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Summary of U.S. Coal Mine Methane Emissions & Available CMM Resources

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For: U.S. EPA Coalbed Methane Outreach Program

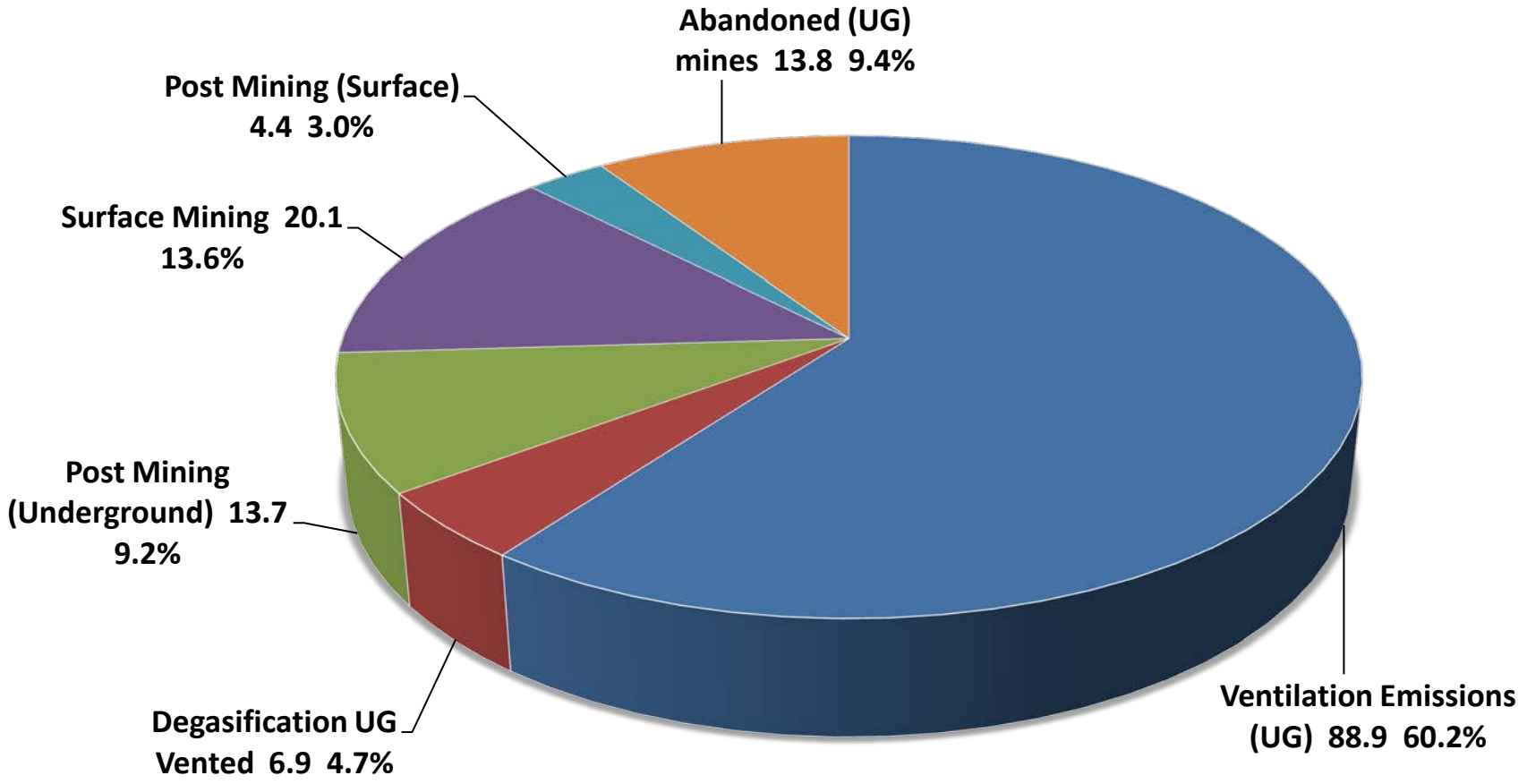
U.S. EPA Coalbed Methane Outreach Program

Overview

- 2013 coal mining emissions overview
- Historical trends in coal production & CMM emissions
- State by State emissions
- Methane Resources
  - Degas
  - AMM
  - VAM

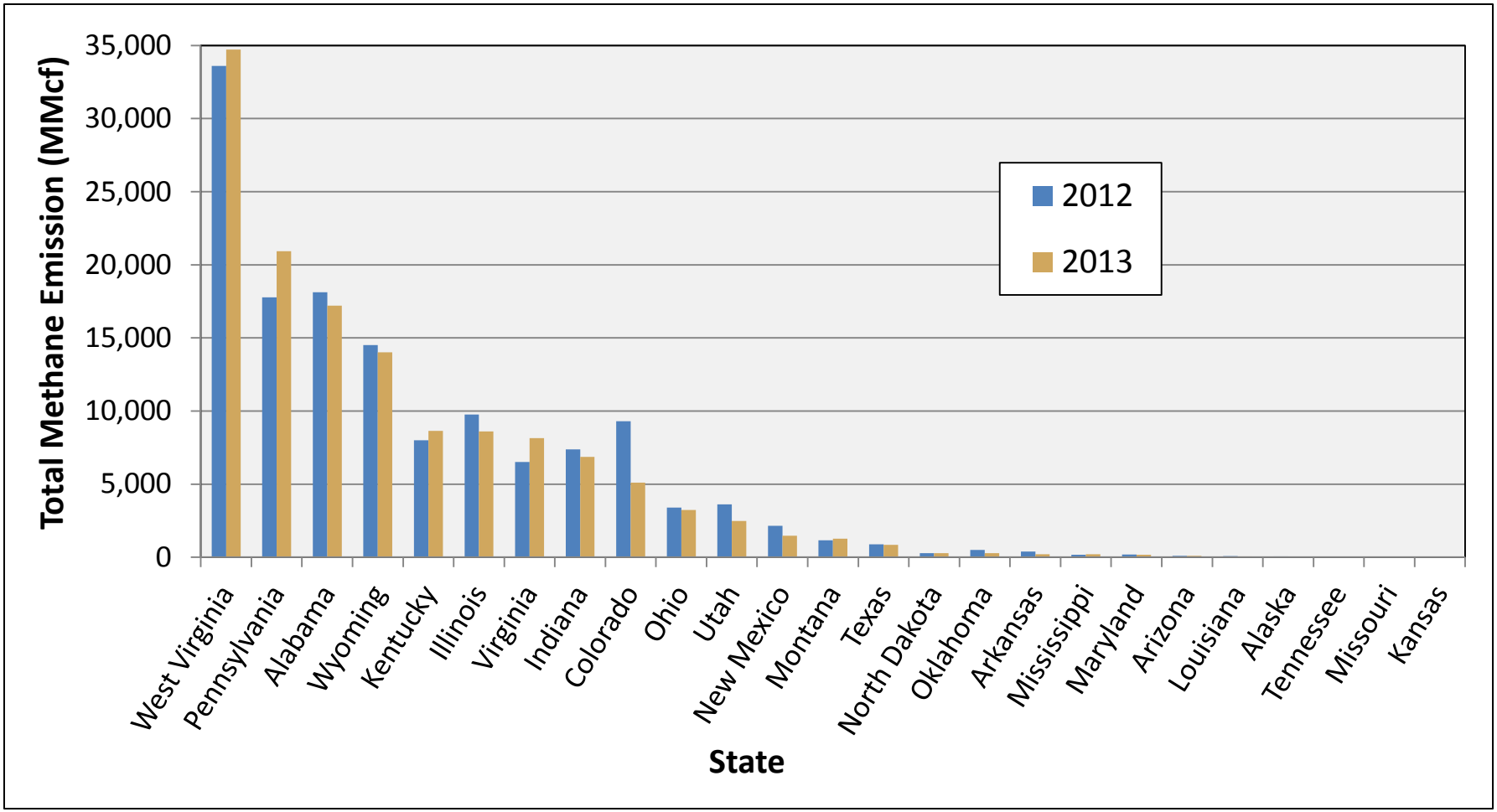
2013 CMM Emissions Overview

Total Coal Mine Methane Emission by Source



2013 Emissions (Bcf)

Total 2012-2013 Emissions by State*



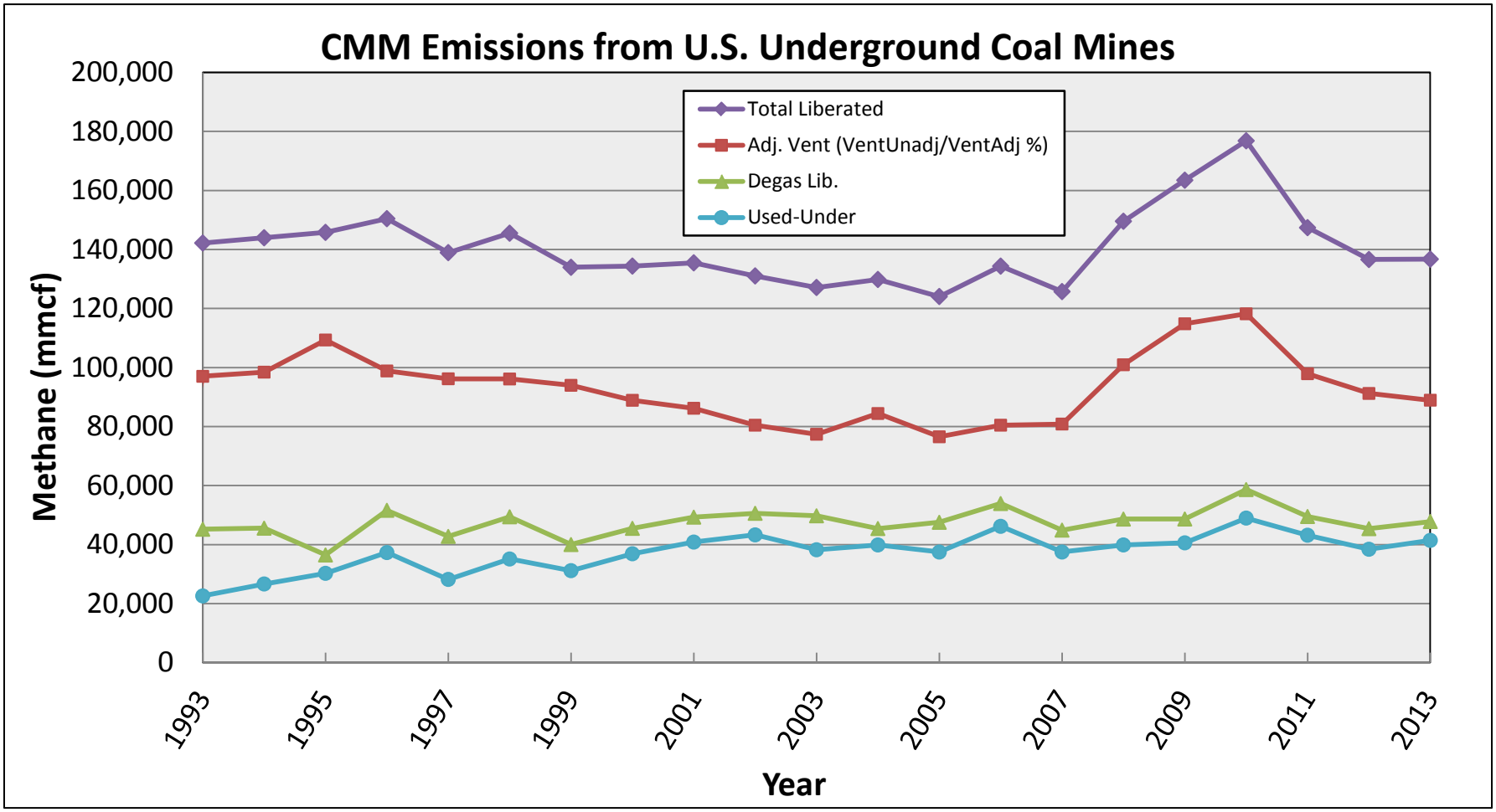
* Emissions include post mining emissions

2013 Updates & Trends

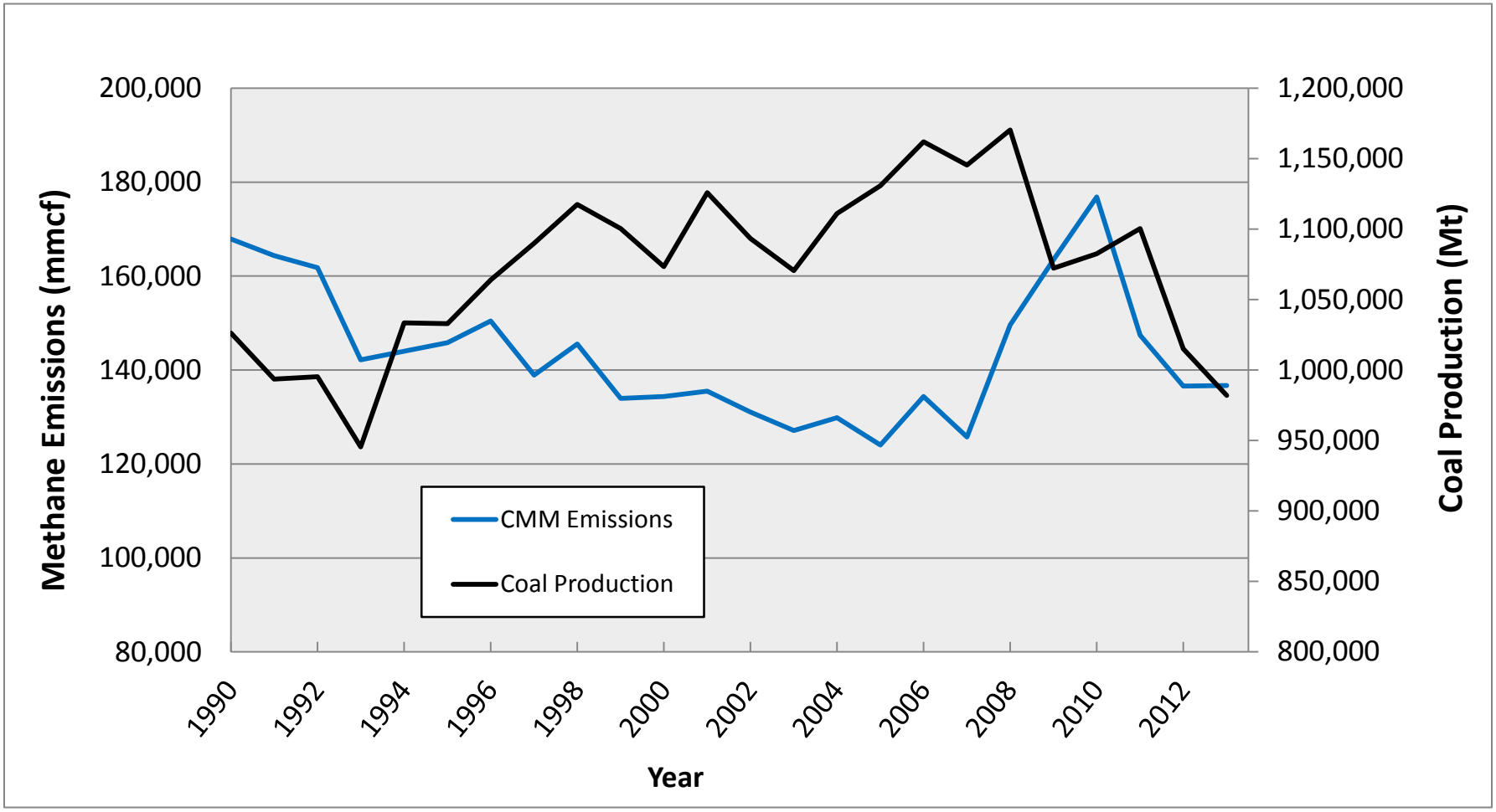
- Coal production and methane emissions decreased slightly for both underground and surface mines
- VAM amount destroyed was highest ever
  - About 500 mmcf methane
- Vented degas methane remains about 7 Bcf
- Number of underground coal mines decreased from 488 to 395
- Eight gassy mines abandoned in 2013
  - Total gassy abandoned mines now = 509

Historical Trends

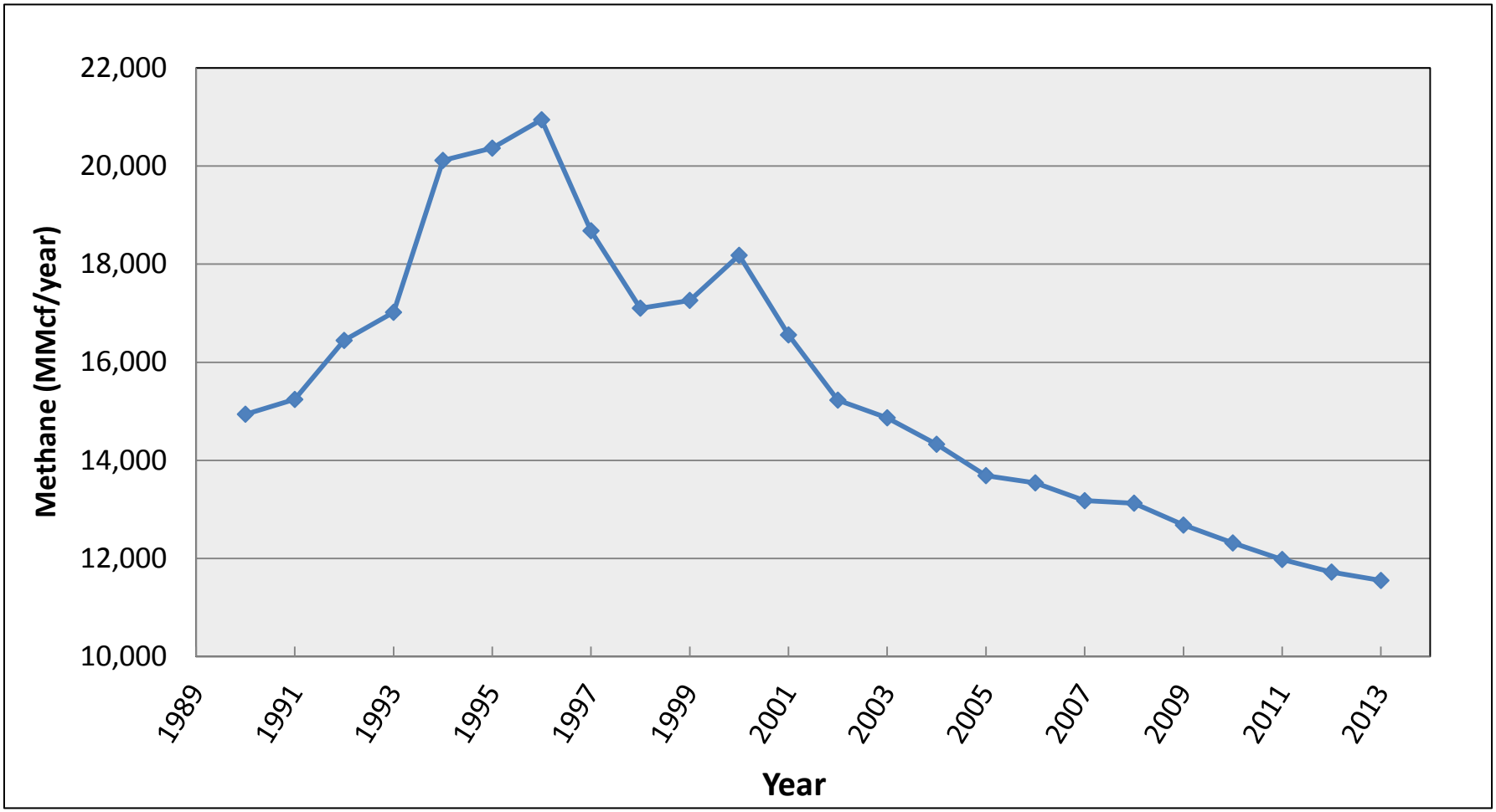
20 Years of Underground Coal Mine Emissions



U.S. Coal Production and Net CMM Emissions 1990-2013



AMM Emissions Since 1990

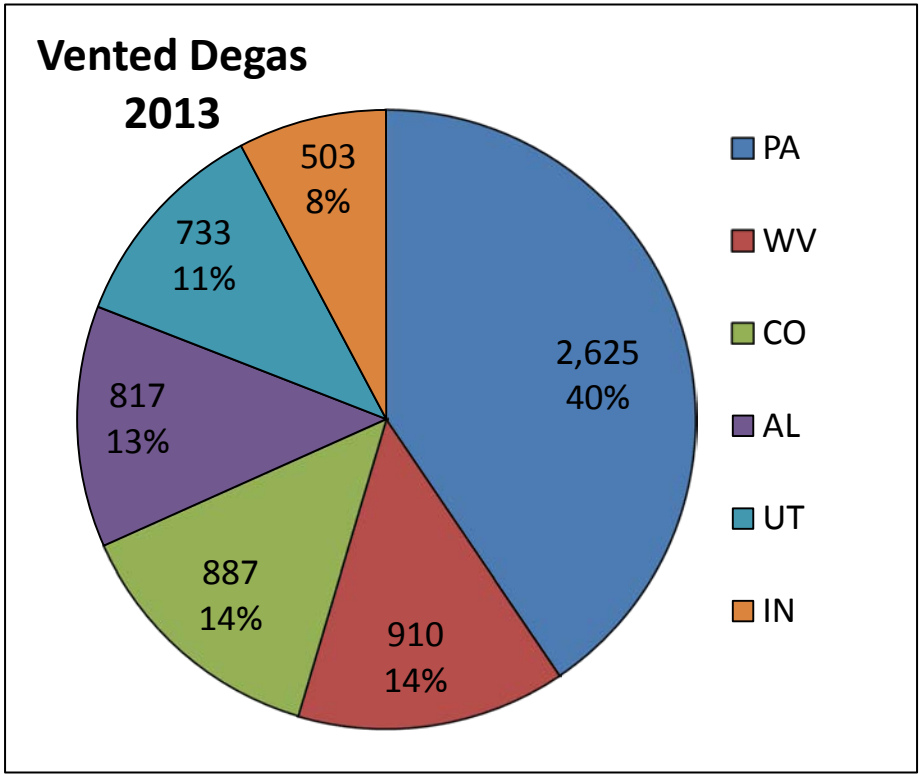


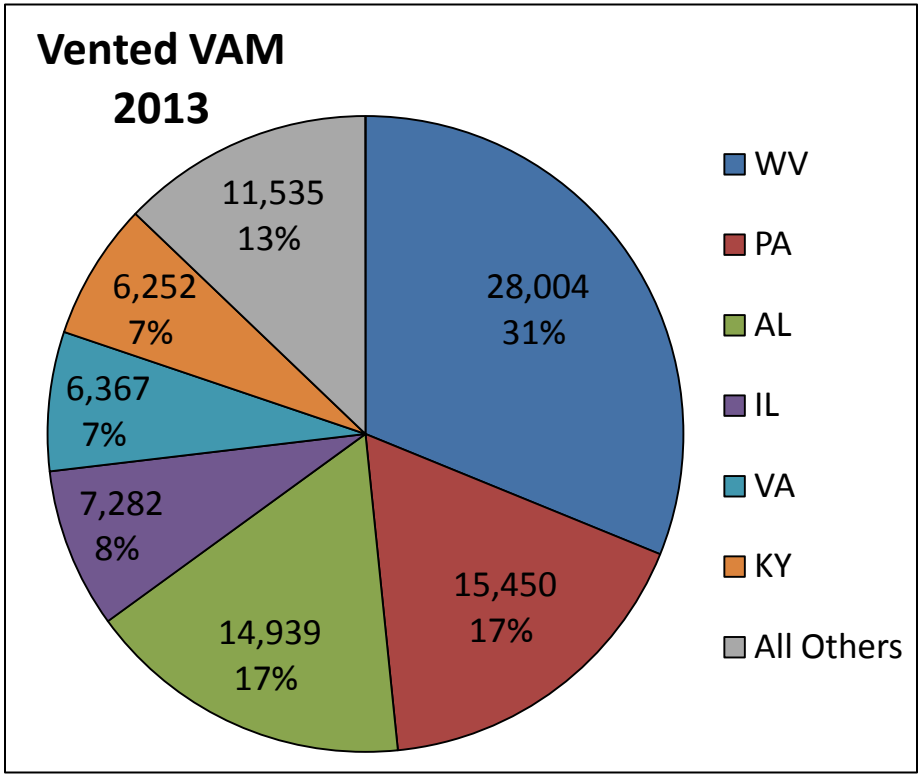
2013 Updates & Trends

- VAM emissions peaked in 2010
  - Have remained flat for past two years
- Degas emissions also peaked in 2010
  - 20% lower in 2013
- AMM emissions continue a steady 13-year decline
- No real correlation between overall U.S. coal production and CMM emissions

State by State Emissions

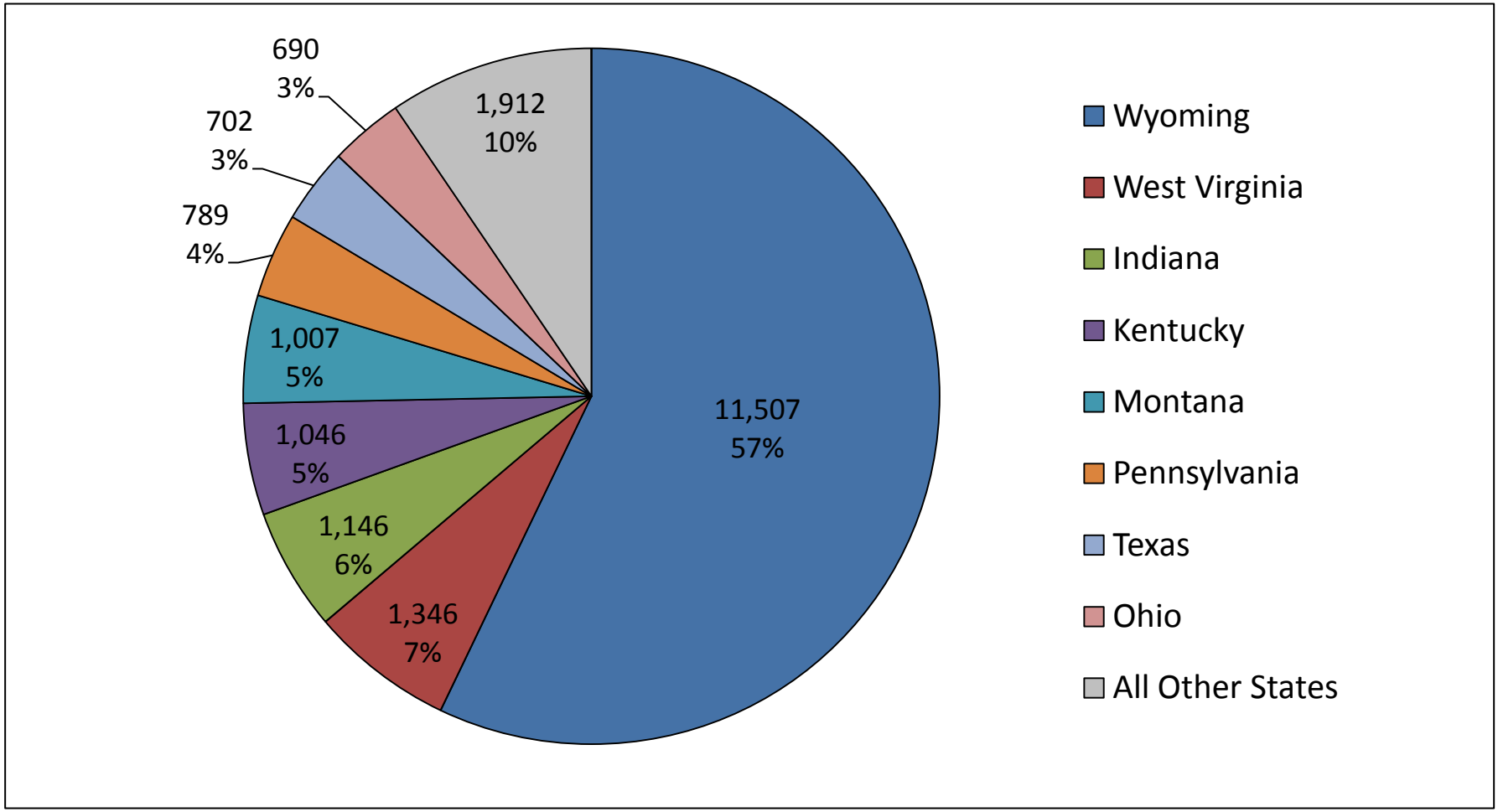
CMM Emissions from Underground Mines by State





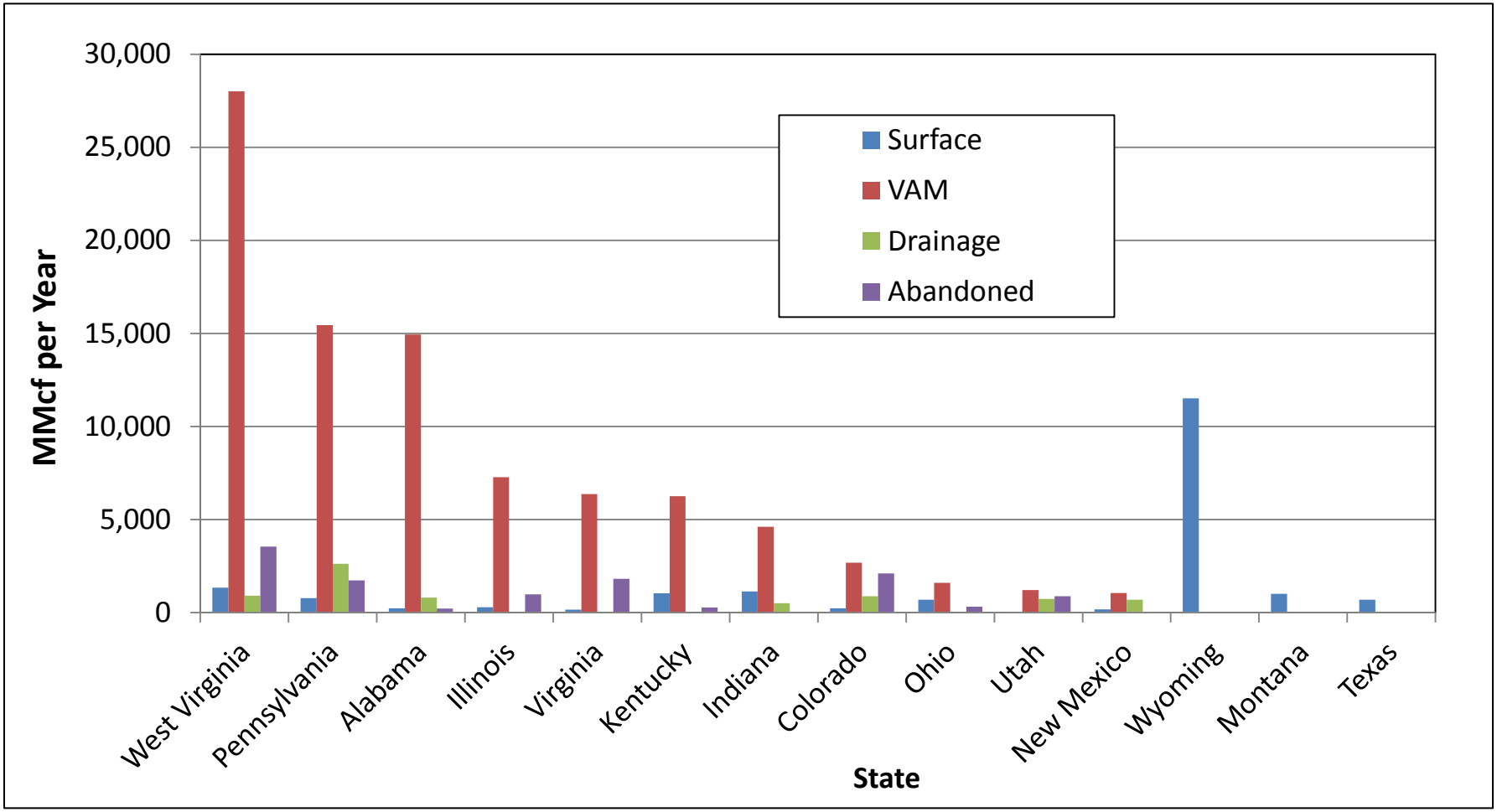
Emissions are in MMcf

SMM Emissions from Surface Mines by State



Emissions are in MMcf

2013 CMM/SMM/AMM Emissions by Mine Methane Source

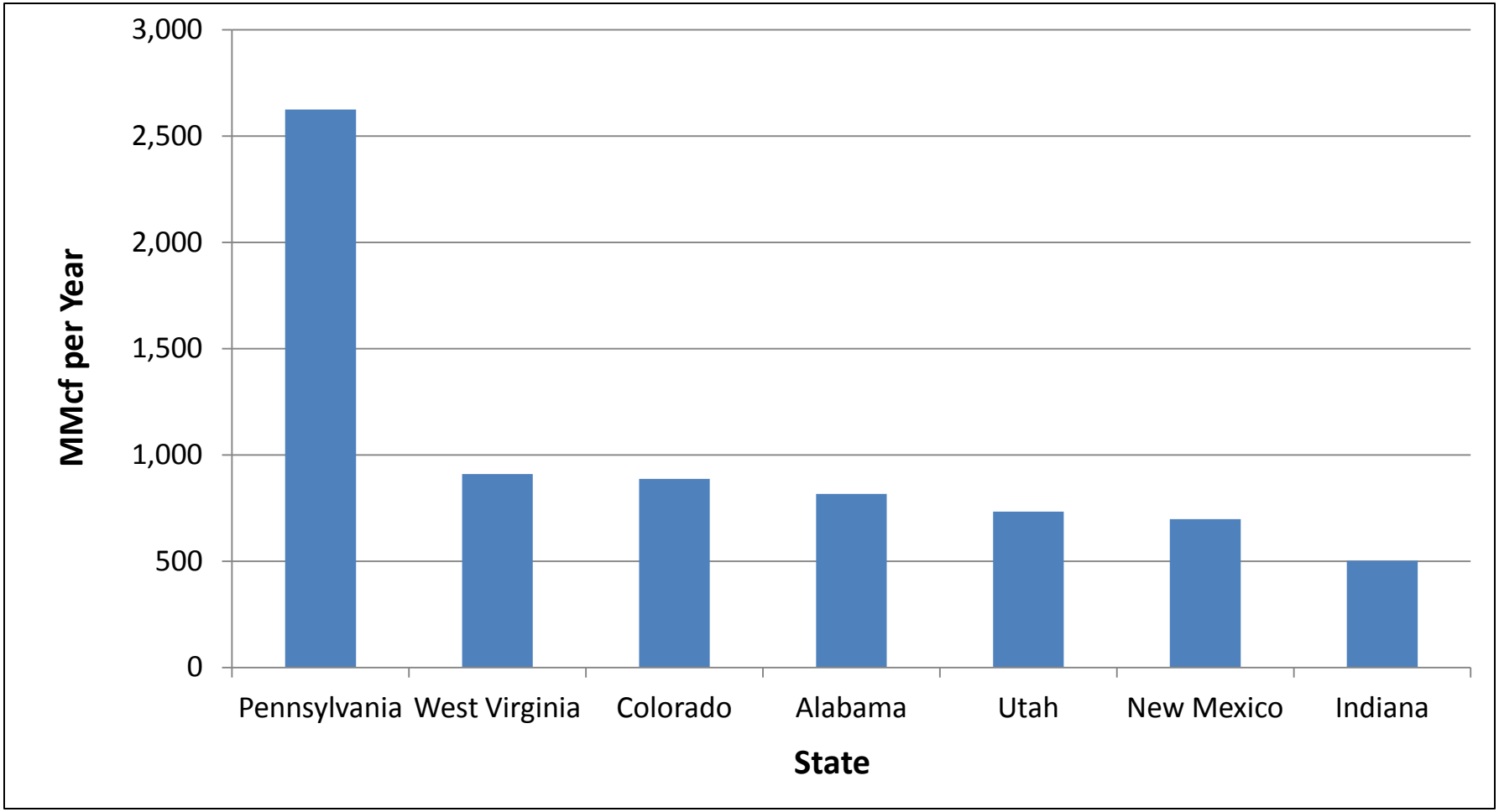


States with Greatest CMM Emissions

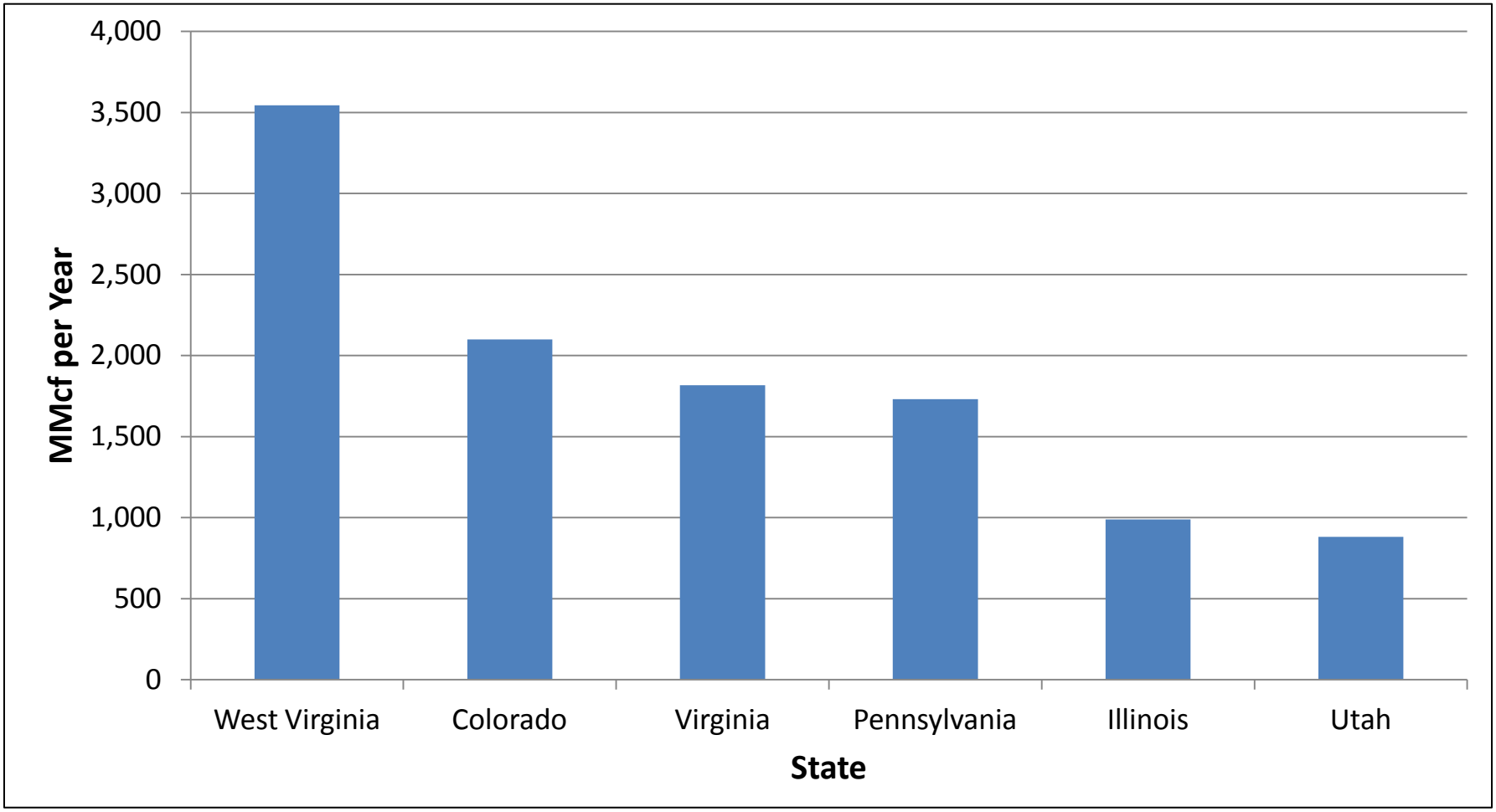
- Underground Mines
  - Largest amount of VAM located in West Virginia, Pennsylvania, Alabama, and Illinois
  - Largest amount of vented degas located in West Virginia, Pennsylvania, Alabama, and Colorado
- Surface Mines
  - Wyoming
- Abandoned Mines
  - Largest AMM emissions located in West Virginia, Pennsylvania, Colorado, and Virginia

Methane Resources

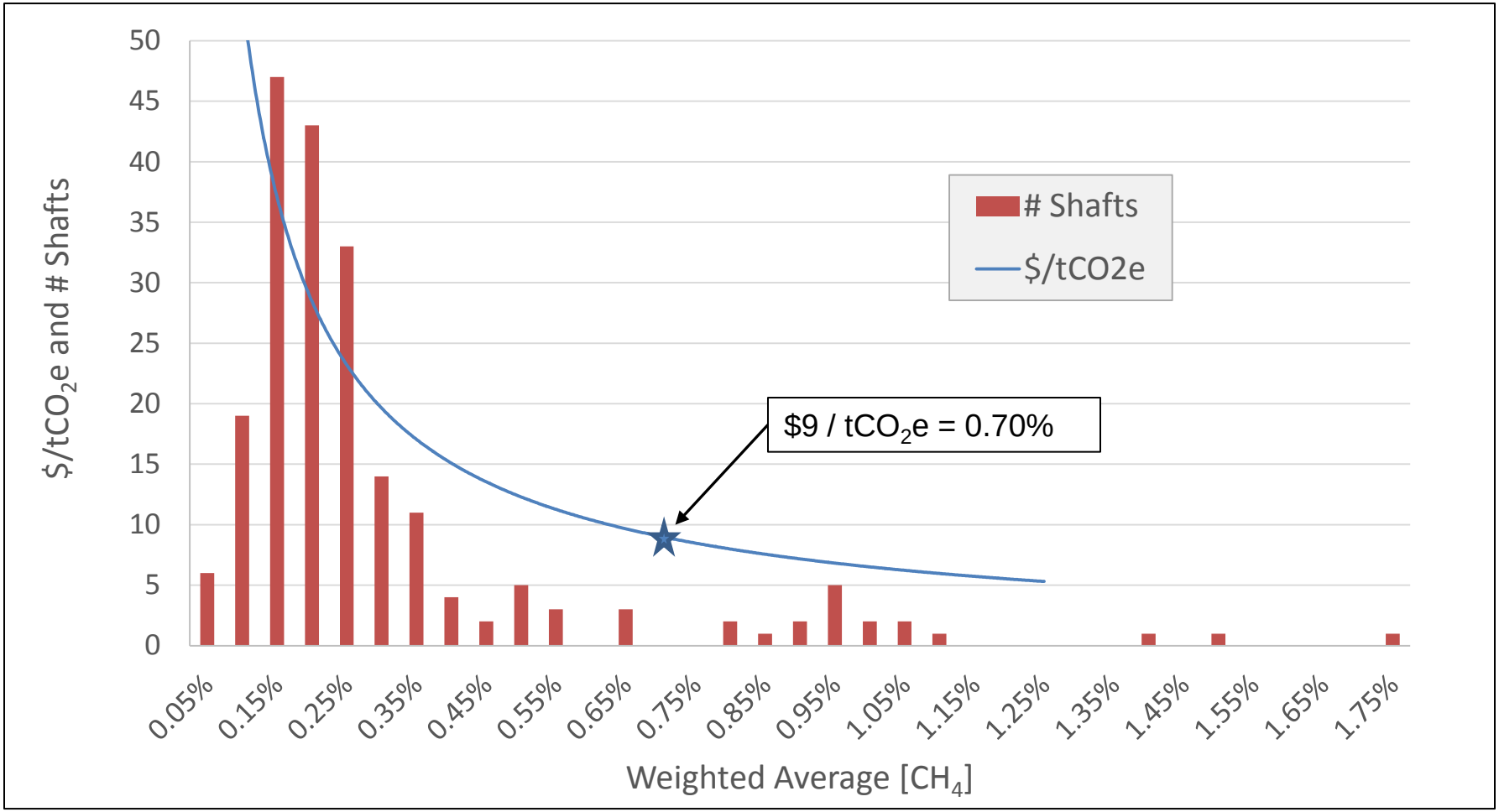
2013 CMM Drainage Emissions



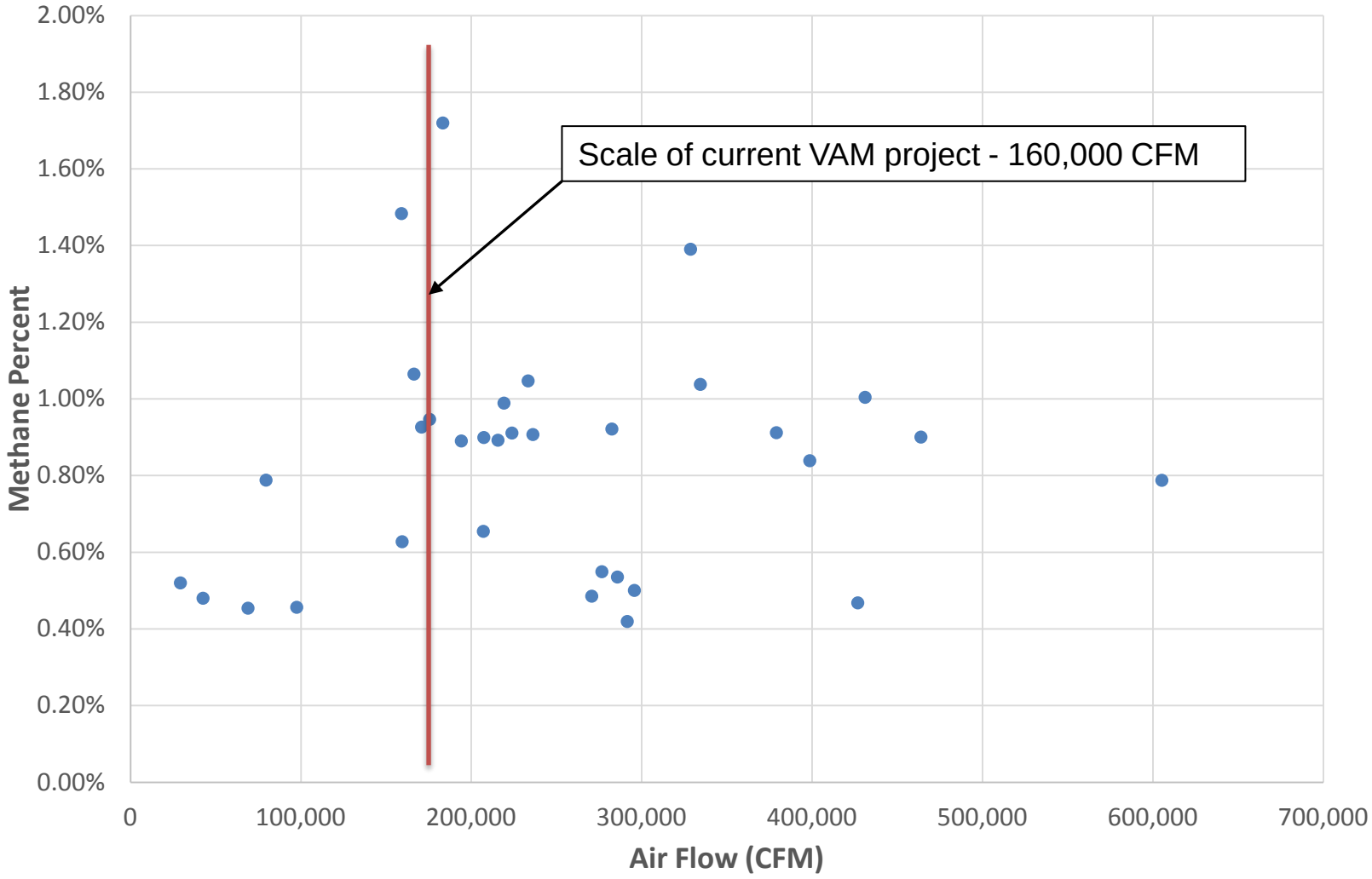
2013 AMM Emissions



Carbon Price & Potential VAM Projects (by Mine Shaft)



VAM Project Potential at 33 Shafts >0.4% CH_4



VAM Mitigation Potential

% CH_4	# of Shafts	% of Shafts	MMcf CH_4/yr	% of Total VAM	MM tCO_2e/yr
>0.05	210	100%	78,038	86%	37.6
>0.1	100	48%	66,810	74%	32.2
>0.4	33	16%	35,647	39%	17.2
>0.7	21	10%	27,059	30%	13.0

Conclusions

- Majority of underground CMM emissions from Appalachian Coal Basins
  - West Virginia, Pennsylvania, Alabama, & Virginia
  - Other states include Illinois, and Colorado
- 21 underground coal mine shafts contain average methane content >0.7%
  - Represents 30% of total VAM emissions
  - Mitigation Potential – 13 million tonnes CO_2e/yr
- About 60% of SMM emissions from Wyoming mines
- Overall AMM potential on the decline

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