Coal Mine Methane Project in China
(Japanese Government Assistance)

March 20 1 0

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General Manager
Resources Department
Japan Coal Energy Center (JCOAL)
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5. NEDO VAM Turbine Project in China

NEDO : New Energy and Industrial Technology Development Organization
1. Introduction of JCOAL
Profile of JCOAL

(1) Name : Japan Coal Energy Center (JCOAL)
(2) Office : 9F, Meiji Yasuda-Seimei Mita Bldg.,
            3-14-10 Mita, Minato-ku, Tokyo 108-0073
            JAPAN
(3) Established : October 16, 1990
                (Merged with CCUJ as of April 1, 2005)
(4) Members : 10 6 Associations
(5) Basic assets : 651 million yen
(6) E-mail : jcoal-info@jcoal.or.jp
(7) URL : http://www.jcoal.or.jp
History of JCOAL

Japan Coal Association
Established: March 1948

Coal Mining Research Centre, Japan
Established: February 1960

Japan Technical Co-operation Center for Coal Resources Development
Established: October 1990

Japan Coal Energy Center (JCOAL)
Recognized and merged as of July 1, 1997

Center for Coal Utilization, Japan (CCUJ)
Established on June 16, 1989

Japan Coal Energy Center (JCOAL)
Merged as of April 1, 2005
Project Scheme with China

JAPAN
New Energy and Industrial Technology Development Organization (NEDO)

China
National Development & Reform Commission (NDRC)

MOU

JCOAL & Coal Mine Implementation Agreement
Private Sector
Project Task Share with China

JAPAN

- Site Selection
- Feasibility Study for
- Detailed Design
- Major Equipment and Technology
- Demonstration Operation Works/Building
- Training/Technology Transfer

China

- Provide Data and Information
  - Application
  - Government
    - Auxiliary Equipment
    - Inland Transportation
      - Civil
    - Construction Work
- Utility Supply
2. NEDO CMM Town Gas Model Project at Tiefia, China
Project Site (Liaoning Province)


Methane Enrichment System (2007-2008)

Shenyang
CMM Town Gas Use Model Project at Tiefa
3. NEDO CMM/VAM Power Generation Model Project at Fushun, China
# Liaoning Fushun Mining / Laohutai

## Project Overview

- **Number of Unit**: 1 Unit
- **Type**: 12MACH-30G (4 cycle, V-type, micro pilot)  
  Power Generation Efficiency 45%
- **Output**: 3,500kW (at generator terminal)
- **Fuel gas**: CMM(30%<) and VAM

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![Map of Liaoning and Fushun City](image-url)
GHG reduction by CMM gas engine

The case of NEDO model plant

CMM gas consumption : 2,925Nm³/h
Methane concentration : 30%
  (4 ~ 5% in engine cylinder)
Amount of methane extraction : 878Nm³/h
  (Operation 8,000hr./year)

Green house effect coefficient of extracted methane is 21 times of CO₂.

Amount of green house gas reduction by one CMM MACH gas engine is 91,000ton/year. (CO₂ conversion)
General arrangement  (KEY PLAN)
General arrangement
(Cross section, First floor)

Scope: Blue marks are supplied by MHI
## Schedule for NEDO model plant

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Fiscal year 2008</th>
<th>Fiscal year 2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and engineering for equipment</td>
<td></td>
<td>Completion of installation</td>
<td>Completion of demonstration</td>
</tr>
<tr>
<td>Counterpart supplied</td>
<td></td>
<td>Unloading</td>
<td></td>
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<tr>
<td>MHI supplied</td>
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<tr>
<td>Civil Engineering</td>
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<td></td>
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<tr>
<td>Construction</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Installation work of equipment</td>
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<td></td>
<td></td>
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<tr>
<td>Counterpart supplied</td>
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<tr>
<td>MHI supplied</td>
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<td></td>
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<tr>
<td>Commissioning test at site</td>
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<td></td>
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<tr>
<td>Demonstration</td>
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</tr>
</tbody>
</table>
Installation of Gas Engine
Gas Engine and Auxiliary Equipment
Engine of Mitsubishi Heavy Industries
4. NEDO CMM Concentration Technology Development Project at Fuxin, China
Introduction : System concept

This system enables to concentrate CMM emitted to the atmosphere without any effective utilization.

- Oxygen, Nitrogen
- Adsorption tower using methane-selective adsorbent
- Product gas
  - Methane concentration: 40% or more
- Vacuum pump
- Product tank
- Electricity supply
  - Gas engine-driven generator
- Heat supply
  - Gas boiler
- Emission to the atmosphere
- CMM
  - Methane concentration: 30% or less
- Prevention of blowout into excavating front through preliminary extraction

CMM with a methane concentration below 30% is emitted to the atmosphere without any effective usage.
Introduction: Effective utilization
Expansion of use applications of CMM

- Auxiliary air for combustion
- Electricity
  - Low-concentration gas power generation
  - Medium-concentration gas power generation
- Electricity
- Town gas
- Industrial utility gas

- Ultra-low-Concentration VAM
- Low-Concentration CMM
- Medium-concentration CMM
- CMM Concentration System
- Medium-concentration CMM
- CMM Concentration System
- CNG
- LNG
- LNG liquefier

- Industrial raw material gas
- High-Concentration CMM

The Concentration of Methane in CMM

- Explosive limit zone
  - 0%
  - 10%
  - 20%
  - 30%
  - 40%
  - 50%
  - 60%
  - 70%
  - 80%
  - 90%
  - 100%

- 5%
- 15%
Specifications of CMM Concentration Plant for Demonstration Test

- **Inlet CMM**: CH$_4$: 20% 1,000 m$^3$/hr
- **Product gas**: CH$_4$: 45% 400 m$^3$/hr
- **Recovery factor**: 90% or higher

Demonstration Test: Specifications
Demonstration Test : Plant appearance

Mixing tank

Adsorption tower

Vacuum pump
Demonstration Test : Results

It was confirmed that CMM of 21% methane gas was successfully concentrated to 48%.

<table>
<thead>
<tr>
<th>Methane concentration (%)</th>
<th>Raw material gas flow rate: 1,000 Nm³/h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>- Product gas</td>
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<tr>
<td></td>
<td>- Raw material gas</td>
</tr>
</tbody>
</table>

Concentrated by approx. 27%
3. Demonstration Test: Results

The target performance of our system was achieved (25% concentration, 90% recovery).

Fig. 1 Dependence of the methane concentration in raw material gas against methane concentration in product gas.

Fig. 2 Dependence of the methane concentration in raw material gas against methane recovery rate.
# Commercial Plant: Specifications

## Standard Specifications of
Methane Concentrating plant

<table>
<thead>
<tr>
<th>Inlet CMM</th>
<th>CH$_4$: 20%</th>
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<tbody>
<tr>
<td></td>
<td>2,000 m$^3$/hr</td>
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<table>
<thead>
<tr>
<th>Product gas</th>
<th>CH$_4$: 45%</th>
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<tbody>
<tr>
<td></td>
<td>800 m$^3$/hr</td>
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</table>

<table>
<thead>
<tr>
<th>Recovery factor</th>
<th>90% or higher</th>
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</thead>
</table>
Commercial Plant : Basic System

Basic System
(Methane concentration in raw material gas: 20% or higher)

CMM
Concentration Plant

CH₄ : 20% or higher
Gas tank
45% or higher
Gas supply

CMM
Concentration Plant

CH₄ : 20% or higher
Gas tank
45% or higher

20% or higher

30% or higher
Effects of Introduction

For example,
if the commercial plant of CMM concentration (flow rate: 2,000Nm3/h) is installed;
- Energy conservation: 2,600 kl/yr reduction (crude oil equivalent)
- Greenhouse gases: 38,000 t/yr reduction (CO₂ equivalent)
## Business Plan

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<tbody>
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<td>Pilot Plant Operation</td>
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<tr>
<td>Basic Design Package</td>
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<td>(commercial plant)</td>
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<td>- Engineering</td>
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<td>- Modification &amp; Localize</td>
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<td>- Partner Search</td>
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<td>- Business Modeling</td>
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<tr>
<td>2. Basic Design Package (commercial plant)</td>
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<td>- Engineering</td>
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<tr>
<td>- Business Modeling</td>
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<tr>
<td>3. NEDO F/S in China</td>
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<td>4. Project Finding</td>
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</tbody>
</table>

**Timeline Details:**
- **2009:**
  - Apr: Pilot Plant Operation
  - Demonstration
- **2010:**
  - Complete
  - Modify Localize
- **2011:**
  - F/S
- **2012:**
  - Demonstration Project ??

**Notes:**
- JCOAL
- NEDO
- Osaka Gas
5. NEDO VAM Turbine Project in China
VAM Turbine

Catalytic Combustion

Heat Exchanger

Only one practical use in the World

Long Time Operation Record

Many Installation

Catalytic Combustion Gas Turbine

1,500kW Gas Turbine : M1A-13X

600kW Gas Turbine : S7A

1,000kW Gas Turbine : M1A-01
Catalytic Combustion

Features:
No NOx, No flame, Low concentration methane be used ( - 5% )

Flame Combustion ( Ordinary Combustion )
Fuel + O₂ Combustion. Minimum methane concentration is +5%.

Catalytic Combustion ( Oxidization by catalyst )
Fuel oxidization at low temperature: Oxidization of O₂ + CH₄ at the surface of catalyst
What can we do with VAM/CMM?

- Generate by utilization of VAM/CMM as fuel
  - Gas Turbine Gene-set
    - Special Combustion
  - VAM Treatment
    - Optional System

- Consume the mine’s fugitive methane (VAM)

Diagram:
- Electricity
- CH₄
- VA M
- Unused CMM
- Ventilation Fan
- Bleed Pump
- Coal Seam
- Stratum
- Gallery
## Performance

**For Reference**

<table>
<thead>
<tr>
<th>Gene-set</th>
<th>Output of Generator (kWe)</th>
<th>850</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilization of VAM &amp; CMM (Nm³/hr)</td>
<td>23,000</td>
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<tr>
<td>GHG Reduction (t-CO₂/year)</td>
<td>54,000</td>
<td></td>
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</tbody>
</table>

**Option**

<table>
<thead>
<tr>
<th></th>
<th>Mitigation of VAM &amp; CMM (Nm³/hr)</th>
<th>***</th>
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</thead>
<tbody>
<tr>
<td>GHG Reduction (t-CO₂/year)</td>
<td>***</td>
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</table>

**Reduce More Than 54,000 GHG**
Features of the System

- **Excellent capability** for VAM mitigation
- **Stable Operation** on low methane concentration (CH$_4$ < 2%)
- **Safety** due to no need for flammable gas compression
- **Electricity generation** by unused VAM and CMM
- **No NOx** emissions
- **No Cooling Water** required
- **Mobile Unit** would be available
- **Low Cost** for GHG reduction
## Schedule of the Planned Project

<table>
<thead>
<tr>
<th></th>
<th>Fiscal Year</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Practical Test Plan</strong></td>
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<tr>
<td>F/S (NEDO Fund)</td>
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<tr>
<td>Design of plant</td>
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<tr>
<td>Manufacturing of plant</td>
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<td>Local foundation work</td>
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<tr>
<td>Installation &amp; test</td>
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<tr>
<td><strong>Commercial Operation</strong></td>
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</tbody>
</table>

*Note: The calendar year 2010 is indicated for planning purposes.*
Thank you!

- JCOAL
  http://www.jcoal.or.jp/

- Mitsubishi Heavy Industries (Gas Engine)
  http://www.mhi.co.jp/

- Osaka Gas (CMM Concentration)
  http://www.osakagas.co.jp/

- Kawasaki Heavy Industries (VAM Turbine)
  http://www.khi.co.jp/