Overview of Abandoned Mine Methane Activities: Project Development and Policy Issues

Workshop on Coal Mine Methane and Abandoned Mine Methane in the context of Sustainable Energy

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RUBY CANYON ENGINEERING

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Presentation Outline

- AMM is an important emissions source
- Including AMM in national GHG emissions inventories
- Forecasting peak coal and AMM opportunity
- Preparing coal mines for AMM projects
- AMM policy and legal issues

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AMM as an Emissions Source

- An abandoned coal mine can be a very large reservoir of methane and source of fugitive emissions
  - Gas is stored in the void volume of the workings
  - Gas is also stored in the coal remaining in contact with the void
- Abandoned mine gas has favorable characteristics
  - Generally contains between 50% and 90% methane, nitrogen, and with small amounts carbon dioxide
  - Just a few wells can drain large underground areas
- Abandoned mines are often nearby active underground mines and CMM projects
  - Combined AMM and CMM projects

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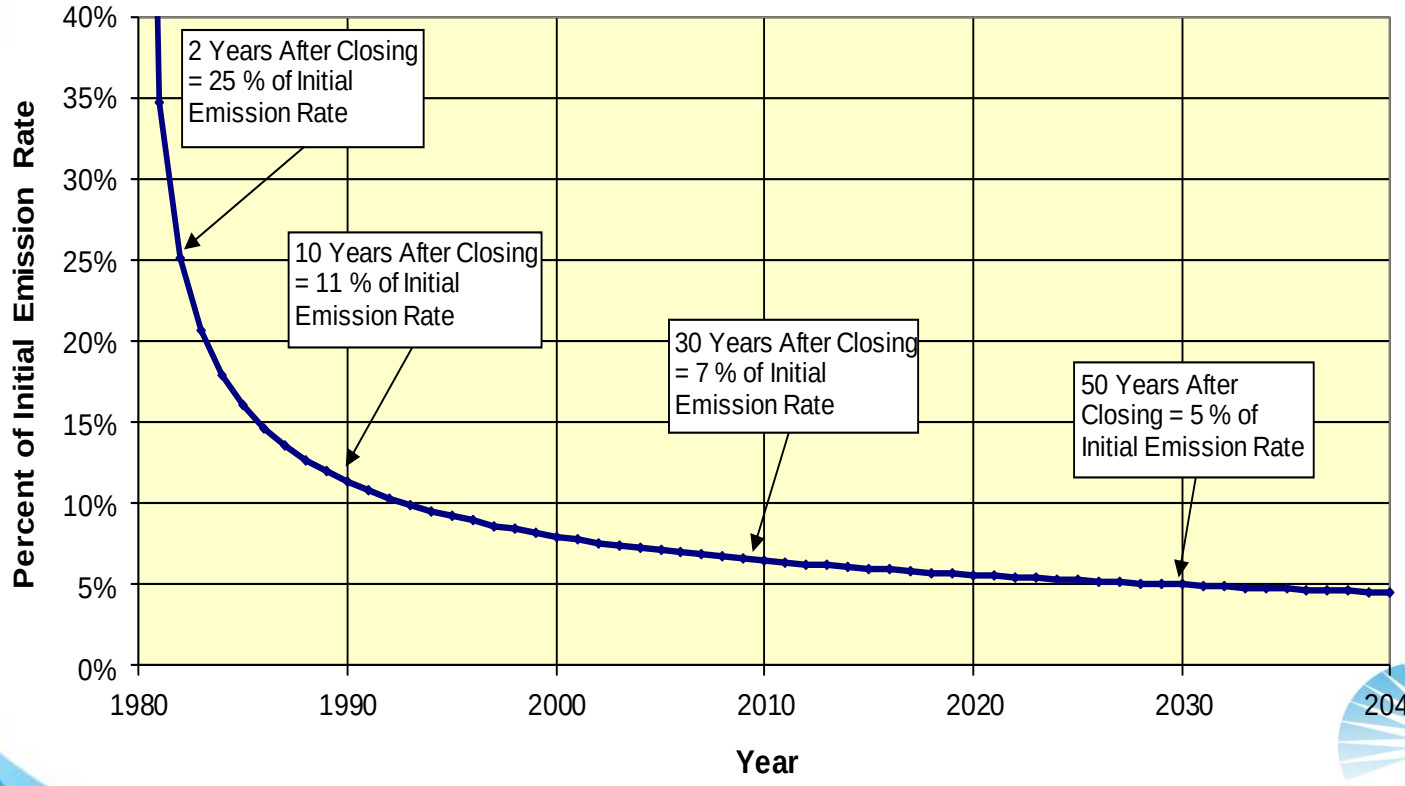
AMM as an Emissions Source

Using decline curve method to estimate emission rates for AMM inventory or project

- IPCC Guidance includes AMM decline curve tables



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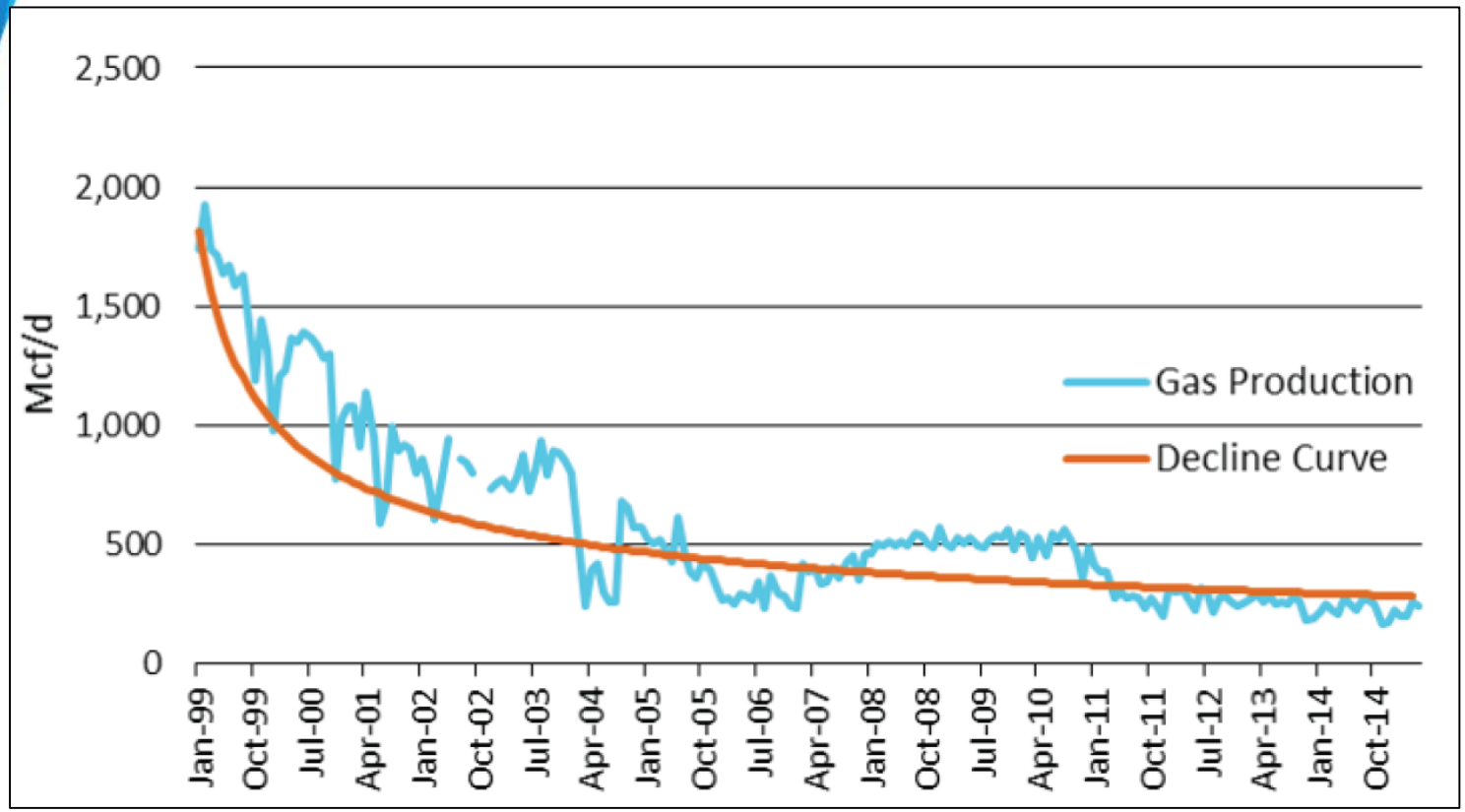
AMM as an Emissions Source

Decline curve not just theoretical!



Source: US EPA Inventory of Sources and Sinks 1990-2015

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INCLUDING AMM IN NATIONAL GHG INVENTORIES

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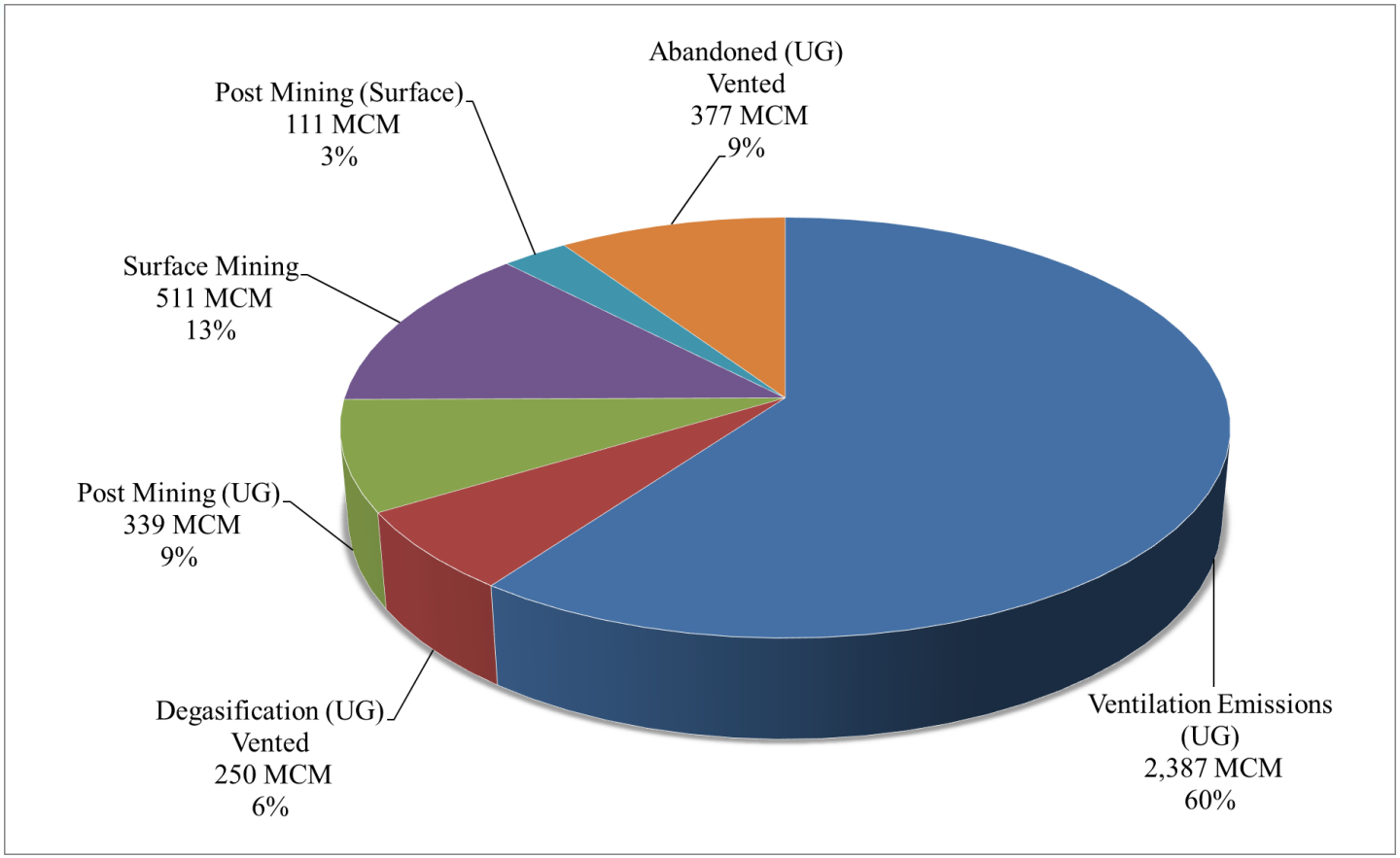
AMM Emissions Included in U.S. GHG Inventory



Source: US EPA Inventory of Sources and Sinks 1990-2015

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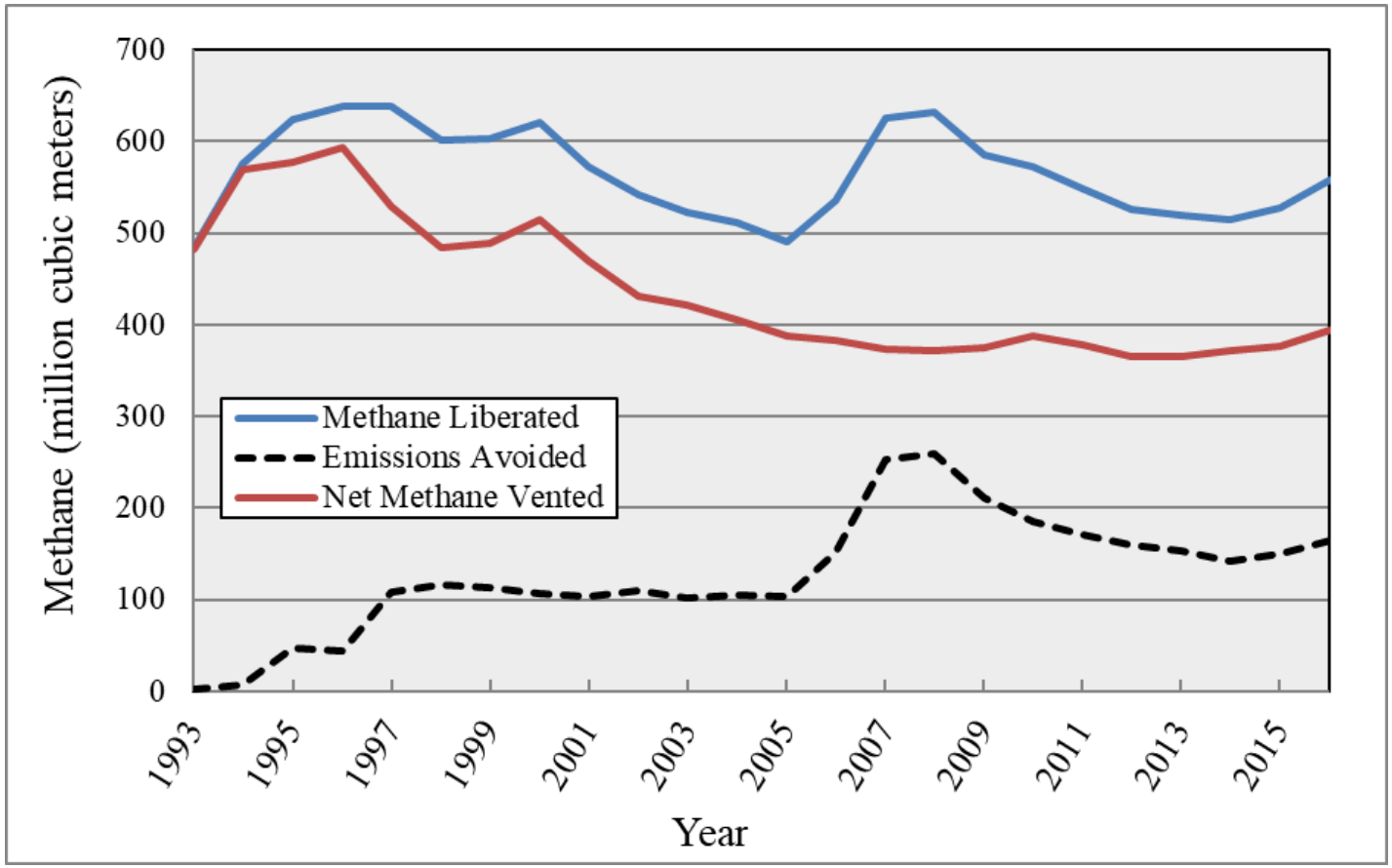
Historical AMM Emissions and Recovery in the U.S.



Source: US EPA Inventory of Sources and Sinks 1990-2015

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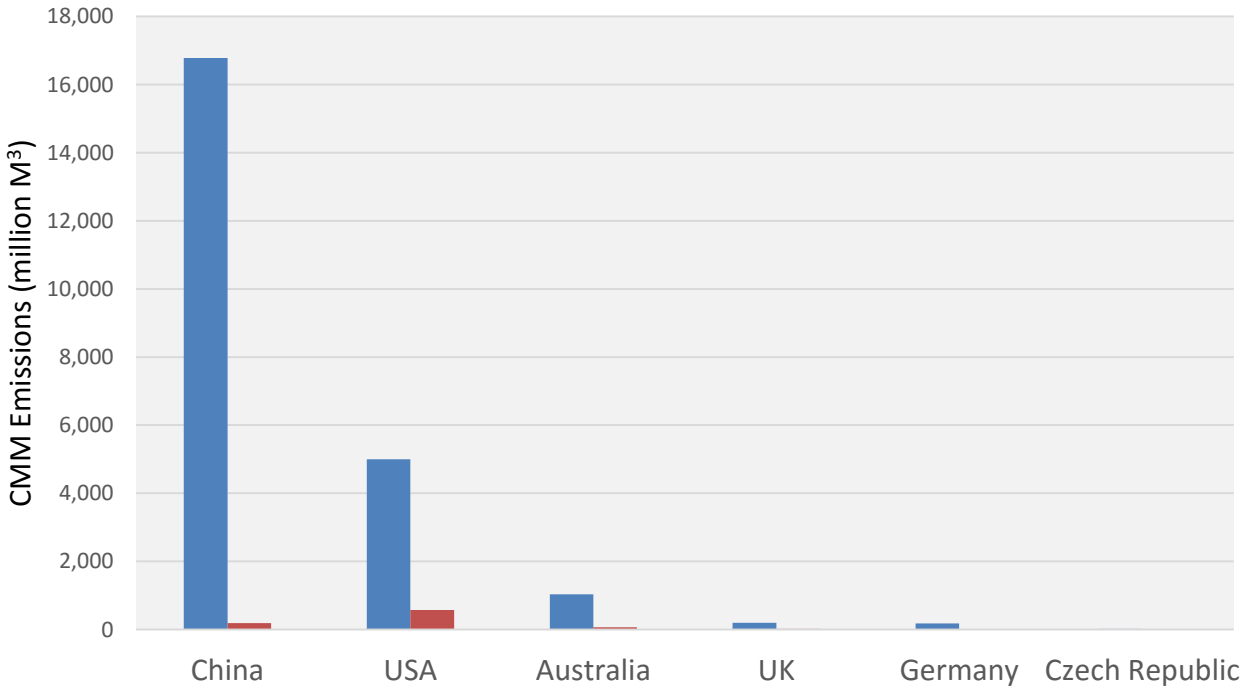
CMM and AMM Emissions Reported to UNFCCC

Emissions from Reporting Years 2005 and 2010



Source: UNFCCC National Inventory Report 2017

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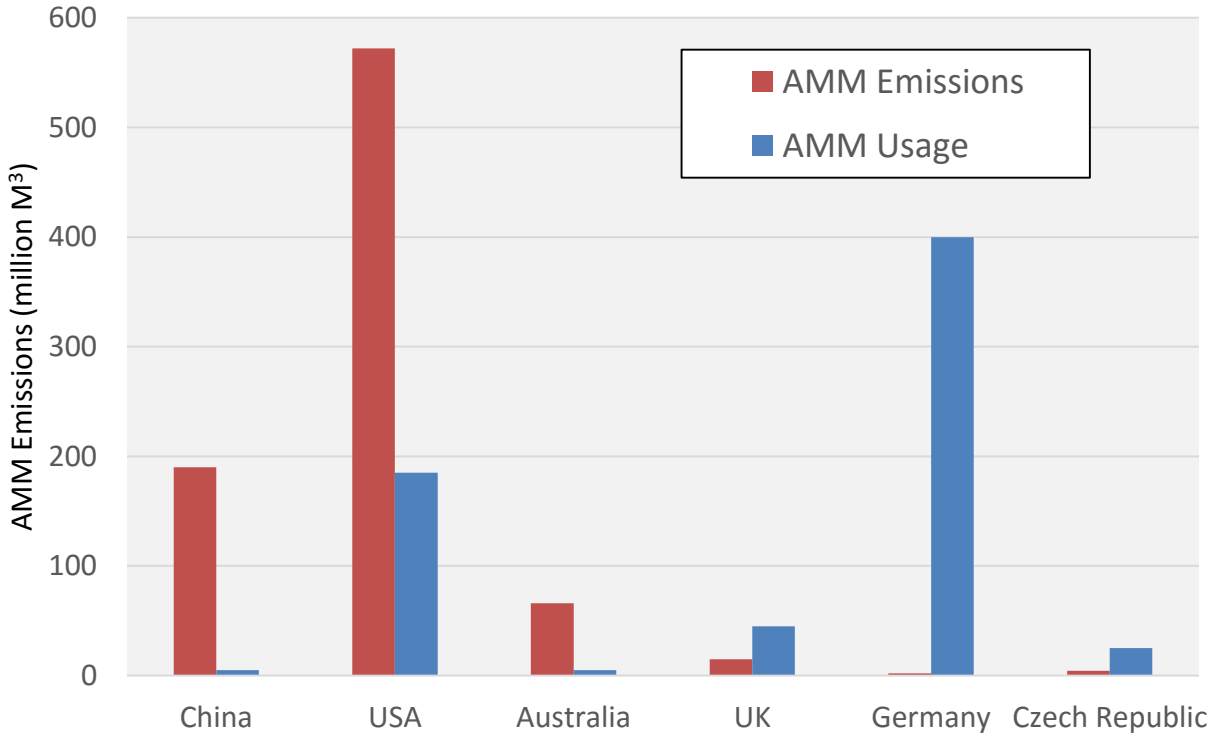
AMM Emissions and Utilization Reported in GMI Country Profiles

AMM Emissions and Utilization from 2005 and 2010



Source: UNFCCC National Inventory Reports & GMI CMM Country Profiles

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Where are the Current AMM Projects Located?

Top AMM Producing Countries

Country	Number of AMM Projects	Methane Emissions Avoided (million M^3)	Primary Utilization Technology
Germany	40	400	Electric Power
United States	20	185	Pipeline Sales
France	5	70	Industrial Use
United Kingdom	20	45	Electric Power
Czech Republic	10	25	Electric Power

Source: GMI CMM Country Profiles, 2015

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Forecasting Peak Coal and AMM Opportunities

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Forecasting Peak Coal and AMM Opportunities

- What is Peak Coal?
  - Generally defined as:
    - *The point in time when production and/or consumption reaches its highest level prior to terminal decline (Hubbert's peak theory)*
  - Forecasts for worldwide peak coal consumption range between 2010 to 2048
  - 5 Largest coal producing countries in 2016 (million tons):
    - China – 3,411
    - India - 692
    - United States - 661
    - Indonesia - 434
    - Russian Federation - 385

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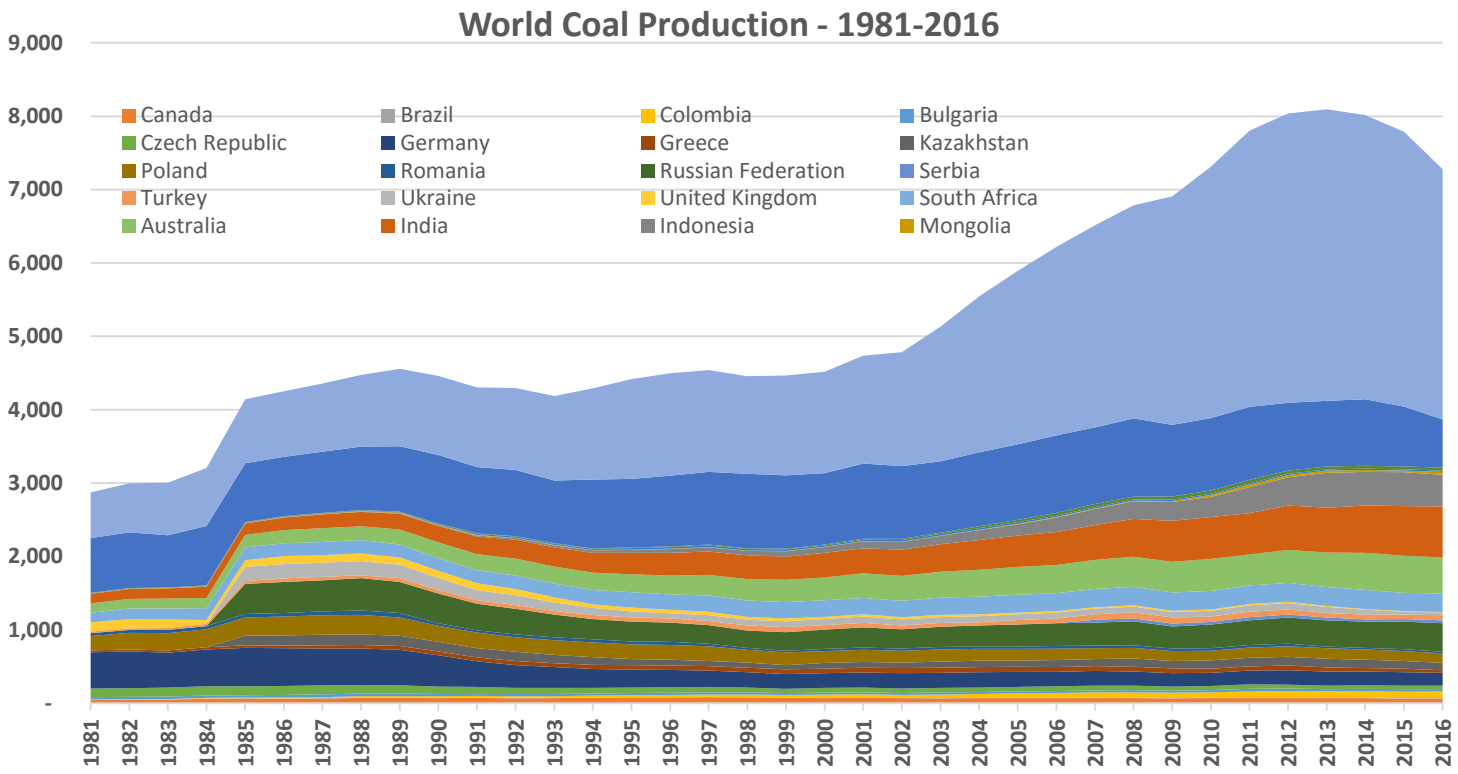
Forecasting Peak Coal and AMM Opportunities



Source Data: BP Energy Outlook 2017

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Forecasting Peak Coal and AMM Opportunities

Peak Coal Forecast Studies	
Study	**Forecast**
Energy Outlook 2017, BP	Coal consumption expected to peak in the mid-2020s
International Energy Outlook 2017, U.S. DOE EIA	Peak consumption by 2025, then levels out through 2040
Coal Information: Overview 2017, IEA	World coal production declined in 2014 for the first time this century, likely peak 2020
New Energy Outlook 2017, Bloomberg	Global coal-fired power generation peaks in 2026
Global coal production outlooks based on logistic model, 2010, Höök, Zittel, Schindler, & Aleklett	A plateau will be reached around 2025 and global production will decline after 2030
Forecasting coal production until 2100, 2009, Mohr & Evans	Worldwide coal production will peak between 2010 and 2048
Energy Transition Outlook 2017, DNV GL	By 2022, if coal use has not already peaked

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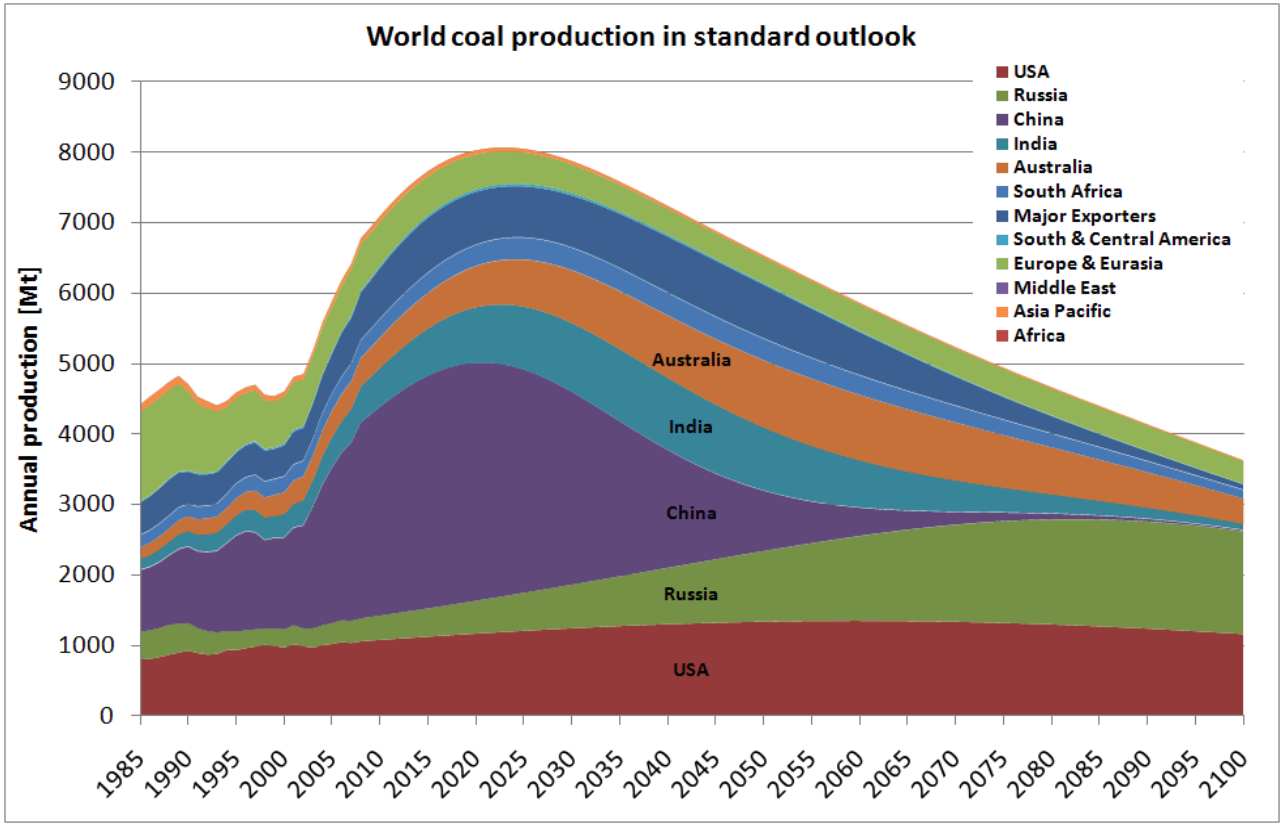
Forecasting Peak Coal and AMM Opportunities



Source: Höök et. al. 2010

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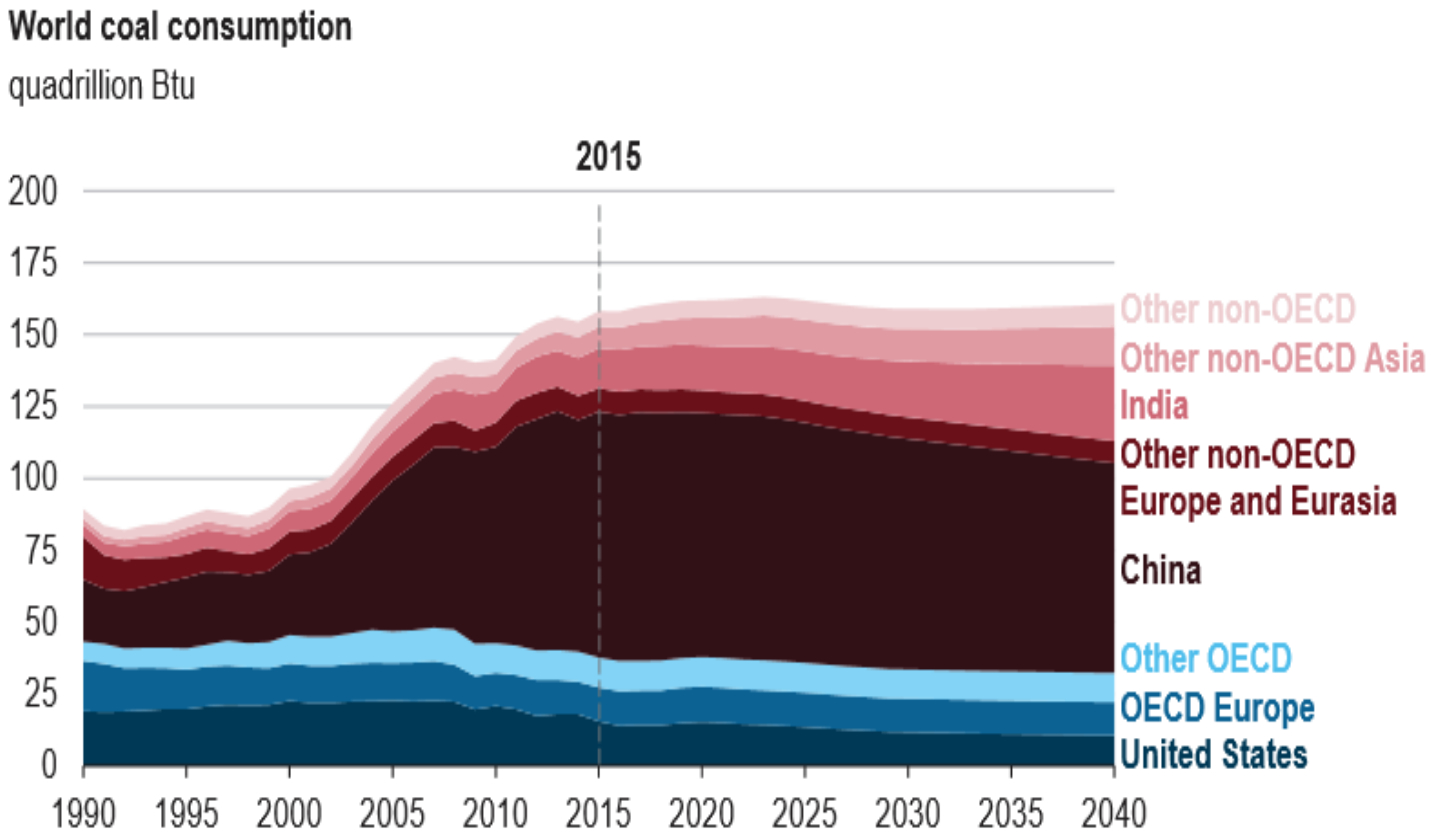
Forecasting Peak Coal and AMM Opportunities



Source: EIA Coal Information: Overview 2017

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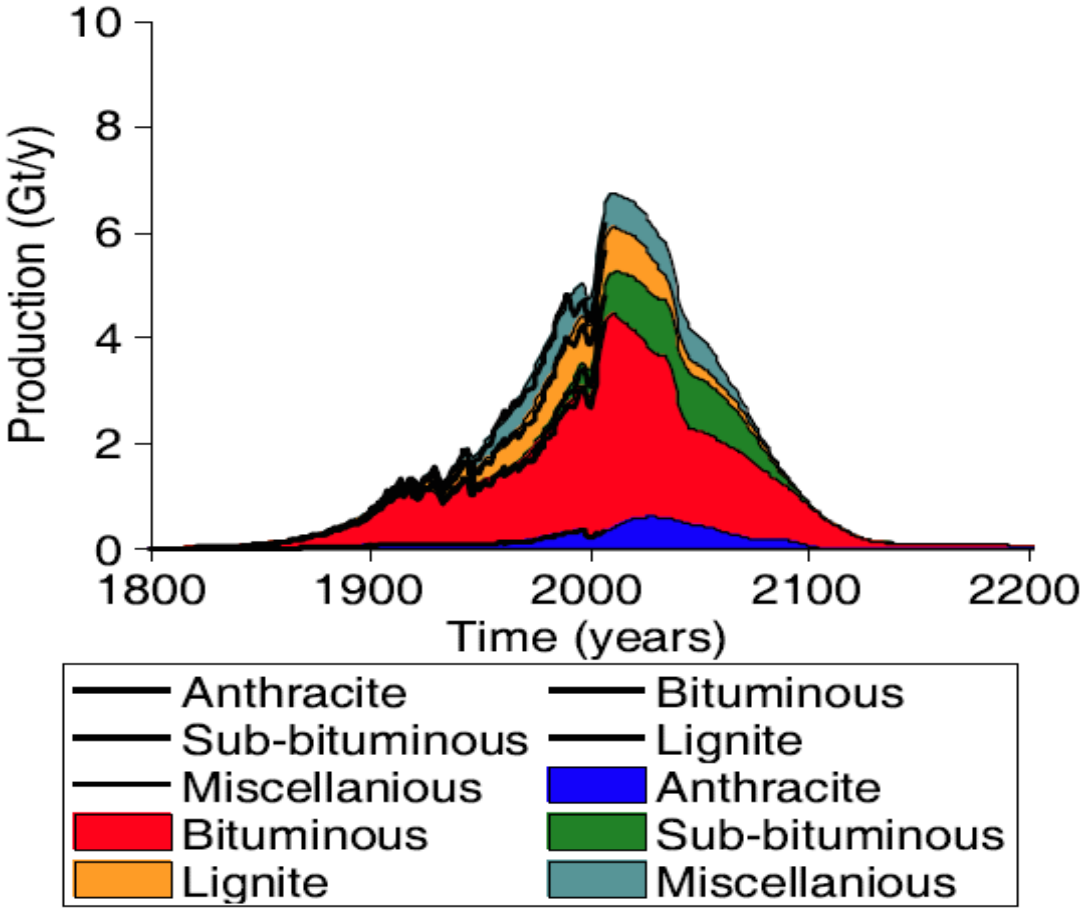
Forecasting Peak Coal and AMM Opportunities



Source: Mohr and Evans 2009

PREPARING COAL MINES FOR AMM PROJECTS

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Preparing Coal Mines for AMM Projects

Things to Consider:

- Accessing sealed mining districts
- Installing gas piping underground
- Using the mine roadways as conduit for gas flow
- Verifying integrity of surface seals to prevent atmospheric air intrusion

Project considerations:

- Methane resource assessment, field testing
- Lead times for financing, gas leasing, project permitting, and equipment manufacture

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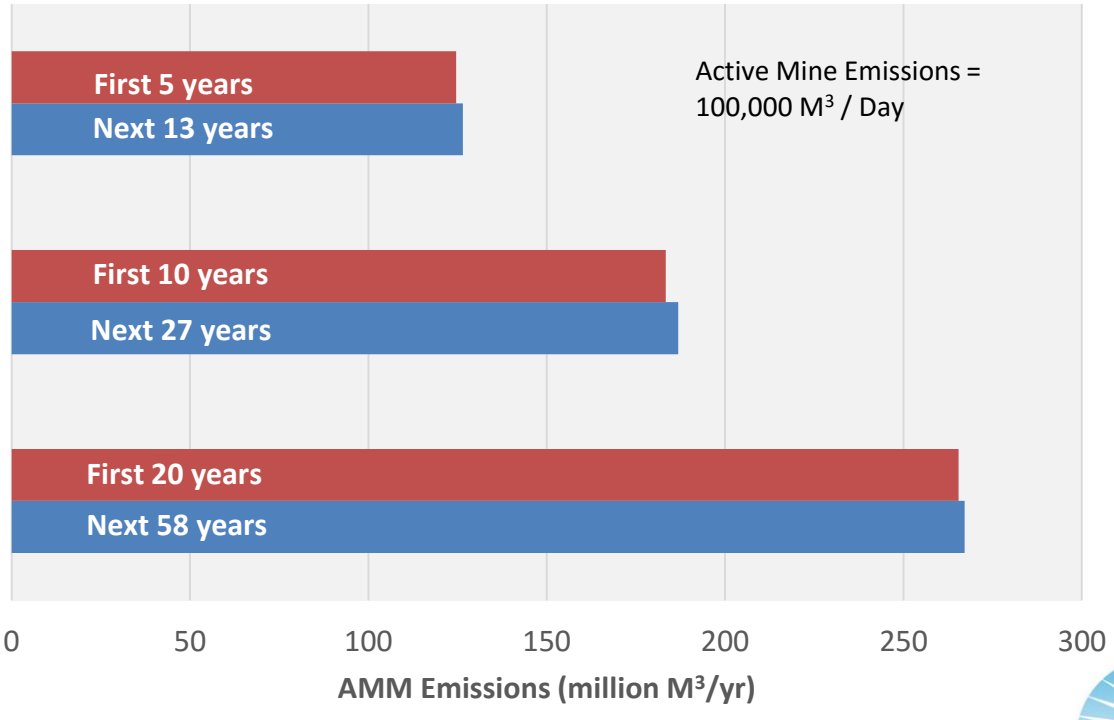
Preparing Coal Mines for AMM Projects

AMM Recovery - Sooner is Better!

- AMM Emissions Forecast Using Decline Curve Estimate



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Preparing Coal Mines for AMM Projects

- **Access methane via underground workings to avoid the need for surface gas gathering systems**
  - Methods are used in both in European and some U.S. AMM projects
  - Minimizes project footprint
  - Reduces operational costs and permitting needs
  - Minimizes surface land disturbance

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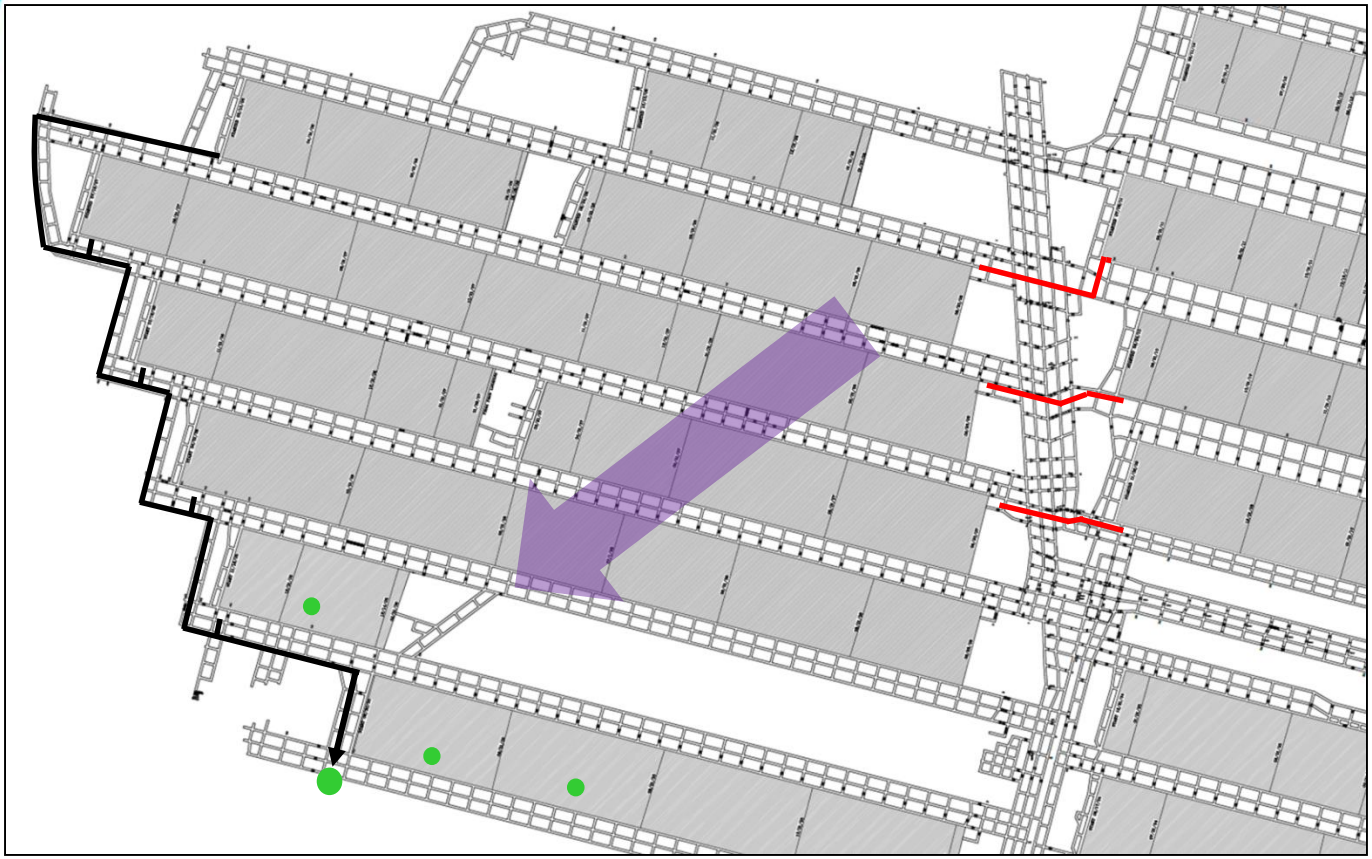
Accessing Sealed Areas Underground via Roadways



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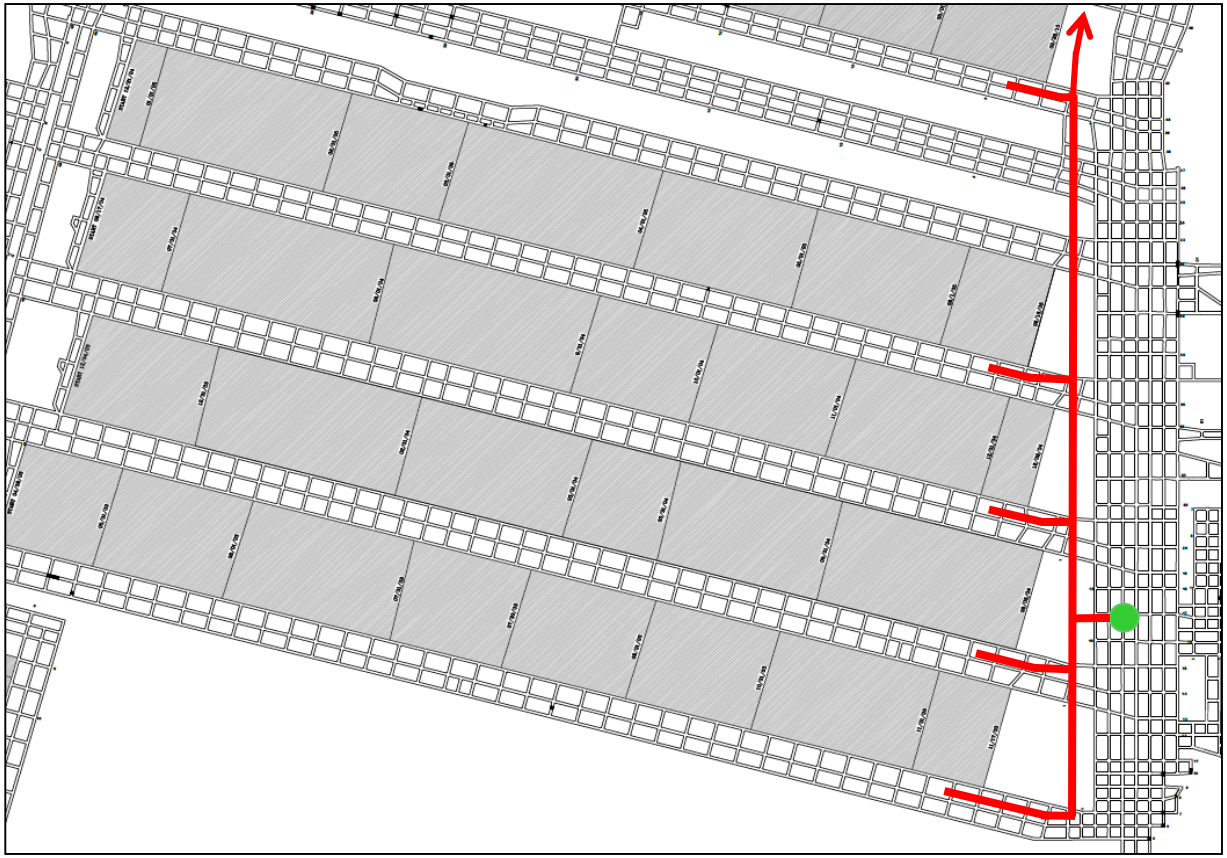
Installing Underground Pipes to Access Sealed Areas



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Colorado AMM Project Example

Elk Creek AMM Project –

- 3 MWe and enclosed flare
- 5 coal mines

Source: Vessels Coal Gas

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Similarities and Differences Compared to CMM Projects

- Size and Scale of Projects
  - AMM projects tend to be 10-25% the size of CMM projects at the same mine, but abandoned mines can be aggregated into a single larger project.
- Utilization Technologies
  - AMM projects are able to use medium-quality gas technologies such as boilers, heaters, reciprocating engines for electric power, and flares/combustors.
- Coal Mine Involvement
  - AMM projects are simplified by not having the mine control all methane extraction activities based on safety considerations.
- Permits
  - AMM projects are complicated somewhat by the need to apply for new (or separate the existing) permits.

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AMM POLICY AND LEGAL ISSUES

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AMM Legal Issues

- AMM Ownership
  - Coal mine operators are often allowed to vent (and use) CMM with just the coal mineral rights, and not necessarily the rights to the methane gas.
  - Some coal mine operators may have the rights to all minerals (and gas) in the lease agreement
  - AMM projects typically need the rights to the methane gas
- Project Permitting
  - Typically, large-scale coal mining operations include a number of permits under the umbrella of an approved mine plan.
  - AMM projects may need to acquire or reapply for all the necessary permits to operate an AMM recovery and use project.

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Policy Issues to Consider

- Greenhouse Gas Markets – Carbon Offsets
  - Three AMM projects currently registered in the California Air Resources Board Compliance Offset Program
  - Current value of credit = $12.00/metric tonne CO_2e
    - Equates to approximately $150/mM^3 methane, which can exceed the value of the gas as an energy source
- Renewable Energy Credits – Green Tariffs
  - CMM/AMM included as a renewable energy resource in German Renewable Energy Act, five U.S. States Renewable Portfolio Standards, and formerly the UK
  - Value can range widely from 1-7cents/kW-hr

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AMM Projects as Sustainable Energy Project Opportunities

- AMM Projects recover fugitive methane emissions similar to landfill, livestock, and wastewater biogas projects.
- Financial incentives for sustainable development such as carbon offset credits and renewable energy credits.
- Overall GHG emission reduction benefits enhanced due to the high global warming potential of methane.

Source: RCE

Environmental Health & Safety Benefits – AMM recovery & flare system installed in Ostrava, Czech Republic neighborhood to prevent methane build-up in basements of buildings.

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AMM Best Practices Guide

- GMI and UNECE plan to prepare draft AMM Best Practices Guide (or guidelines)
- Covers the following areas:
  - Modeling the methane resource
  - Controlling factors of methane releases during active underground mining
  - Estimating potential methane recovery rates
  - Mitigating areas of risk
    - Atmospheric contamination
    - Water flooding
    - Compartmentalization
  - Preparing mines for closure
  - Sustainable development & management of AMM Projects

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Conclusions

- Important to include AMM in national GHG inventories and UNFCCC reporting
- Set goals to reduce CMM/AMM emissions under policy frameworks
- Prepare closed mines for AMM recovery based on mine-specific conditions
- Need for incentives and policies that make AMM projects more financially attractive
- AMM as sustainable energy
- Need for AMM BPG

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