Global CMM and AMM Emissions: Implications of Mining Depth and Future Coal Production

Nazar Kholod[1], Meredydd Evans[1], Raymond C. Pilcher[2], Michael Coté[3], Ron Collings[3]

[1] Pacific Northwest National Laboratory; [2] Raven Ridge Resources; [3] Ruby Canyon Engineering

9TH INTERNATIONAL FORUM ON ENERGY FOR SUSTAINABLE DEVELOPMENT

November 15, 2018, Kyiv, Ukraine

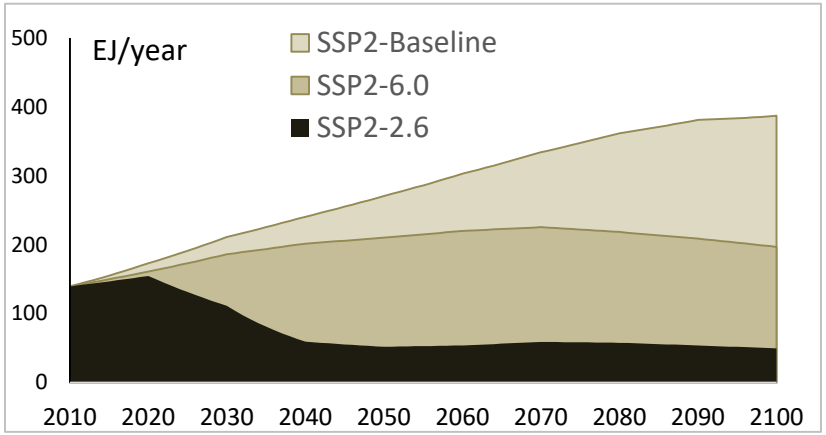
Global Methane Initiative

Introduction: CMM Emissions and Coal Production

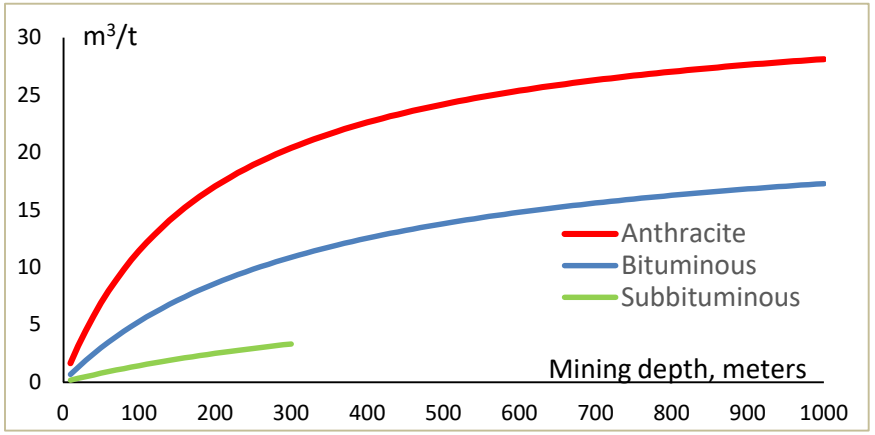
- Coal mines get deeper every year and methane emissions grow with increasing mining depth
- Data show flat or declining coal production, while CMM emissions continue to grow
- No studies on future AMM estimates
- Purpose: estimate global CMM and AMM emissions from hard underground and surface coal with increasing mining depth through 2100
- This study was born out of discussions on emissions and mine depth during GMI Coal Subcommittee meeting

CMM Methodology

- Use coal production data from the Socioeconomic Pathways (2010-2100)
- Split hard coal by underground and surface
- Estimate the rate of change in mining depth
- Establish emission factors at given depths and for different coal ranks using measured data



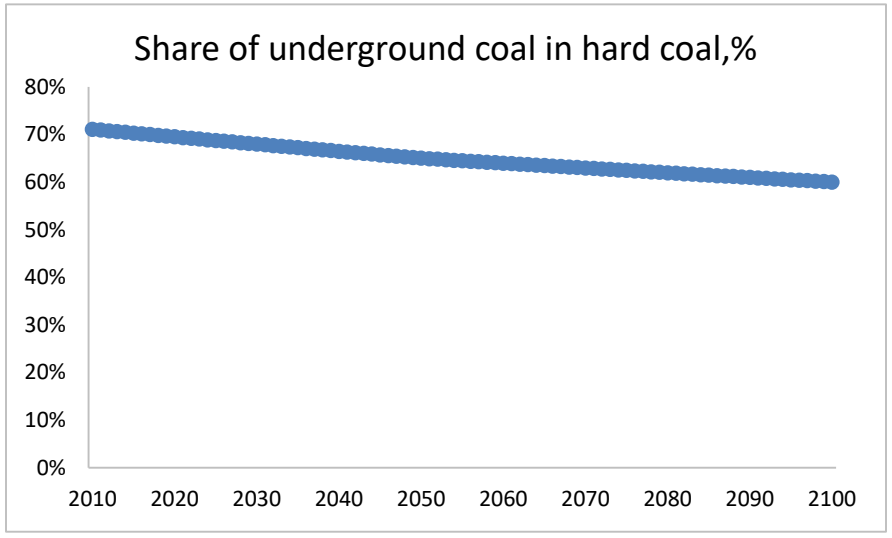
Estimates of future coal production under various scenarios

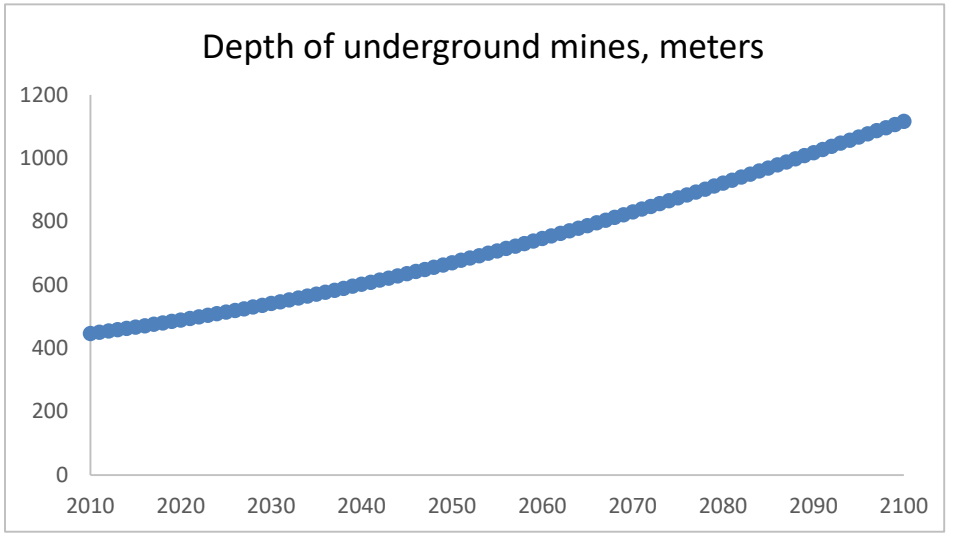


Gas content depend on coal rank and mining depth. Raven Ridge developed the formula using data from over 250 coal samples from North America, South America, Asia and Europe

Trends in Global Coal Mining

- The study uses data from key coal producing countries in 1990-2010
- The share of underground mining is shrinking because surface mining is more economical
- Depth of underground mines is increasing
- Share of brown coal is decreasing
- Trends are extended by 2100

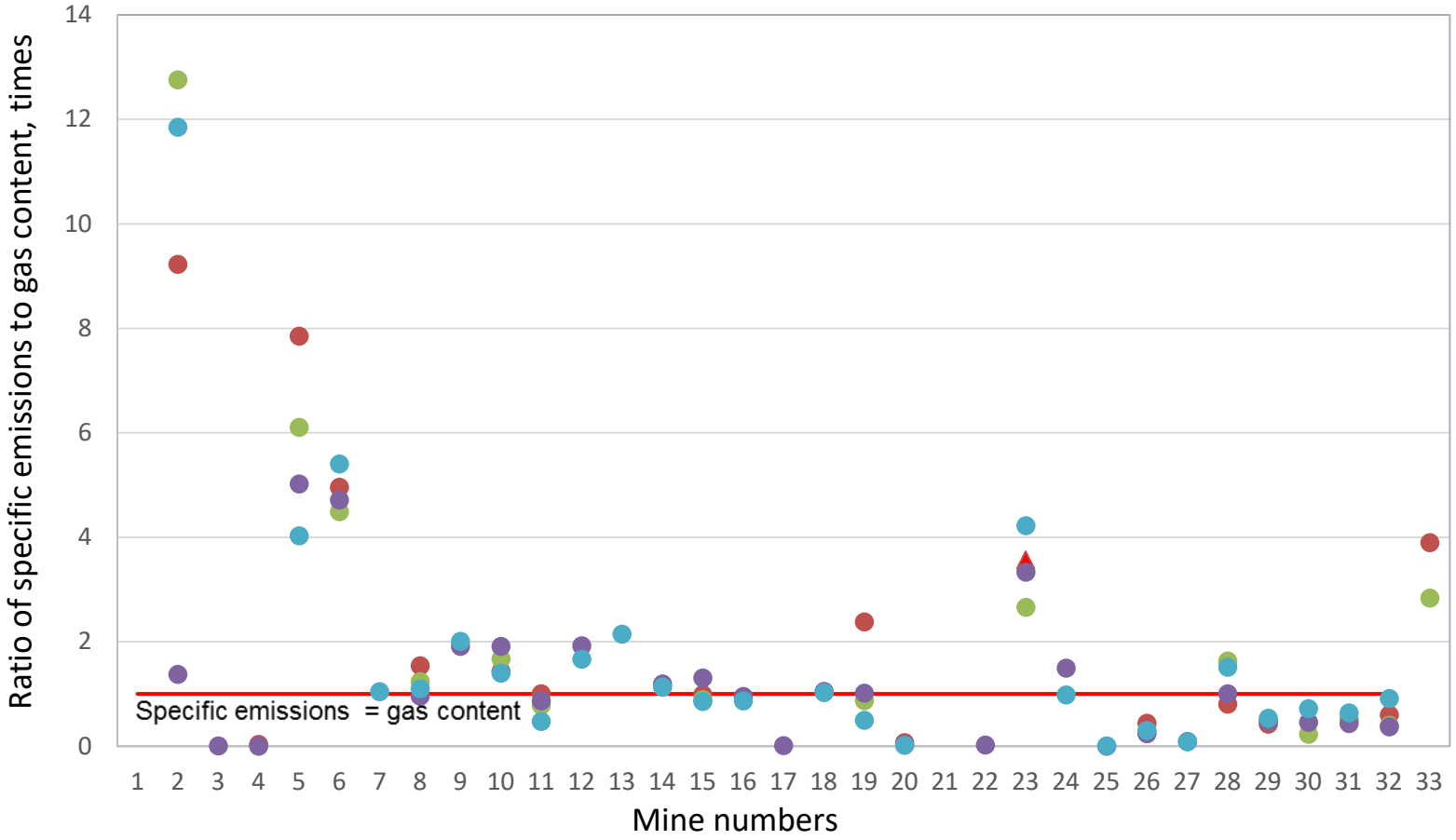




SSP2-Baseline; Preliminary data

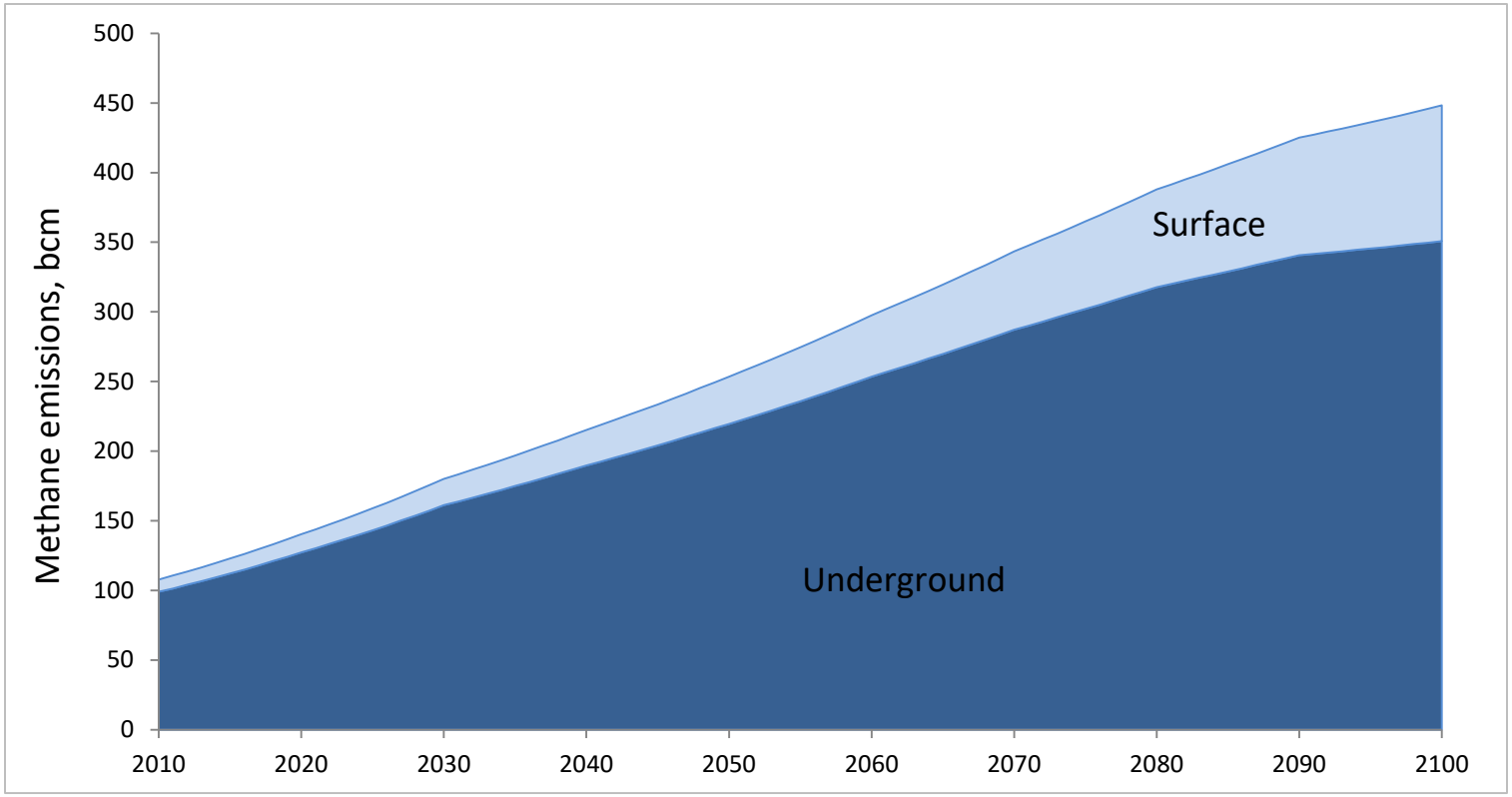
Ratio of Emissions to Formula-Derived Gas Content

- Based on coal production, emissions and mining depth data, the ratio of emissions to gas content is estimated at 1.7



Global CMM: Reference Scenario

- Share of CMM emissions from underground hard coal in total CMM emissions is 92% in 2010 and 78% in 2100



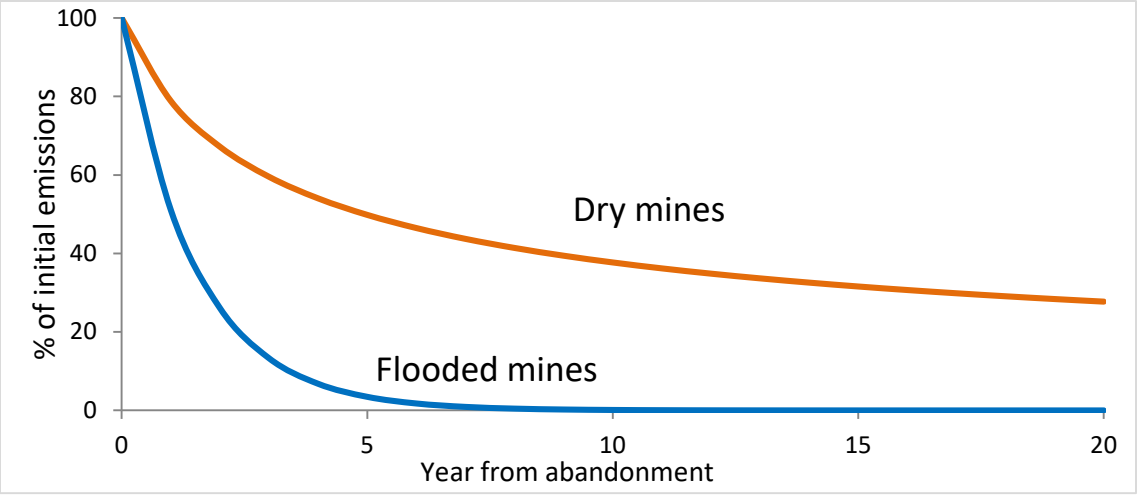
SSP2-Baseline (average); Ratio 1.8; No utilization. Preliminary data

AMM Methodology

- Calculate initial emissions from abandoned mines based on the CMM methodology
- Calculate the global average coal abandonment rate
- Make assumption on the decline rates in emissions over time in dry and flooded mines
- Calculate the emissions from the coal mines abandoned in the past (1971-2010)
- Calculate future AMM emissions from dry and flooded mines

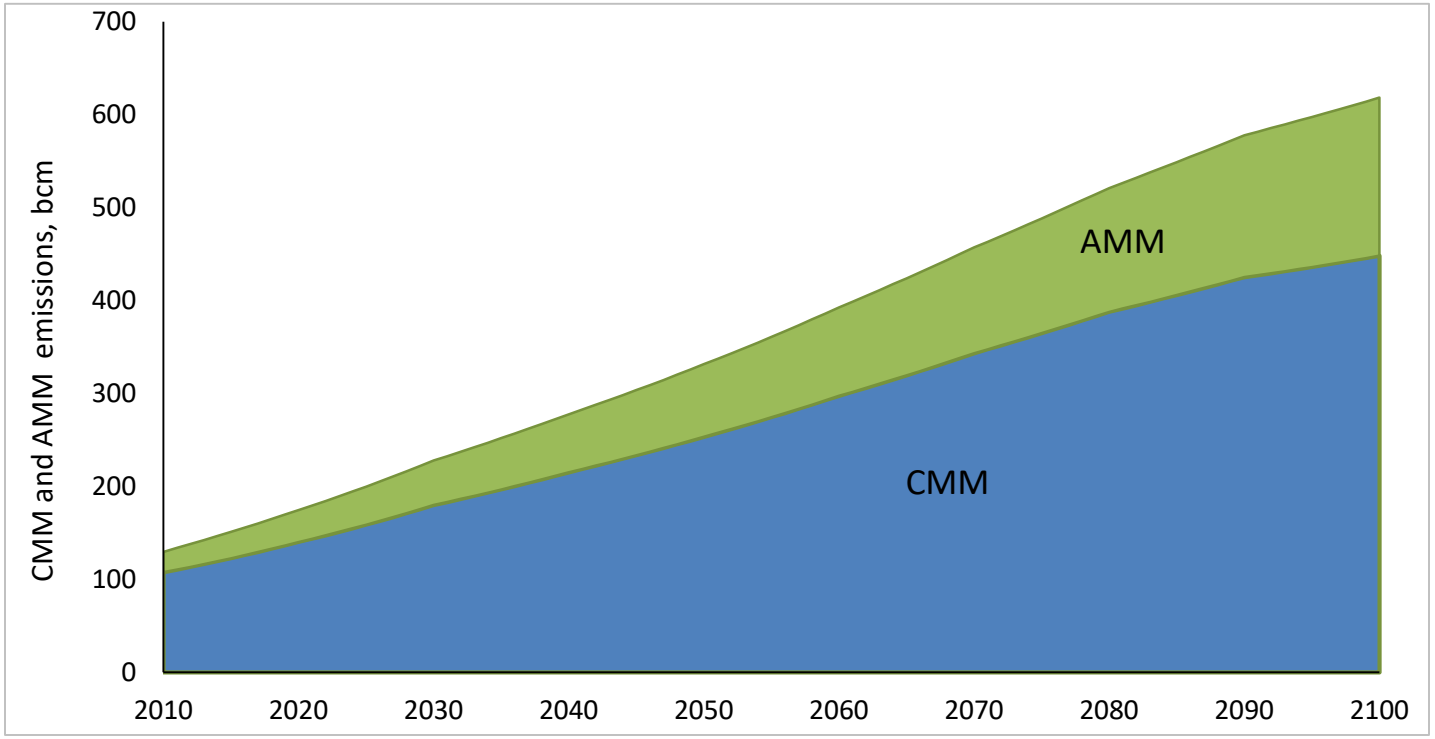
Coal abandonment rate = Abandoned coal production (capacity) / Total coal production (capacity)

Global abandonment rate = 5% of coal production (capacity) per year



Global AMM Emissions: Reference Scenario

- AMM's share in total methane from coal is 17% in 2010
- This share is projected to increase to 24% in 2050 and 27% in 2100

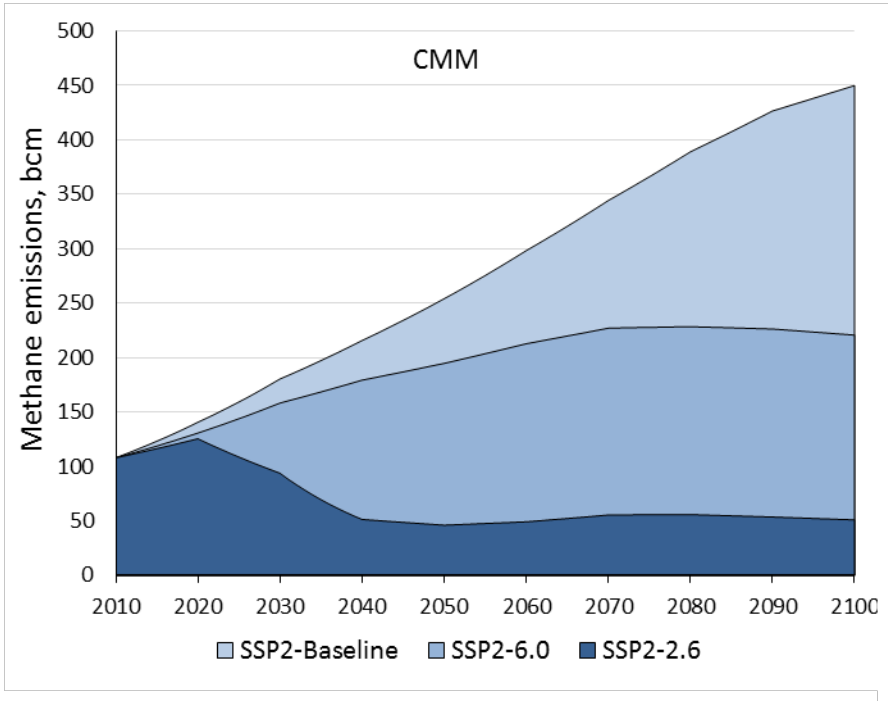


SSP2-Baseline (average); Ratio 1.7; No utilization. Preliminary data

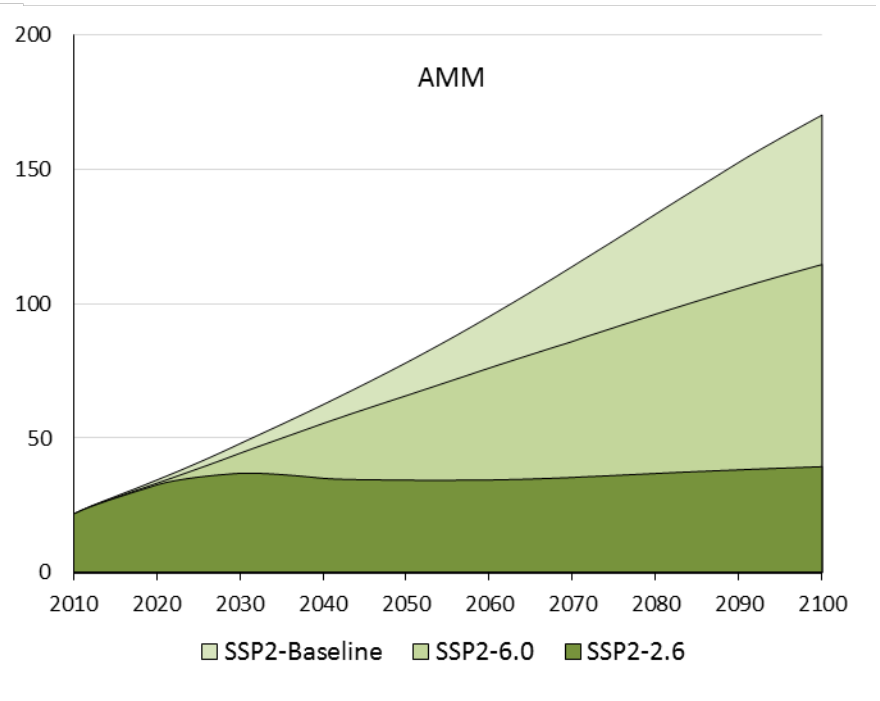
Importance of AMM: Baseline and Policy Scenarios

- AMM increase faster than underground coal production and CMM
  - Underground coal by 2.6 times, CMM by 3.5, AMM by 7.8 times
- AMM's share in total emissions increases in policy scenarios
  - 34% in SSP2-6.0 and 44% in SSP2-2.6 in 2100

CMM emissions follow the trajectory of coal production



AMM emissions continue to grow even if coal production and CMM decline



Improving Inventories and Emission Factors

- Methodology and data used in this study could help improve future inventories and emission factors
- CMM emission factors by depth and coal rank are more detailed than current emission factors
- AMM methodology can help in capturing more complete emissions, mitigation opportunities
- Methodology can also be used to cross-check more detailed, bottom-up estimates

Global Methane Initiative

Conclusions

- Estimates are double those of previous studies because of the additional detail on mining depth and AMM
- AMM emissions will remain significant by the end of the century regardless of future coal production
- Methodologies used in this study may help improve future emission factors and inventories, for example, with underground CMM and more comprehensive AMM emissions