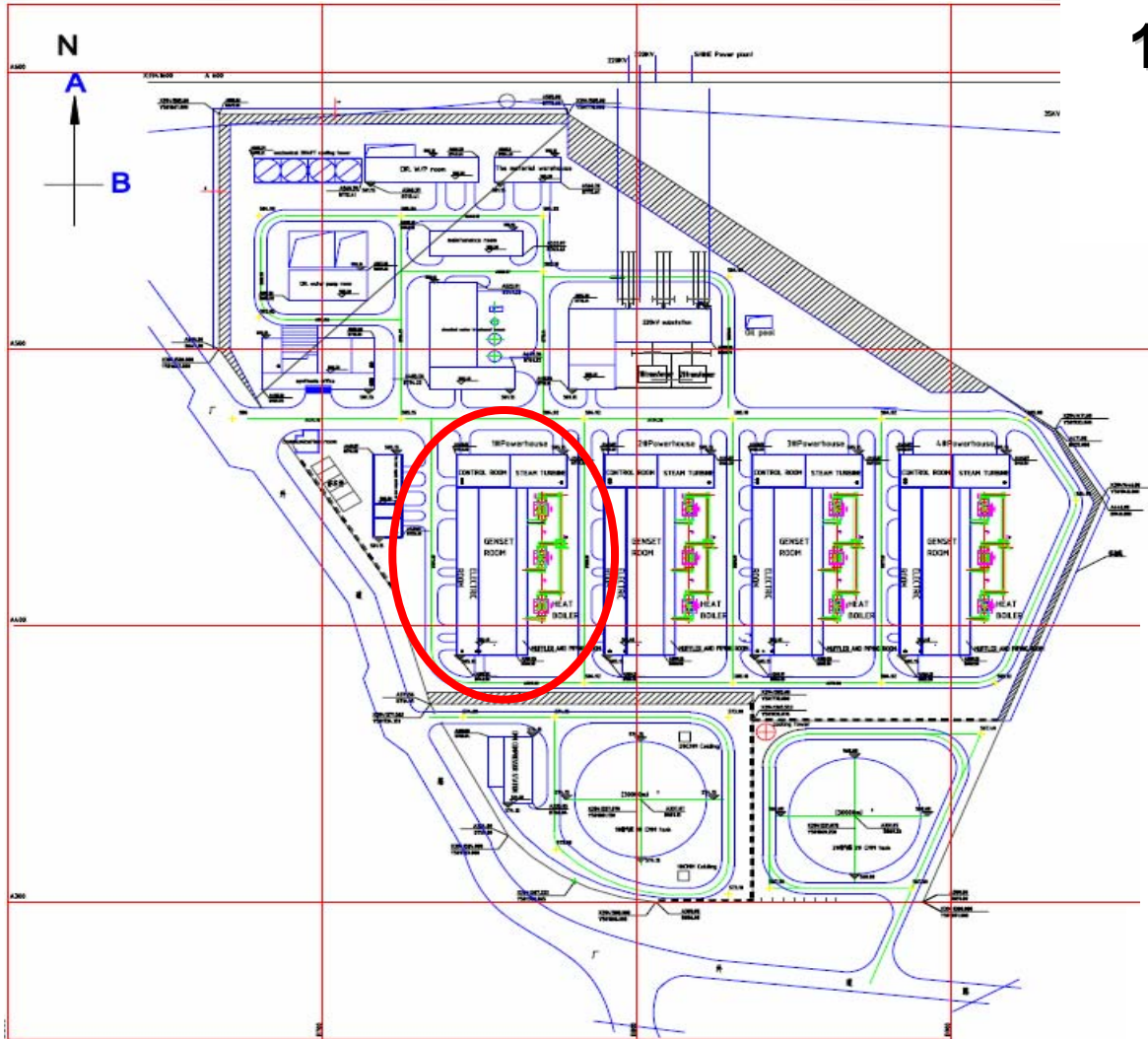
Project Timeline(Post Contract)



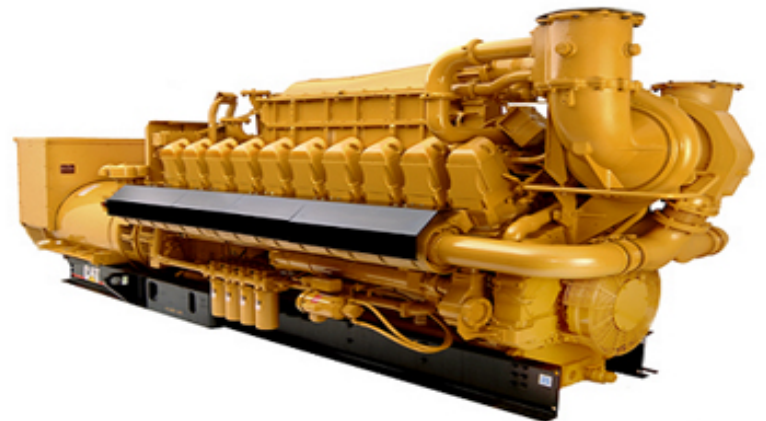
Phase 1 - First 30 packages
Phase 2 - Second 30 packages

Project Timeline(Post Contract)





120 MW Coal Mine Methane Cogeneration Power Plant

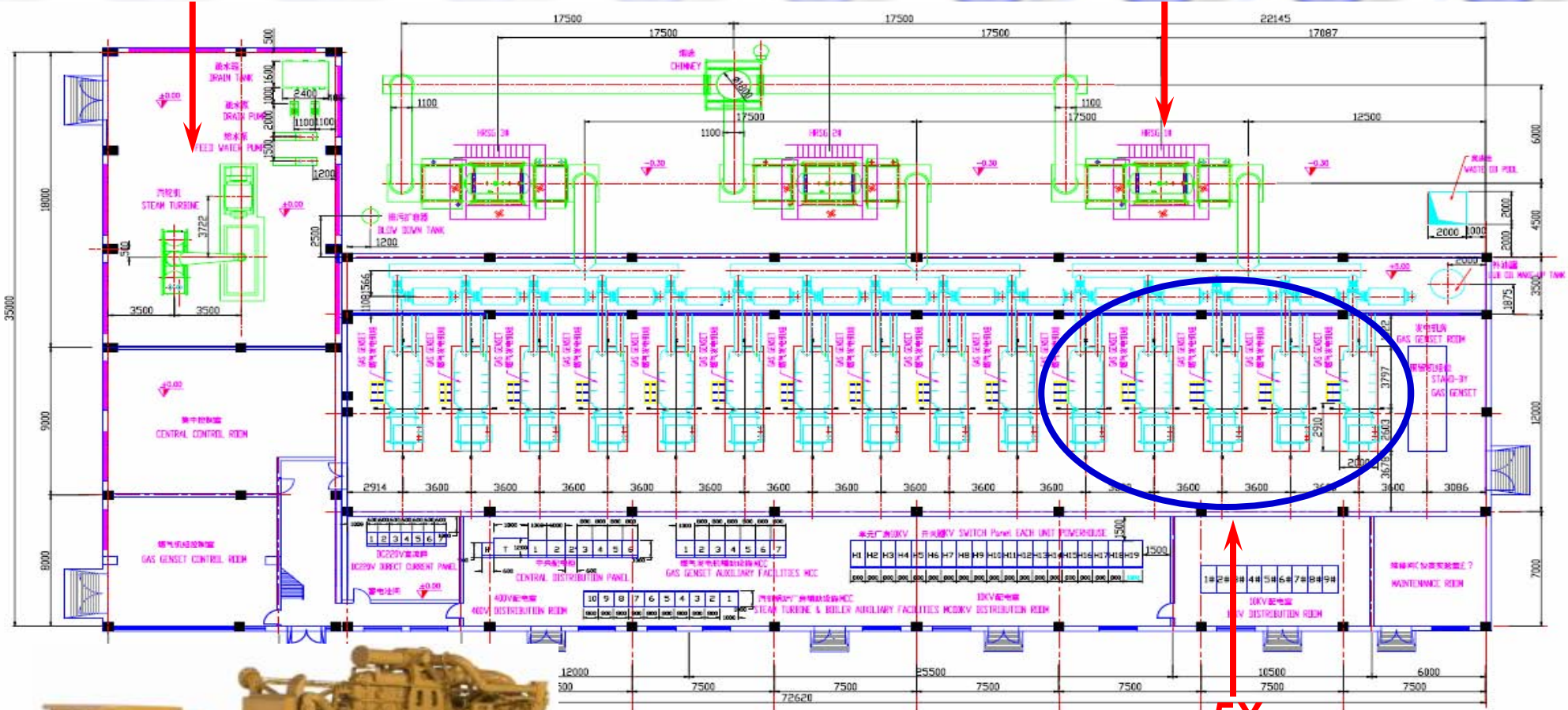


Project Scope

- **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



5X
G3520C



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 ₂ H ₆	vol %	2.5	3.8	---
Hydrogen Sulfide	H ₂ S	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

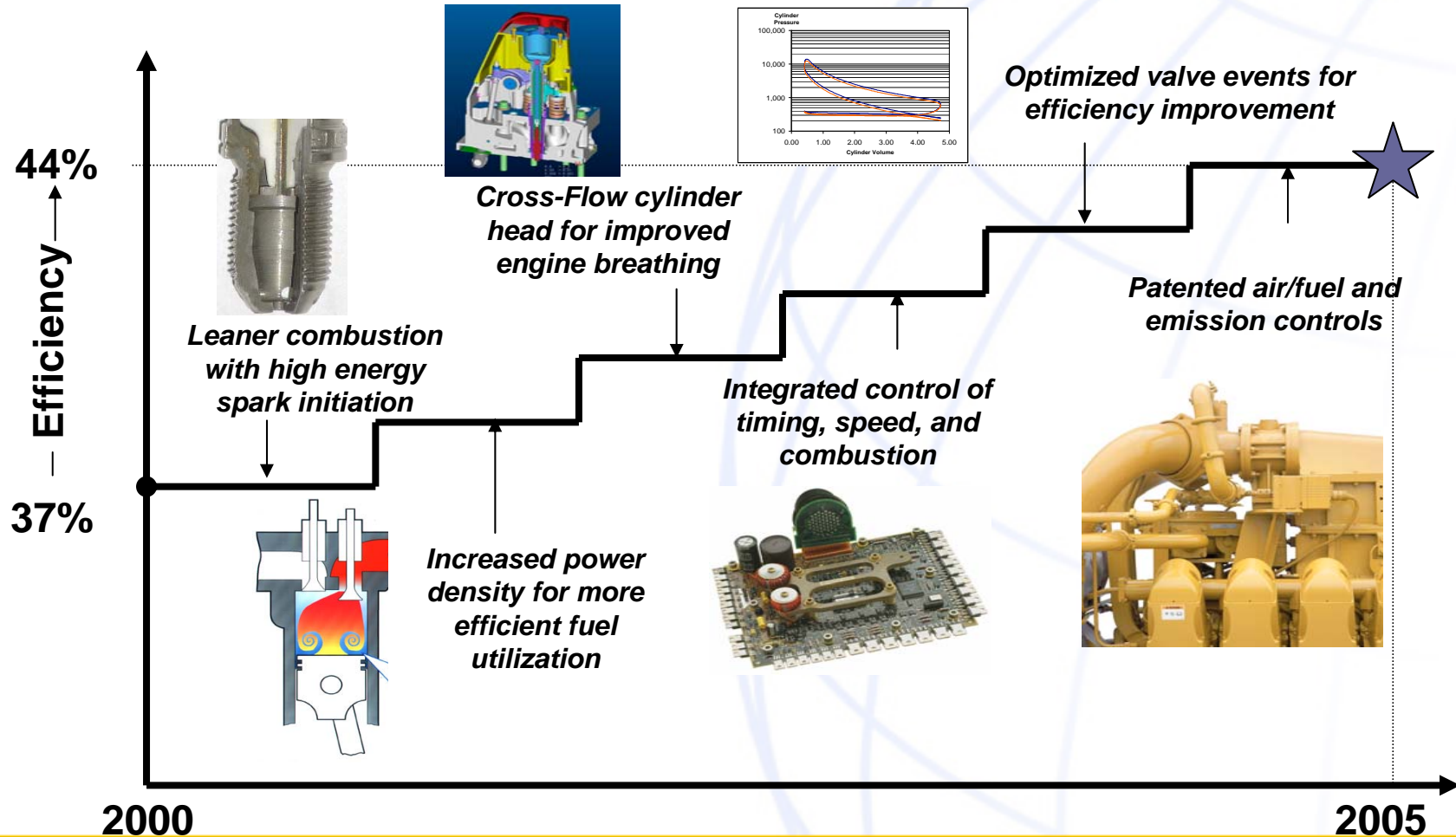
- **From all the selection criteria, the following emerge:**
 - Require Engines operating with lower gas pressures
 - Due to volume variation multiple units required
 - Require have High Voltage Generation
 - Ability to response quickly to fuel swings

Engine Technology Development

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

Voice of the Customer!

Efficiency Improvements



Engine Emission Enhancement

- **Power Density Impact**

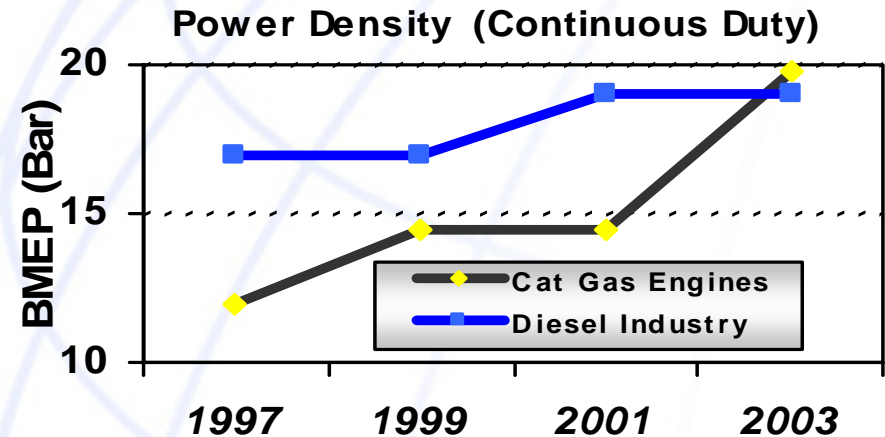
- New Gas Engines Have Higher Power Density Than Comparable Diesel Engines at Continuous Ratings

- **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











James Connaughton, Chief Council of Environment Quality White House, visits the Jincheng 120mW Power Plant in China. Connaughton is seen in the foreground, pointing towards the right, while other men in hard hats look on. In the background, there is a large piece of machinery with the 'CAT' logo on it.

Cat generators in China lauded

Machines will help cut greenhouse gases at mine

By [unreadable]

CHINA'S growing reliance on coal-fired power plants has led to a surge in greenhouse gas emissions. To help reduce these emissions, Caterpillar's advanced generators are being used at a new power plant in China. The plant, known as the Jincheng 120mW Power Plant, is one of the largest in the country. The plant's generators are designed to be more efficient and produce less waste than older models. This will help reduce the plant's carbon footprint and make it a greener source of energy.

Cat's presence in China

Caterpillar's presence in China has grown significantly in recent years. The company has invested heavily in research and development to create products that meet the needs of the Chinese market. One of the key areas of focus is power generation. Caterpillar's generators are widely used in China, particularly in the mining and industrial sectors. The company's commitment to quality and reliability has earned it a strong reputation in the market. This has led to a steady increase in sales and a growing customer base. Caterpillar's success in China is a testament to its global reach and its ability to adapt to different markets.

"The Jincheng plant is a great example of how Caterpillar's generators can help reduce greenhouse gas emissions. The plant's generators are designed to be more efficient and produce less waste than older models. This will help reduce the plant's carbon footprint and make it a greener source of energy."

James Connaughton, Chief Council of Environment Quality White House, visited the plant in August 2007.

to provide an additional solution to the power plant's energy needs. The plant's generators are designed to be more efficient and produce less waste than older models. This will help reduce the plant's carbon footprint and make it a greener source of energy.

"The plant's generators are designed to be more efficient and produce less waste than older models. This will help reduce the plant's carbon footprint and make it a greener source of energy."

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James Connaughton Chief Council of Environment Quality White House

Visited

Jincheng 120mW Power Plant in

August 2007

Thank You