The China National Petroleum Corporation's (CNPC) Methane to Markets Experience

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Objectives

- Raise awareness of cost-effective opportunities to reduce CH_4 emissions and improve energy efficiencies at oil and natural gas facilities in China.
- Share lessons learned in North America and other countries.
- Work toward achieving significant cost-effective GHG emission reductions in China.
- Capacity building.

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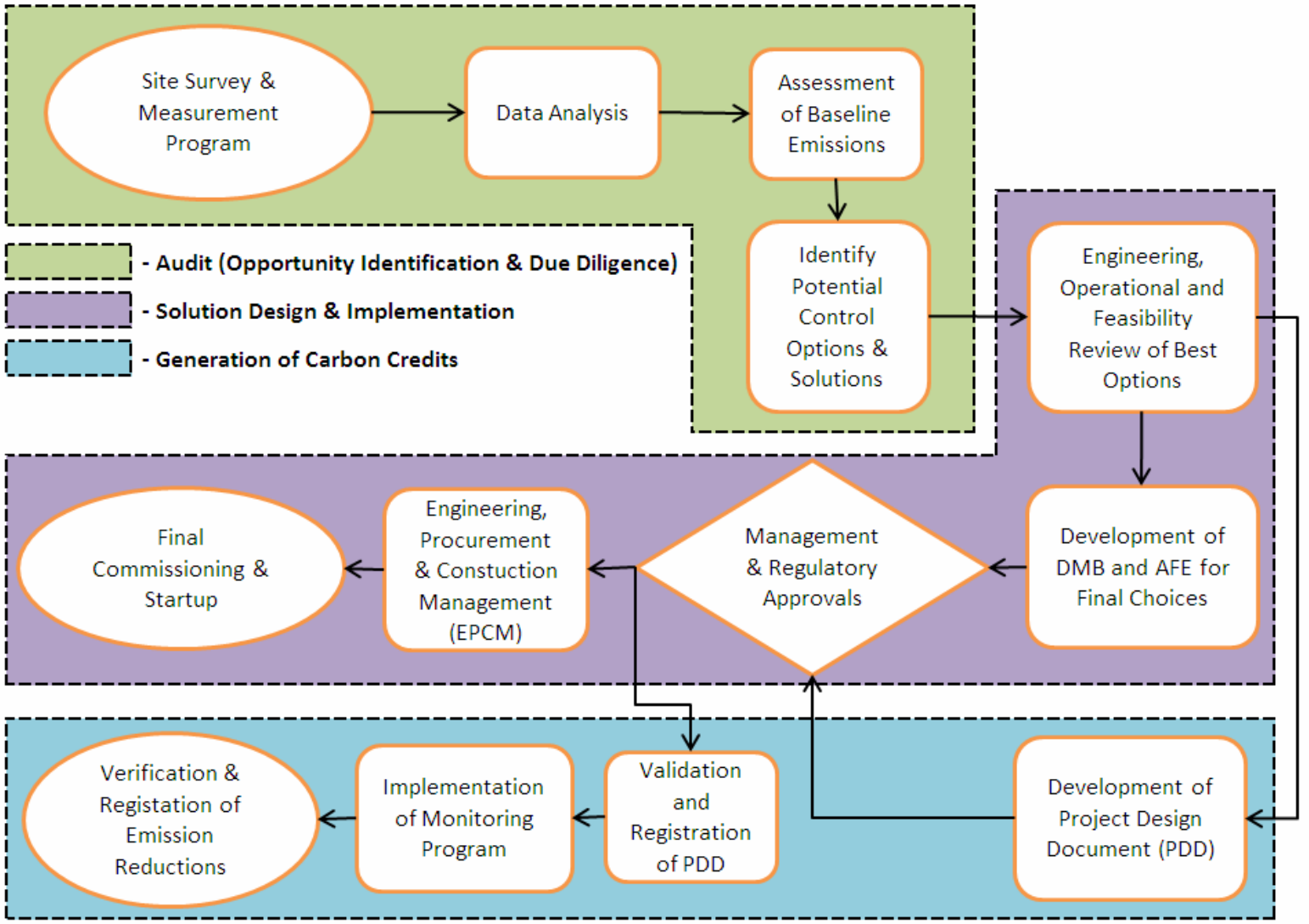
General Project Flow Diagram



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Site Audits

- Conducted jointly by experts from CNPC RISE and North America.
- Utilized a range of specialized testing equipment and data analysis methods.
- Key objective was to identify and quantify all significant methane reduction and energy efficiency improvement opportunities.
- Practical means for training and technology transfer.

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Site Audits: Target Opportunities

- Fugitive equipment leaks.
- Process venting:
  - Casing Gas Venting
  - Glycol Dehydrators
- Flaring.
- Storage losses.
- Combustion and thermal efficiencies of natural gas-fired heaters and boilers.
- Compressor inefficiencies.
- Engine inefficiencies.
- Overall process optimization.

Measurement and Detection Equipment

Equipment used during surveys:

- Infrared thermal imaging camera.
- Combustion and emission analyzers.
- Various velocity and flow meters.
- Hi-flow sampler.
- Combustible gas detectors.
- Pressure and temperature sensors.

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Fugitive Equipment Leaks

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Engines and Process Heater Combustion Analysis

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Casing Gas Venting and Flaring

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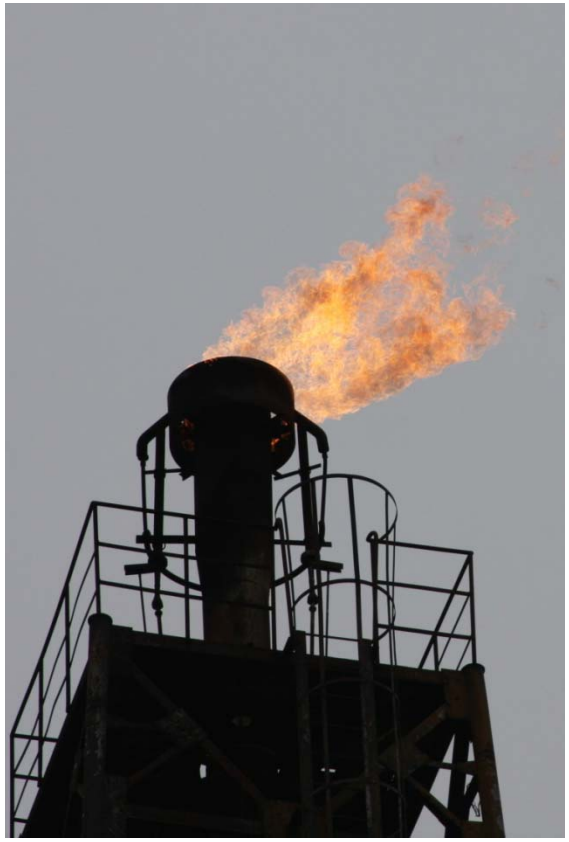
Flare Systems



Field Measurement Activities at CNPC Facilities

- NW China (September, 2007):
  - 1 natural gas processing plant (1996).
  - 4 oil batteries (early 1990's).
  - 1 central oil treating facility (early 1990's).
  - 5 oil well production pads (early 1990's).

Field Measurement Activities at CNPC Facilities

- Central China (November, 2008):
  - 3 natural gas processing plants (1980 to 2004).
  - 2 gas distribution meter stations (early 1990's).
  - 1 gas battery (early 1987).
  - 2 compressor stations (1988 & 1995).

Field Measurement Activities at CNPC Facilities

- NW China (May, 2009):
  - 2 natural gas processing plants (1997 & 2000).
  - 1 oil station (1992).
  - 1 oil battery.
  - 1 power generation plant.

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Front End Engineering Analysis

- A detailed analysis of energy efficiency and methane emission reduction opportunities identified in the site audit reports
- Develop a short list of technology options with the potential to achieve cost effective energy efficiency gains and reductions in methane emissions
- Consult with equipment suppliers to collect detailed technical information for the various options
- Obtain budgetary pricing from technology providers for these technologies

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Front End Engineering Analysis

- Identify site specific constraints that may limit application of certain technologies (e.g. space restrictions, capacity bottlenecks, utilities etc.)
- Prepare a design basis memorandum (DBM) with the supporting engineering information required to proceed with detailed engineering
- Provide recommendations for the most practical and cost effective options to pursue
- DBM to include sufficient technical and cost details for CNPC to perform an evaluation and make recommendations to management for implementation.

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Front-end Engineering Analysis – Group Discussion

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Control Options Reviewed

- Engine and compressor management systems
  - Air-to-fuel ratio control
  - Ignition systems and speed governors
  - Compressor vent gas recovery
  - Compressor and engine performance monitoring

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Control Options Reviewed

- Flare systems:
  - Ultrasonic flare meters.
  - Fuel-efficient and reliable pilots.
  - Purge gas management.
  - Flare gas recovery systems.

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Control Options Reviewed

- Onsite power generation using waste gas streams:
  - Micro-turbine generators.
  - Small natural gas generators.
- Vent and casing gas recovery:
  - Tank vapor recovery units.
  - Reciprocating compressor packages.
  - Scroll compressor units.

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Control Options Reviewed

- Process heaters:
  - Air-to-fuel ratio control.
  - Combustion efficiency monitoring.
  - Flame failure detection.
- Waste heat recovery:
  - Reciprocating engine heat recovery.
  - Gas turbine heat recovery.

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Control Options Reviewed

- Glycol dehydration:
  - Optimized glycol circulation rates.
  - Still column condenser and thermal oxidizer.

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Study Tours

- Meetings with selected technology vendors in Calgary and Houston.
  - 1 to 2-hour presentations and demonstrations by each vendor followed by a question and answer period.
- Visits to the manufacturing facilities of selected vendors.
- Visits to oil and gas facilities where specific technologies of interest are in use.

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Study Tour – Vendors' Office and Shop Visit

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Study Tour – Oil and Gas Facilities Tour

Energy and GHG Management Guidelines - Purpose

- Guidance for verifiably reducing energy consumption and methane and non-methane emissions:
  - Opportunity identification and quantification techniques.
  - Where to focus efforts.
  - Practical control options.
  - Best management practices.
  - Ongoing performance monitoring.
  - Relevant regulatory requirements and performance. Standards.
  - Guidance on generating marketable carbon credits.

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Next Steps

- Continued site audits.
- Additional training on data analysis methods.
- Rollout of the developed guidelines.
- CNPC evaluating the purchase of measurement and testing equipment.
- CNPC putting forward specific implementation project ideas for senior management approval.

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Thank you!