UNECE

Estimating CMM Resources and Converting them to Reserves

Coal Mine Methane as a Valuable Energy Source

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Poland ICE-CMM

Operating under auspices of the UNECE Group of Experts on Coal Mine Methane

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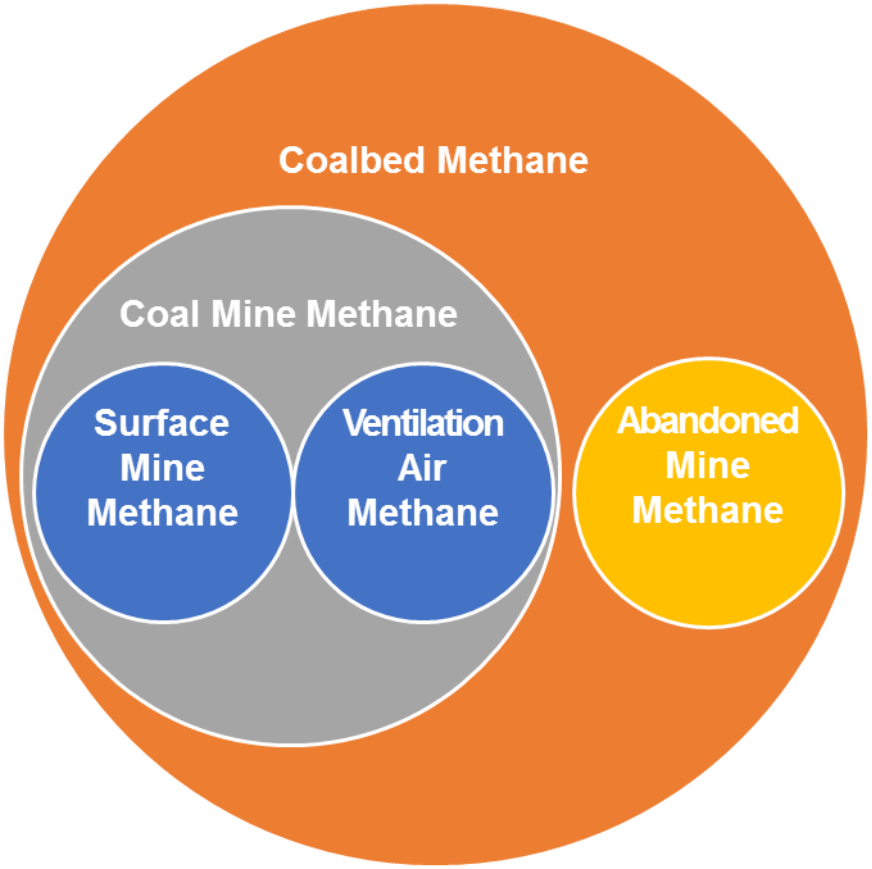
RAVEN RIDGE RESOURCES INCORPORATED

Background

The future of methane management is innovation in policy, business and technology deployment

- For the purposes of this presentation, coal associated methane, referred to as coal bed methane (CBM), coal mine methane (CMM), surface mine methane (SMM), ventilation air methane (VAM),abandoned mine methane(AMM)
- There is significant potential to lower carbon emissions throughout the coal mining cycle.



Value of coal associated gas reserves are not recognized as corporate assets

- Other unconventional energy resources such as CBM and some SMM are booked as assets on corporate balance sheets, but CMM, VAM, AMM are not.
- The Group of Experts on CMM and the Expert Group on Resource Management will work together to create a customized classification scheme under the United Nations Framework Classification.
- It will provide clear and consistent specifications, guidelines, and best practices so that these resources are exploited transparently and sustainably in a socially acceptable manner.
- Adoption of the classification system will help produce meaningful statistics that will allow the use of these resources to be monitored and valued appropriately.

Resource Estimation and Classification Schemes

Input considerations for resource assessments

- CMM
  - SMM integrates knowledge gained from coal resource exploration and coal mine development; generally requires experience in region to reliably forecast resource and producibility and is reliant on coal mine timing.
  - AMM utilizes historical information regarding size and extent of mining and the void created, methane emission during active mining, and time since closure to estimate potential resource. Forecasting is unreliable without AMM gas production reliability.
  - VAM resources largely determined by volume of ventilation air and exposure of coal in mine workings; safety considerations establish limits on methane and ventilation air.

Resources classifications

- Resources classifications should:
  - Facilitate and organize exploration and development information and data so that the magnitude of a potentially valuable resource is reliably reported,
  - Capture the uncertainty of the discovery and the potential for commercial development, and
  - May incorporate legally defined categories.
- Resources classifications are used to assess the relative value of the resource base.
- The basis on which resources are publicly reported may be strictly regulated.

What external factors can/should be considered when estimating and reporting resources and reserves?

- economic
- technological advancement
- environmental
- market
- legal
- political
- social

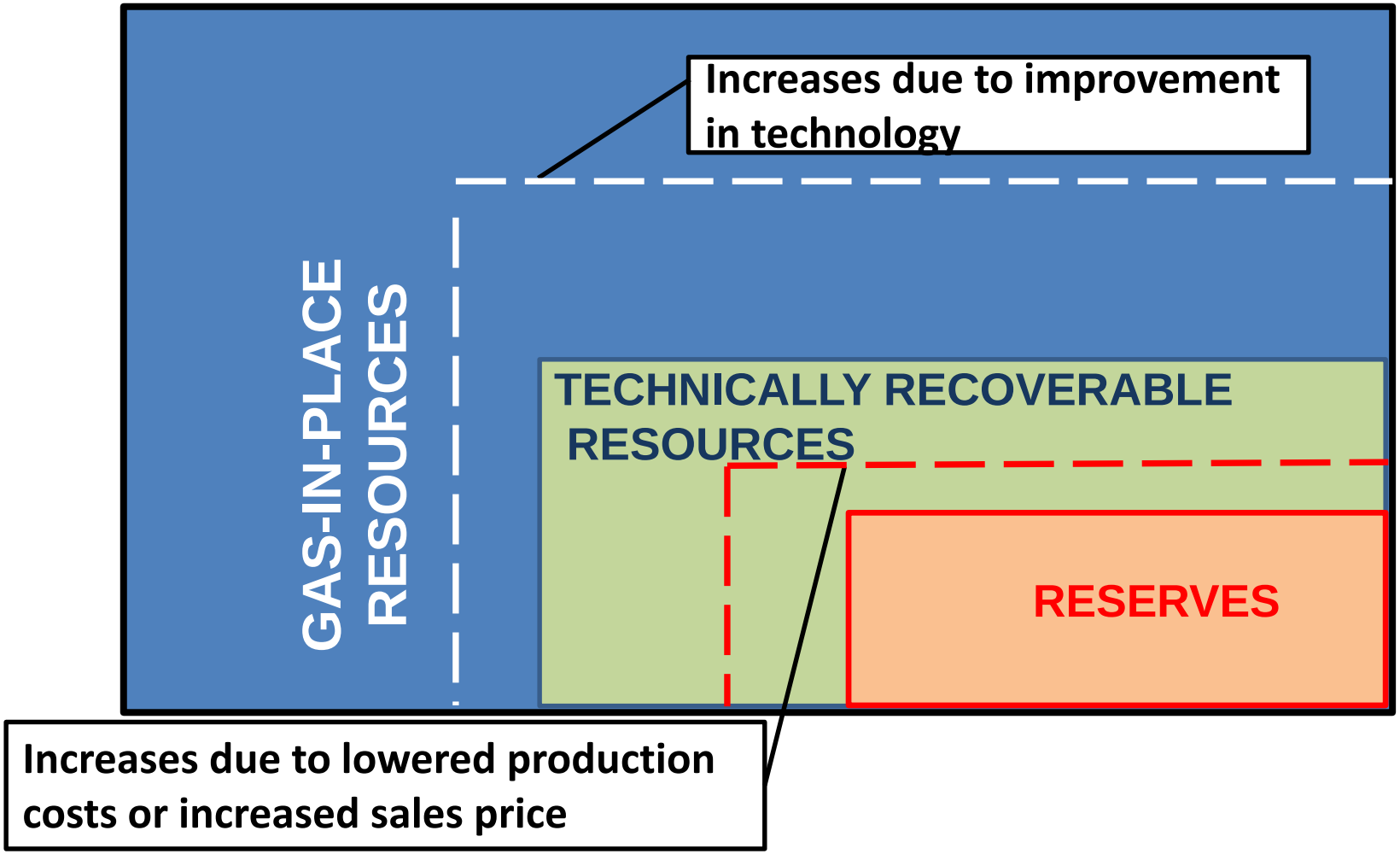
Classification Schemes and Methods of Resource Estimation

Mckelvey (1972) diagram implies relative commercial potential of resources by mapping uncertainty

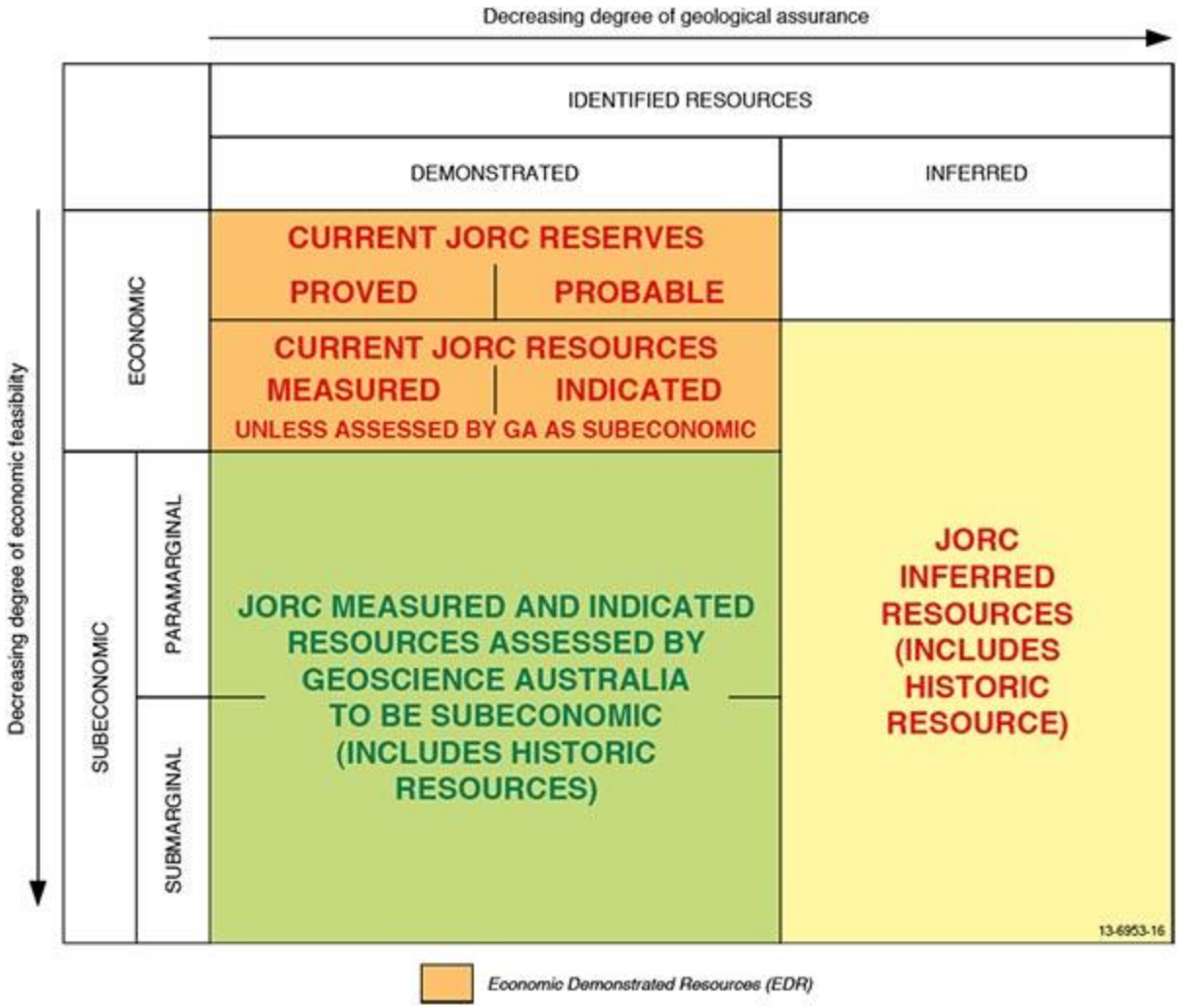
Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Other Occurrences	Includes nonconventional and low-grade materials

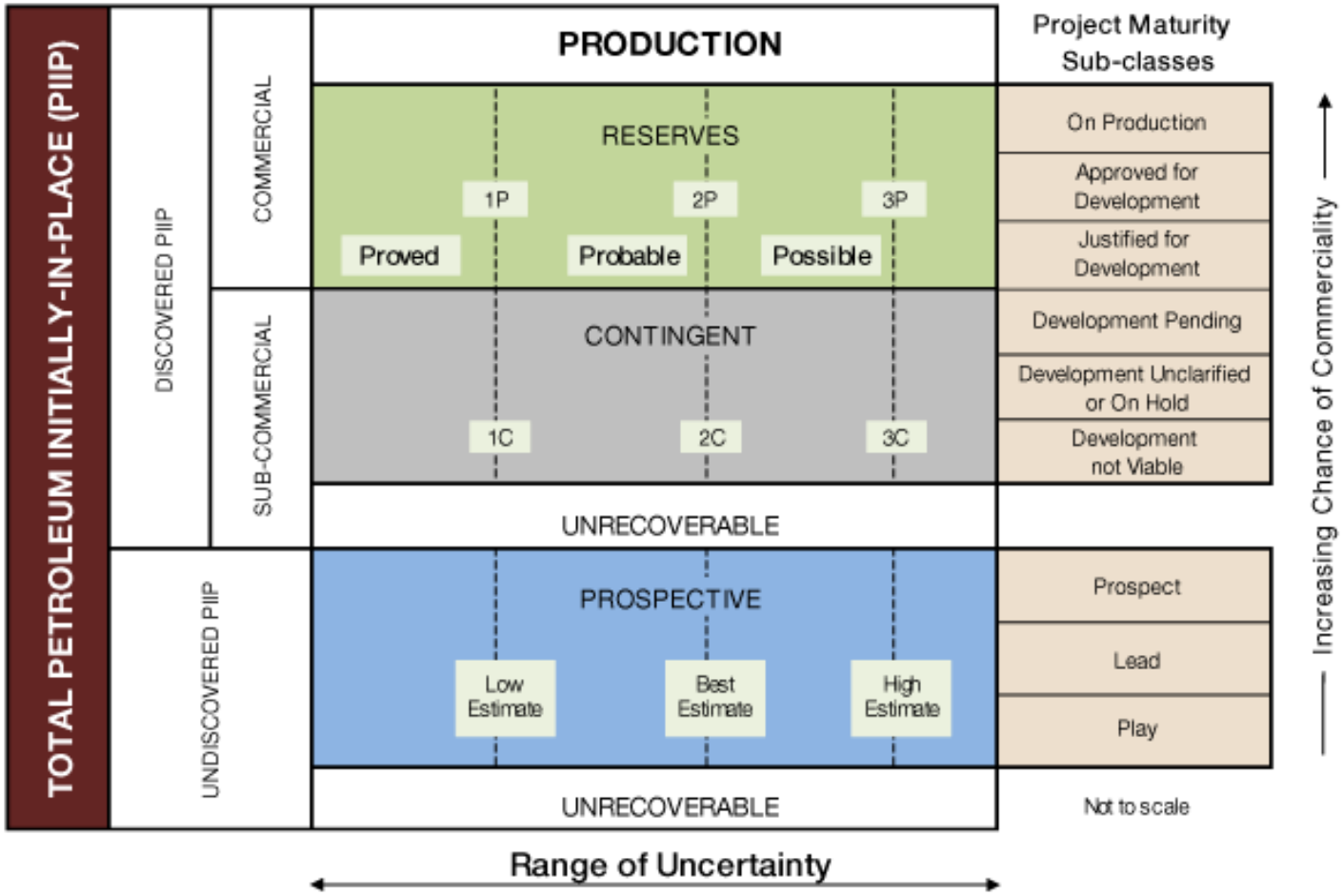
Converting resources to reserves – what determines the commercial potential?



Joint Ore Reserves Committee mineral resources classification



The Petroleum Resources Management System (SPE, WPC, AAPG)



Principles of CMM Resources Estimation

Approaches to estimating CBM and CMM resources

CBM

- Commonly a volumetric calculation for resources:
  - Multiply mass of coal (tonnes) by gas content (cubic meters of methane per ton of coal) = volume of gas in place (equivalent to OGIP or PIIP).
  - Two accepted approaches to calculate estimate:
    - Use low, high, and mid range single values for all parameters; result is a resource estimate ranging from low to high forecasts.
    - Stochastic estimate using probability functions developed for each parameter yielding a probabilistic forecast of resources.
    - May also include sophisticated reservoir simulation using proprietary or commercially available software.
- Reserves estimates are dependent on understanding historical production and economics and governed by reserve classification schemes approved by government entities.

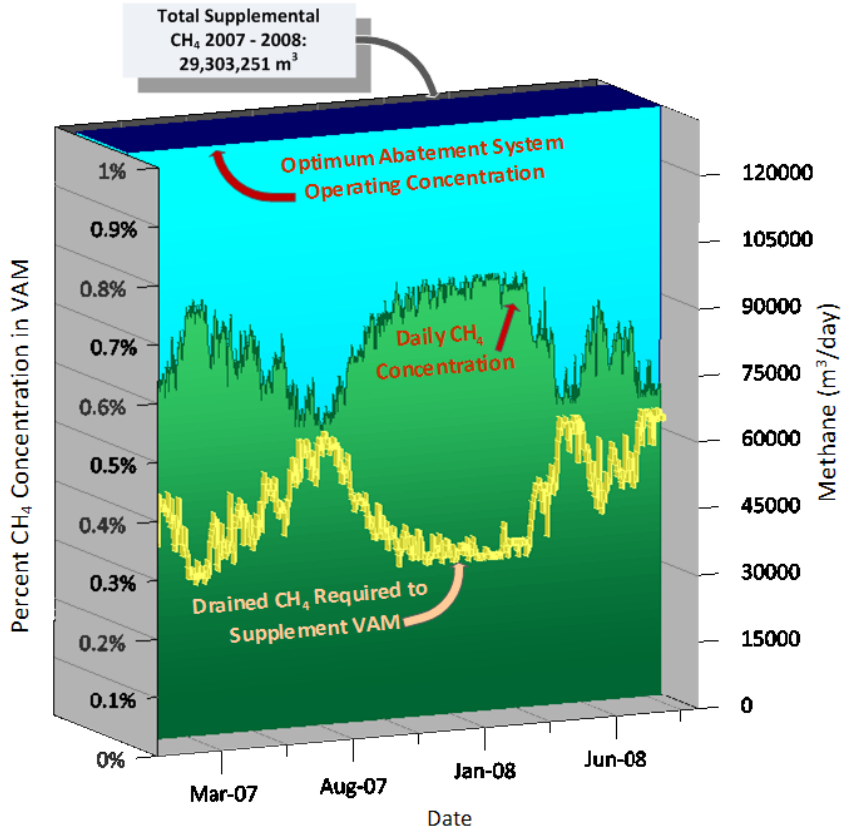
Approaches to estimating CBM and CMM resources (2)

CMM

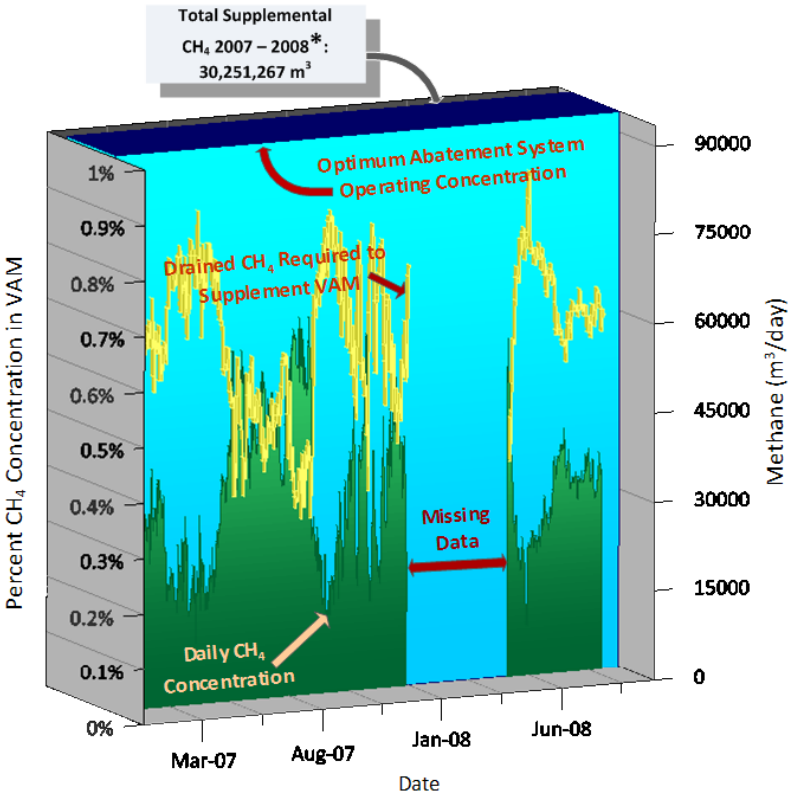
- Commonly a volumetric calculation for pre-mine (CMM and SMM) drainage:
  - Multiply mass of coal (tonnes) by gas content (cubic meters of methane per ton of coal) = volume of gas in place (equivalent to OGIP or PIIP).
  - Two accepted approaches to calculate estimate:
    - Use low, high, and mid range single values for all parameters; result is a resource estimate ranging from low to high forecasts.
    - Stochastic estimate using probability functions developed for each parameter yielding a probabilistic forecast of resources.
    - May include reservoir simulation.
- Estimates of energy resources that will be recovered from post mine drainage of CMM and VAM are dependent on analysis of historical data documenting volume/mass of production and the rates at which coal and gas were produced.
- AMM resources may be estimated by various approaches, but reserves estimation is wholly dependent on testing and establishing stable (but declining) production; it is complicated, and the focus of work that the UNECE GoE on CMM and GMI are conducting.

Example of VAM data and energy resource calculations

Datong Coal Mine

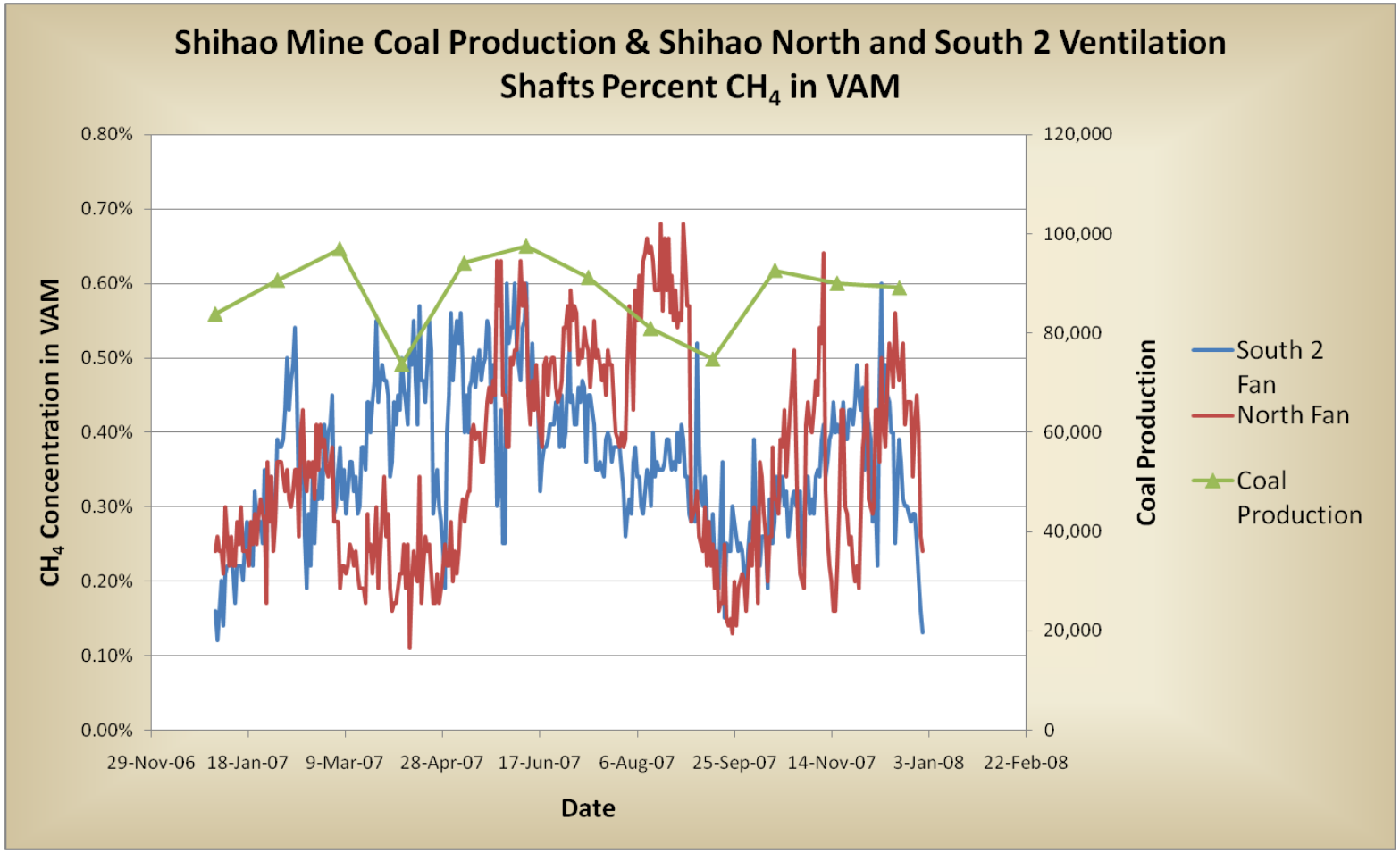


Shihao Coal Mine North Fan

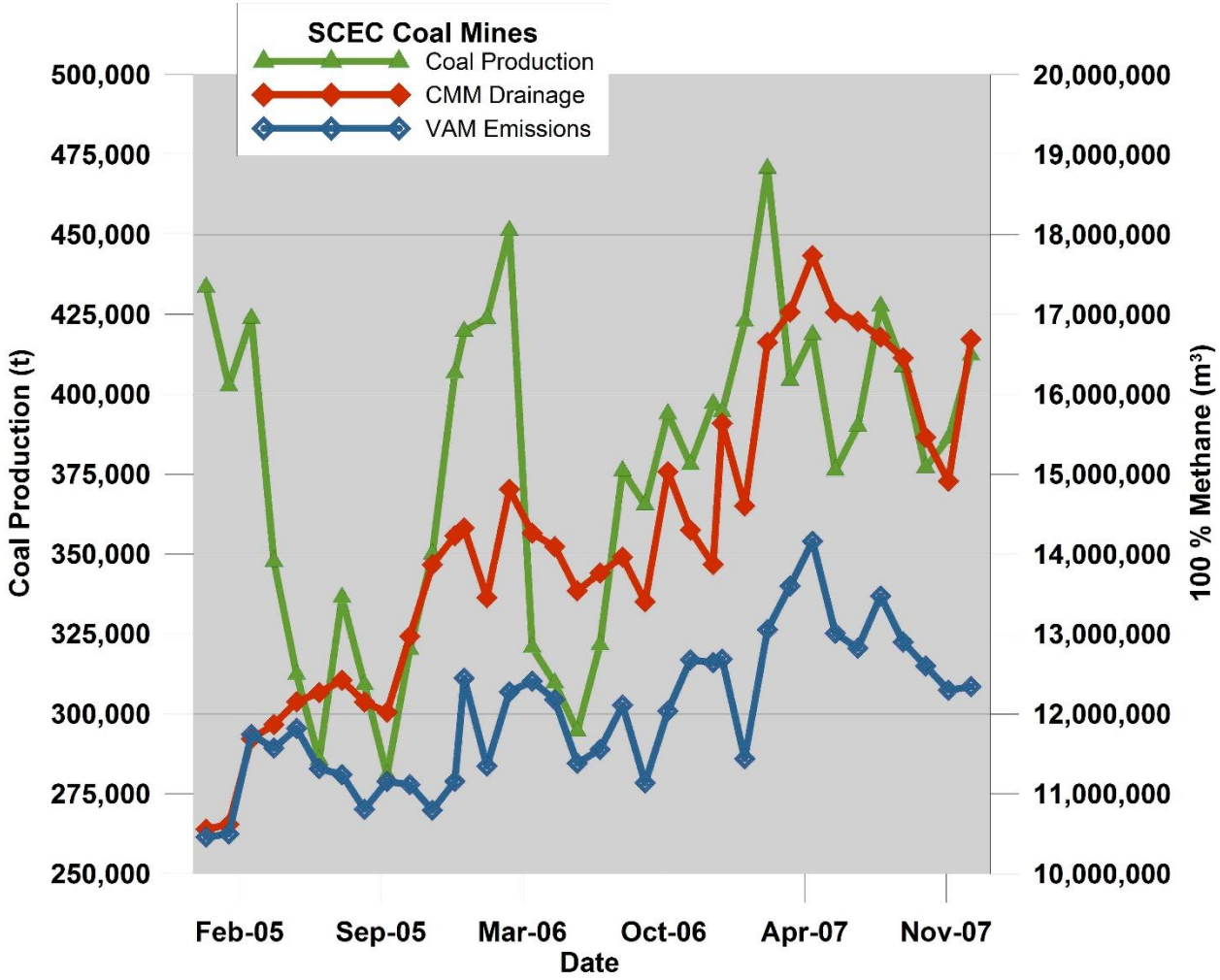


* Total does not include period of missing data.

Example of correlation of VAM concentration to rate of coal production



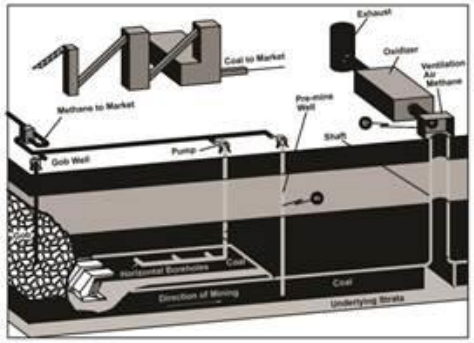
Drained and vented gas correlated to coal production



Coal and Gas Resources and the Coal Mining Life Cycle

Coal Mining Life Cycle

Mine Planning	*Active Mining*	*Mine Closed*
Undeveloped Coal Reserves	**Developed Coal Reserves**	**Depleted Coal Reserves**

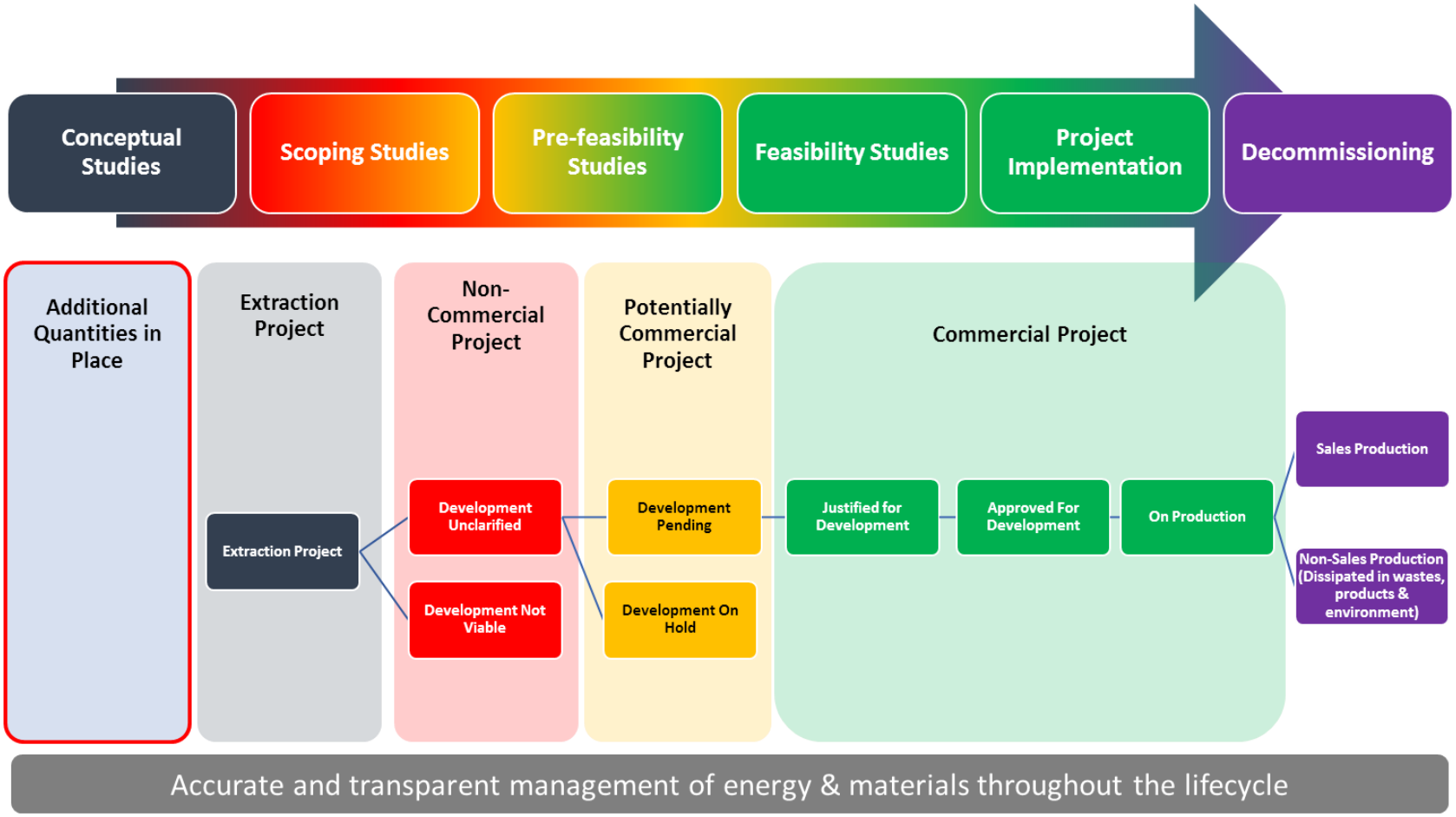


Gas Resources Evaluated and Production Plan Adopted	**Gas Produced and Sold During Mining**	**Enhanced CH_4 Recovery and CO_2 Sequestration**
Exploration	*Pre-mine and Gob Drainage*	*Post-mining Gas Production*

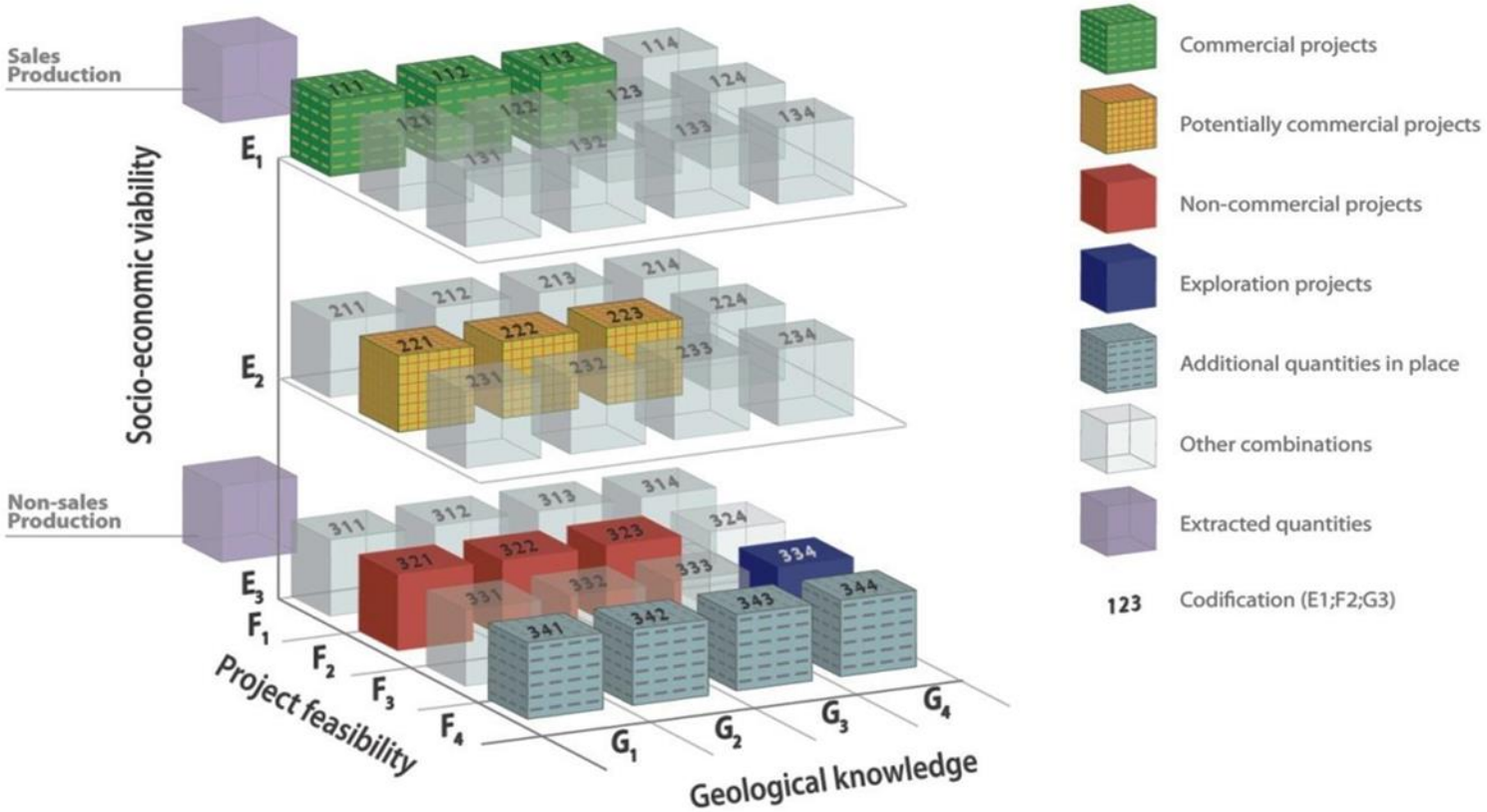
Gas Production Life Cycle

Pilcher, 2013

Comprehensive extraction lifecycle



How the UNFC uses economic, social and knowledge of occurrence to classify the resource



Conclusions

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- Principles of resource and reserve calculation schemes must be understood and consensus reached among regulatory agencies in order to establish reasonable policy that:
  - encourages commerce,
  - protects the environment,
  - protects the rights of the mineral owner,
  - protects investors, and
  - provides energy security to society.
- As a community, we need to adopt an approach to CMM resource and reserve estimation that ensures the above listed principles.

Dziękuję Ci I Gracias!

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