European Commission

Tackling methane emissions from unused coalmines

Just Transition Platform Meeting: Coal Regions in Transition virtual week and Carbon-intensive regions seminars

16 November 2021

Coal mine closure and methane management

Raymond C. Pilcher

Chair, Group of Experts on Coal Mine Methane and Just Transition
Vice Chair, Committee on Sustainable Energy

16 November 2021

Just Transition Platform Meeting Workshop:
Tackling methane emissions from unused coal mines

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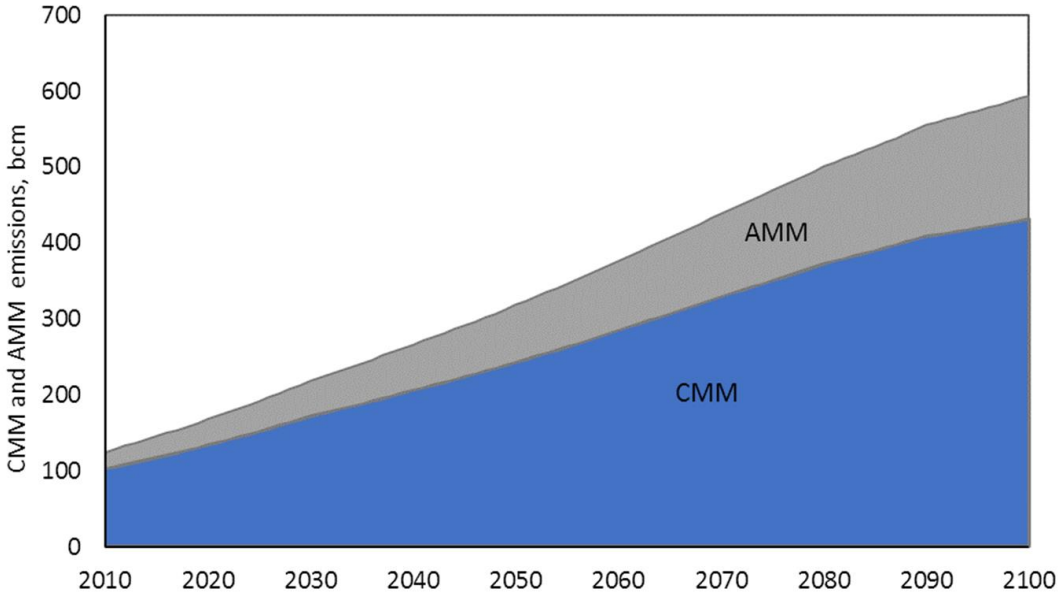
Gassy active mines become gassy closed mines

- **Abandoned Mine Methane (AMM) and Coal Mine Methane(CMM) emissions will continue unless supportive policies are enacted, and funding sources are established.**
- **The way in which gassy coal mine are closed is critically important to ensure methane capture and abatement.**



Kholod et al , 2019

The aim of coal mine closure planning

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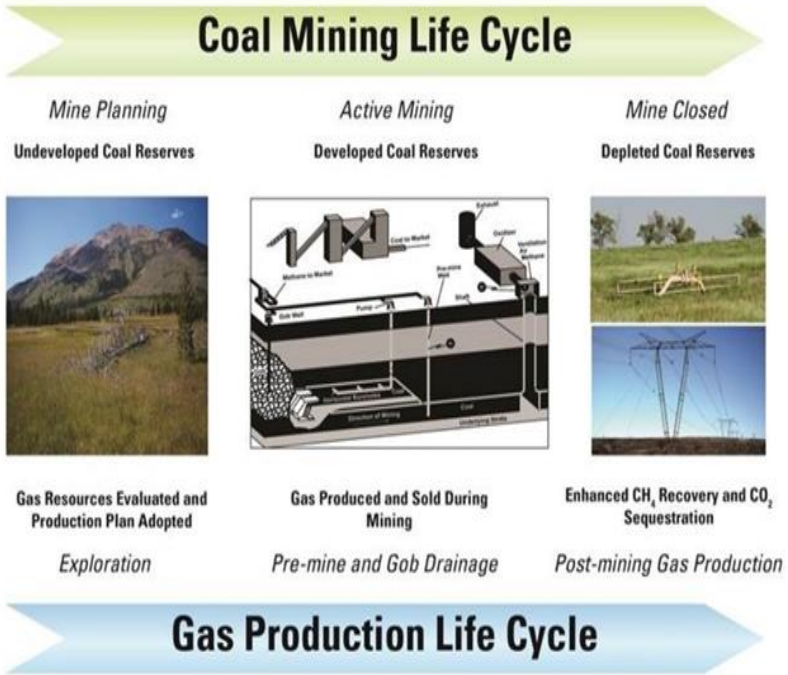
Coal mine closure planning should begin early in the mining life cycle —mining practices employed during mining should be chosen with an eye toward inevitable closure

Planning should be directed at mitigating the impact of risks and charting a path to a sustainable post-closure future

Unaddressed risks increases costs of closure, reduces value of remaining natural resources, and increases potential for unintended local and global environmental consequences

Well planned closure envisages a sustainable future and the highest use of remaining assets and natural resources after the mine closes



Present day methane emissions indicate likelihood of closed mine emissions

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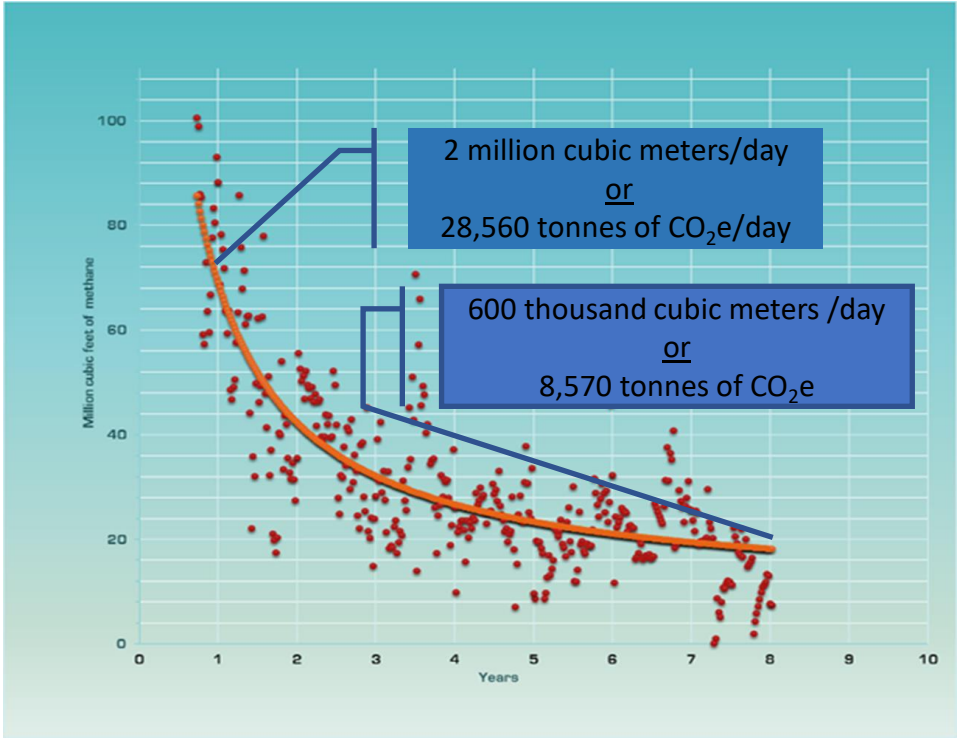
Methane emissions at an active mine in western Colorado, USA operated by Arch Coal



Europe has long experience with closed mine methane emissions reductions

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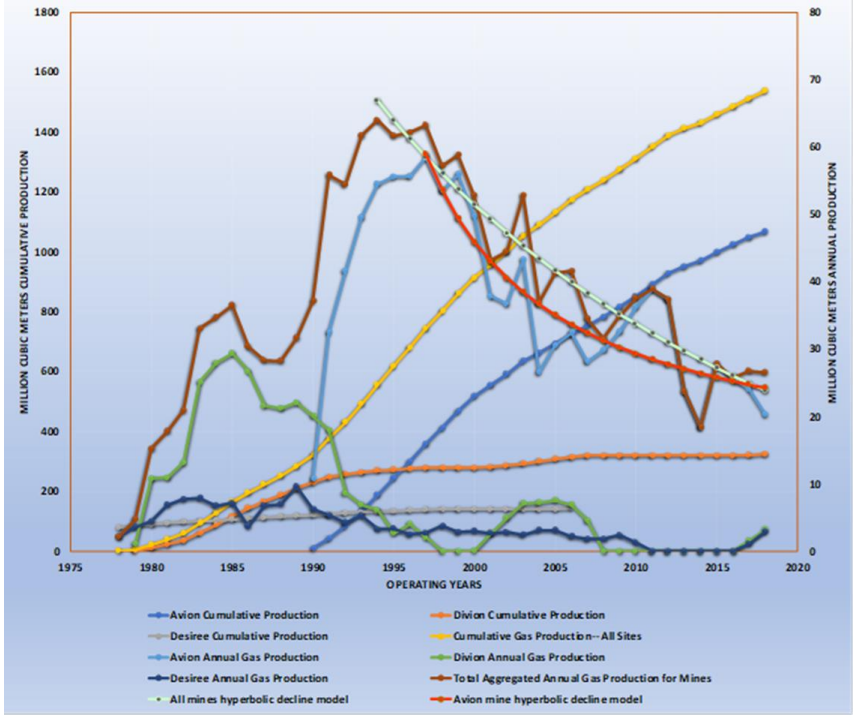
Methane production at an abandoned mine complex in France operated by Francaise de l' Energie



Not all AMM capture and use qualifies for emissions offset credits in the USA

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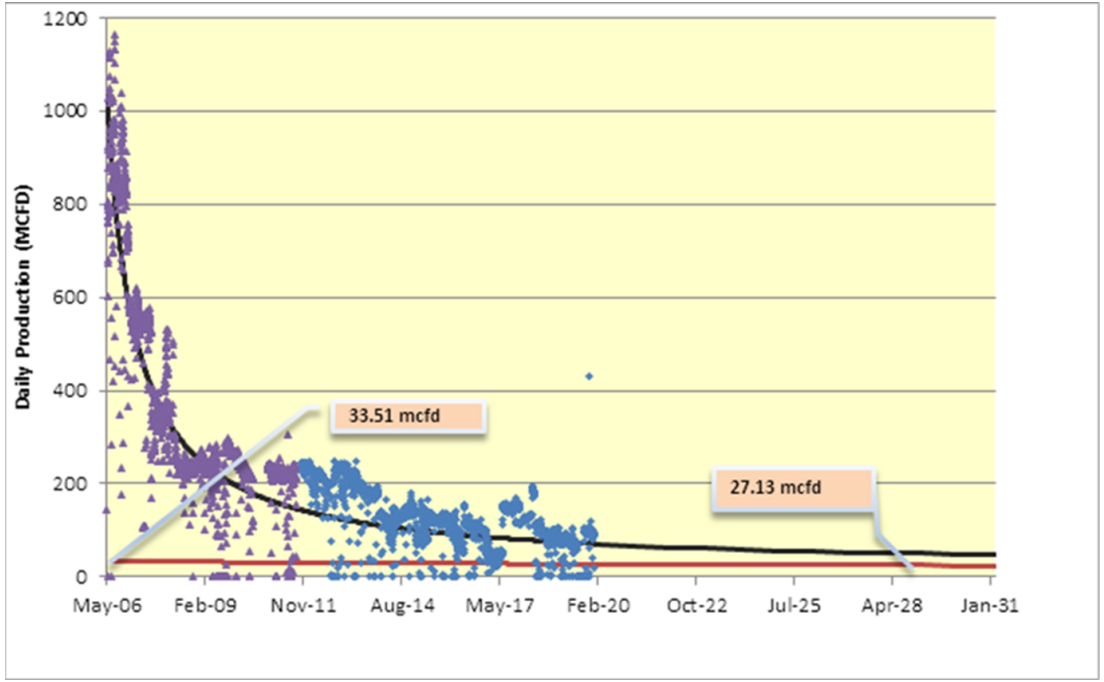
Methane production at room and pillar abandoned mines complex in Illinois, USA



Mine closure is being tracked and addressed in many ways by various organizations

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- The World Bank is working on global mine closure standards and mined land repurposing tools. This work promotes good practices and risk-based principles for sustainable closure practices.
- Several groups, such as the Global Energy Monitor are tracking coal mining and its emissions and publishing reports that are likely to bring more attention (and facts) to use for addressing problems.
- The Global Sustainability Standards Board are supporting drafting a set of standards which encourage transparency related to extractive industry impacts. Their Global Reporting Initiative will cover the oil, gas and coal sectors
- Similarly, the IFRS Foundation is focusing on the financial reporting aspects of sustainability and accountability

Mine closure planning and funding for future environmental needs must start when a mine opens

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- Sustainable mine closures depend on coal, water, and methane resource management
- Mine restoration and mined land repurposing are crucial elements of resource management—but it happens after mining income has stopped.
- Mining development plans should include mine closure plans that are reviewed periodically
- Funding mechanisms for closing mines needs to be revisited:
  - Multilateral and commercial banks and managed investment funds are quickly backing away from funding coal mining projects-including projects to clean up legacy problems such as fugitive methane emissions
  - Surety bonding for mine closure and restoration are found to be woefully inadequate in many coal mining areas—there is are environmental disasters looming in areas that are already in crisis from lost of high paying mining jobs

Thank you!

Contact us!
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Just Transition Platform Meeting - Coal Regions in Transition Workshop on Tackling Emissions from Unused Coal Mines 16 November 2021

Just Transition Platform Meeting Workshop:
Tackling methane emissions from unused coal mines

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FLORENCE SCHOOL OF REGULATION

ROBERT SCHUMAN CENTRE

Tackling methane emissions from unused coalmines: EU policies and global initiatives

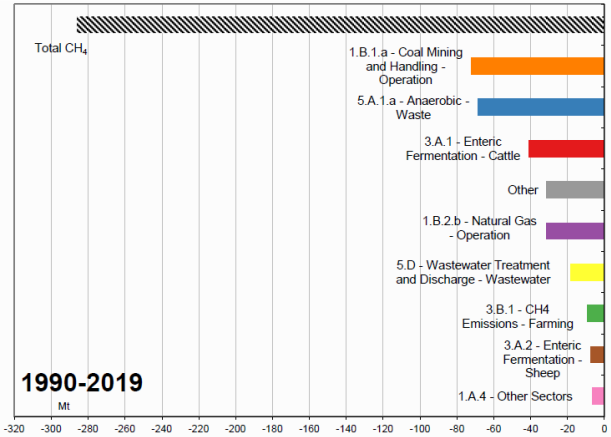
Maria Olczak, FSR
16 November 2021

www.eui.eu

CMM and AMM in the EU

Coal-related methane emissions account for 5% of all EU man-made methane emissions

Steady decrease since 1990, due to the decline in coal mining activities



Absolute change of CH4 emissions by large key source categories 1990 to 2019 for EU-KP
Source: EU GHG Inventory, 2021, p. 71.

Co-funded by the Erasmus+ Programme of the European Union

2020 EU Methane Strategy

- methane reduction necessary to meet the 2030 and 2050 climate objectives
- no binding reduction targets, but:
  - **3 sectors:** agriculture, waste, energy
  - **2 dimensions:** internal and external
  - **1 priority:** improved measurement and reporting

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU KP Emissions in 2015	Change 1990-2015		Change 2018-2019		Method	Emission factor information
	1990	2018	2019		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	299	NO,NA	NO,NA	-	-299	-100%	-	-	NA	NA
Belgium	396	41	40	0.2%	-355	-90%	0	-1%	D	D
Bulgaria	1 325	244	203	1.0%	-1 122	-85%	-41	-17%	T2	CS
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	7 544	1 155	923	4.5%	-6 621	-88%	-232	-20%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 734	10	10	0.0%	-4 724	-100%	0	0%	T2,T3	CS,PS
Germany	25 396	1 566	65	0.3%	-25 332	-100%	-1 502	-96%	T3	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	1 055	29	28	0.1%	-1 026	-97%	0	-2%	T1	D
Ireland	56	19	18	0.1%	-37	-67%	0	-2%	T1	D
Italy	20	10	9	0.0%	-11	-57%	-1	-14%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	19 583	15 132	13 407	64.8%	-6 176	-32%	-1 725	-11%	T3	D
Portugal	140	16	16	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 282	5 205	5 052	24.4%	-230	-4%	-153	-3%	T1,T2	D
Slovakia	680	227	243	1.2%	-437	-64%	15	7%	T2	CS
Slovenia	361	220	215	1.0%	-146	-41%	-5	-2%	T2,T3	CS,D,PS
Spain	1 620	69	16	0.1%	-1 604	-99%	-53	-77%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 616	435	456	2.2%	-21 161	-98%	21	5%	T2,T3	CS
EU-27+UK	**90 164**	**24 377**	**20 699**	**100%**	**-69 465**	**-77%**	**-3 678**	**-15%**	-	-
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 616	435	456	2.2%	-21 161	-98%	21	5%	T2,T3	CS
EU-KP	**90 164**	**24 377**	**20 699**	**100%**	**-69 465**	**-77%**	**-3 678**	**-15%**	-	-

Coal Mining – underground mining: Countries contribution to CH4 emis
Source: Table 3.110 EU GHG Inventory, 2021

Source: EU Commission, 2020

Co-funded by the Erasmus+ Programme of the European Union

Upcoming methane regulations

Actions in the energy sector

6. The Commission will deliver **legislative proposals in 2021** on:

- Compulsory **measurement, reporting, and verification** (MRV) for all energy-related methane emissions, building on the Oil and Gas Methane Partnership (OGMP 2.0) methodology.
- Obligation to **improve leak detection and repair** (LDAR) of leaks on all fossil gas infrastructure, as well as any other infrastructure that produces, transports or uses fossil gas, including as a feedstock.

7. The Commission will consider legislation on eliminating routine venting and flaring in the energy sector covering the full supply chain, up to the point of production.

8. The Commission will work to **extend the OGMP framework to more companies in the gas and oil upstream, midstream and downstream as well as to the coal sector and closed as well as abandoned sites.**

9. The Commission will promote **remedial work under the initiative for Coal Regions in Transition**. Best-practice recommendations and/or enabling legislation will be brought forward if necessary.

EU Parliament: “calls on the Commission to develop a specific programme to address methane emissions from closed and abandoned coal mines”

European Parliament resolution of 21 October 2021 on an EU strategy to reduce methane emissions

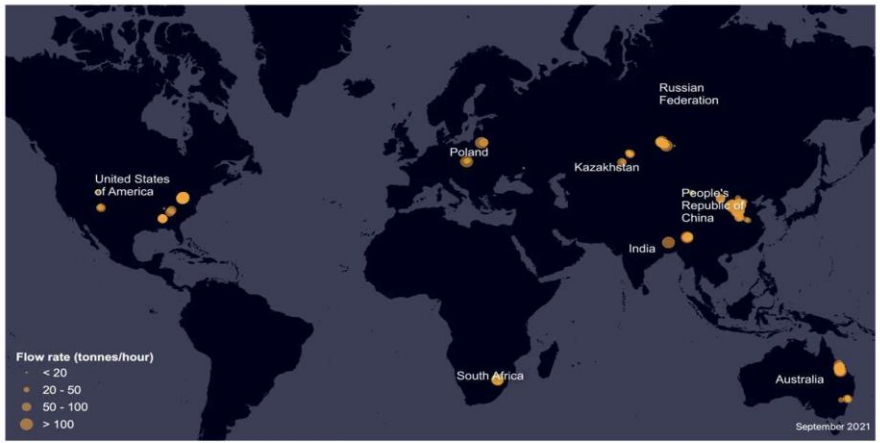
Co-funded by the Erasmus+ Programme of the European Union

Getting the data right: OGMP2.0 and IMEO

International Methane Emissions Observatory (IMEO):

- OGMP2.0 to be extended to metallurgical coal
- 2022 IMEO Phase 1 Coal Studies
- Satellite observations

Large scale coal-related methane leaks detected by satellite from 2019-2021
Curtailing Methane Emissions from Fossil Fuel Operations



Source: Kayrros

International Energy Agency

Co-funded by the Erasmus+ Programme of the European Union

Global Methane Pledge

- a collective goal of reducing man-made methane emissions by **at least 30%** from 2020 levels **by 2030**
- moving towards using best available inventory methodologies to **quantify methane emissions**, esp. high emission sources
- supported by EU, US, 100+ countries

Source: ENDS Europe

Co-funded by the Erasmus+ Programme of the European Union

US-China Joint Glasgow Declaration

- Reduction of methane as one of climate priorities in the 2020s
- What to expect before COP27?
  - additional measures to enhance methane emission control (national, sub-national)
  - China to develop “a comprehensive and ambitious National Action Plan on methane”
  - 2022: meeting on enhancing measurement and reduction of methane

Local Energies – Positive Impacts

European Commission - Just Transition Platform Meeting - Coal Regions in Transition

November 2021

A UNIQUE ENERGY PRODUCER

A European Energy Producer with negative carbon footprint

Over 1 Million tons of CO2eq emissions currently avoided annually in the former coal mines of Northern France and Wallonia (Belgium)*

10 existing sites in operations

- 6 sites producing electricity
- 2 sites injecting gas
- 2 sites producing heat

Sustainable development

Long term certified gas reserves equivalent to almost 150 years of existing production

Resilient and predictable

- Over 75% of the energy produced is sold locally through long term contracts (PPAs or feed in tariffs supply agreement with the State)

* Sources: Ineris 2019, LFDE

THE EXAMPLE OF BETHUNE CITY – THE BASELINE

2017: Bethune city launched a bidding process for supplying energy, from 1st of Jan 2021, to its district heating network with 4 constraints/objectives

- Clean energy only
- Energy needs to come from within a 50 kms radius
- Energy supplier needs to be able to commit to an 18 years contract
- Energy cost for the end user needs to be flat at most compared to current solution

2017: FDE got involved and…

- Identify 2 wellbores within 20kms from Bethune city
- Tested the local reservoir for Abandoned Mine Methane
- Identified an abandoned gas pipeline previously used by the former State-Owned coal mine operator
- Teamed up with the regional unit of Dalkia for them to operate the District Heating Network

End of May 2017 : FDE wins the bidding process and goes to work…

Bidding Process

1 Billion m3 of AMM certified in the area
with 60% CH4 content
15,6kms of gas pipelines completely refurbished
2 new cogenerations (2,7MW) installed
Completed an full life cycle assessment of the project

01 jan 2017 – 31st of May 2017

Till 31st of December 2020

THE EXAMPLE OF BETHUNE CITY – THE OUTCOME

6 500 Homes supplied with heat

> 150 000 tons of CO_{2eq} emission avoided per annum

> 30% decrease in annual energy bill

01 jan 2021 — 2021 -2039

Start of production

Long Term gas, heat and power supply contracts

Helping the coal regions to transition towards a cleaner future.

Thank you for your attention.

Julien Moulin – Chairman

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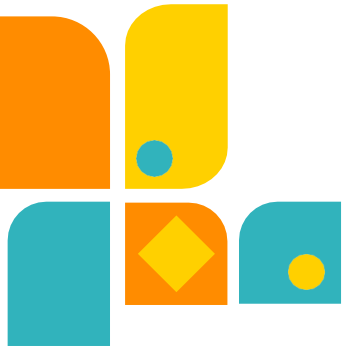
www.francaisedelenergie.fr



FDE

Technische
Hochschule
Georg Agricola

Abandoned mine methane project development in the Saar region

Dr.-Ing. Dipl. Wirt.-Ing. Stefan Möllerherm

Workshop:
Tackling methane emissions from unused coalmines

Methane emission sources

Technische Hochschule Georg Agricola

natural degassing


venting


utilisation

Challenges

Technische Hochschule Georg Agricola

Differentiation between natural occurncen or mining-induced
Mobile mesaurement

No methane monitoring

Decreasing methane concentration

Challenges in utilisation

Technische Hochschule Georg Agricola

Decreasing methane concentrations

⇒ Shut down of Cogen plants (CH_4 < 20-Vol-%)

⇒ Incentives phase–out (Methane considered to be a renewable energy)

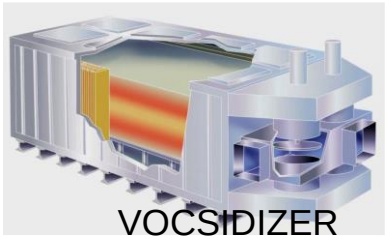
⇒ Influence of mine water rebound processes on methane generation

⇒ Increase in methane emissions

Solutions

Technologies able to handle CH_4 concentrations starting at 0.3 Vol-% CH_4

produce heat and power



JUST TRANSITION PLATFORM MEETING

COAL REGIONS IN TRANSITION VIRTUAL WEEK

CARBON-INTENSIVE REGIONS SEMINARS

Technische Hochschule Georg Agricola

Thank you for your attention

Glückauf

stefan.moellerherm@thga.de
www.post-mining.org

Research Fund for Coal & Steel

Methane recovery and harnessing for energy and chemical uses at coal mine sites (METHENERGY +)

Salvador Ordóñez,
Dep. of Chemical and Environmental Engineering (CRC)
University of Oviedo, Oviedo (SPAIN)

CRC
CATÁLISIS, REACTORES Y CONTROL
CATALYSIS, REACTORS & CONTROL

METHENERGY +

Methenergy+: Overview

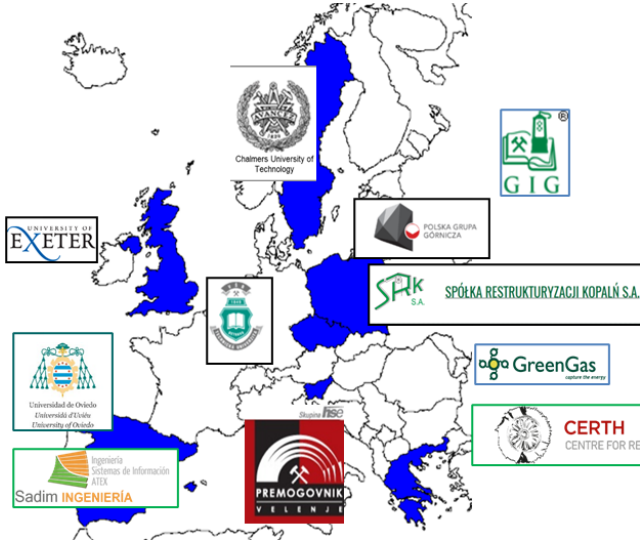
WP1. Mine site studies: Optimization of flow-rates and methane concentration

WP2. Adsorption processes

WP3. Membrane processes

WP4. Thermal upgrading

WP5. Chemical upgrading

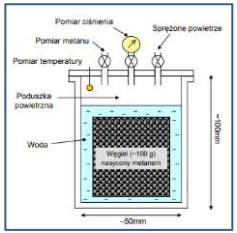


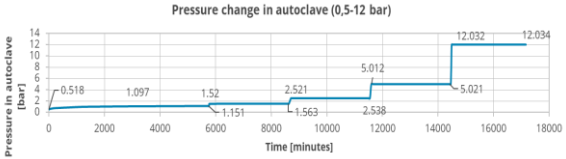
Extraction → **Separation** → **Upgrading**

METHENERGY +

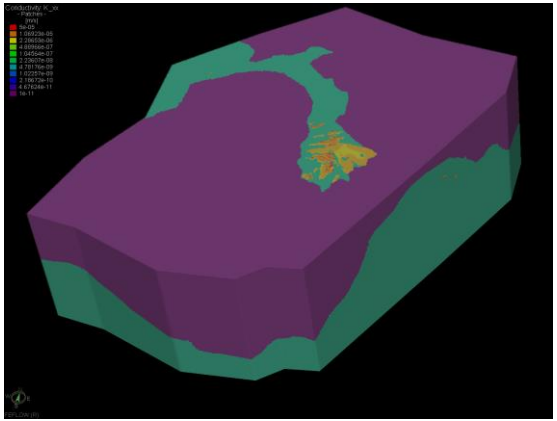
WP1: Methane recovery

Determination of methane release during coal mine flooding

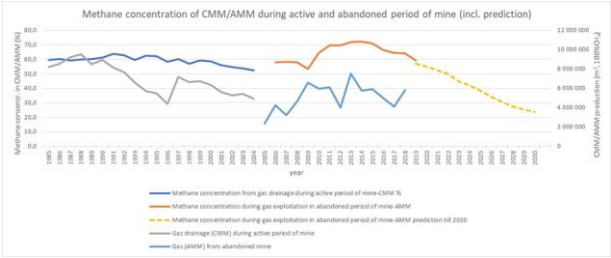


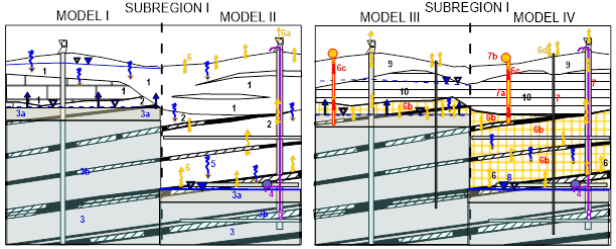


Modelling of AMM flooding (FEFLOW)



AMM formation forecasting

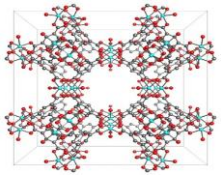


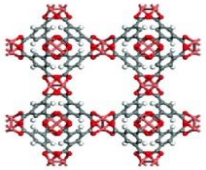


WP2-Adsorption

Materials

MOFs (UNIOVI)
Fly-ash derived zeolites (CERTH)
Carbonaceous materials (UNEXE)

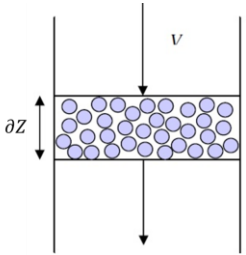


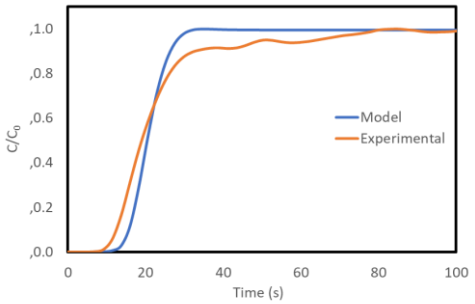


$$u_0\left[\frac{dC}{dz}\right]_t + \left[\frac{dC}{dt}\right]_z + \rho_a\left(\frac{1-\varepsilon}{\varepsilon}\right)\left[\frac{dq}{dt}\right]_z = \mathfrak{D}_L\frac{d^2C}{dz^2}$$

$$\frac{dq_i}{dt} = 15\cdot\frac{4D_i}{d_p^2}\cdot(W_i - W_{i\,eq})$$

Parameter	Meaning
u_0	Surface velocity
C	Concentration of adsorbate in gas phase
ρ_a	Bed density
ε	Bed porosity
$\mathfrak{D}_L$	Axial dispersion
d_p	Particle diameter
D_i	Intrapore transport diffusivity
W_i	Concentration of adsorbate in solid phase





Fitting parameter: $D_i = 3x10^{-9}\ m^2/s$

- Development of normalized procedures for estimating adsorption capacities base on TG measurements, used in UNIOVI, CERTH and EXETER
- Thermodynamic and kinetic modellling of the adsorption
- Interesting insights on the role of microporous structure in methane adsorption


Microporous and Mesoporous Materials 298 (2020) 110048

Contents lists available at ScienceDirect

Microporous and Mesoporous Materials

journal homepage: http://www.elsevier.com/locate/micromeso

Adsorption of methane and nitrogen on Basolite MOFs: Equilibrium and kinetic studies

David Ursueguía, Eva Díaz, Salvador Ordóñez*

Catalysis, Reactors and Control Research Group (CRC), Department of Chemical and Environmental Engineering, University of Oviedo, 33006, Spain


Separation and Purification Technology 251 (2020) 117374

Contents lists available at ScienceDirect

Separation and Purification Technology

journal homepage: www.elsevier.com/locate/seppur

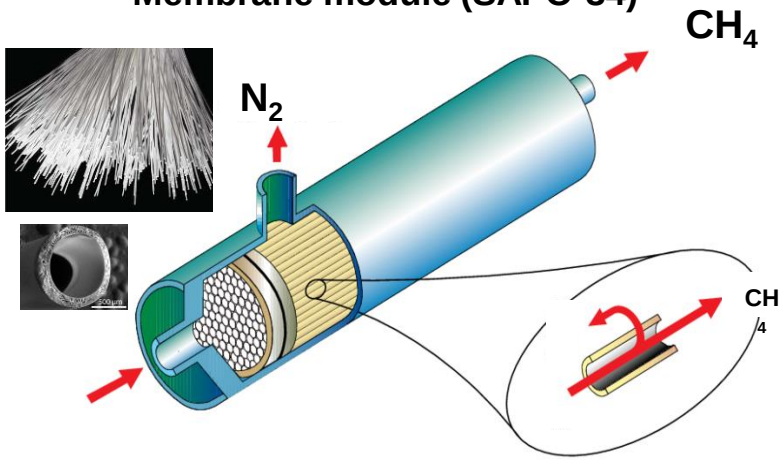
Methane separation from diluted mixtures by fixed bed adsorption using MOFs: Model validation and parametric studies

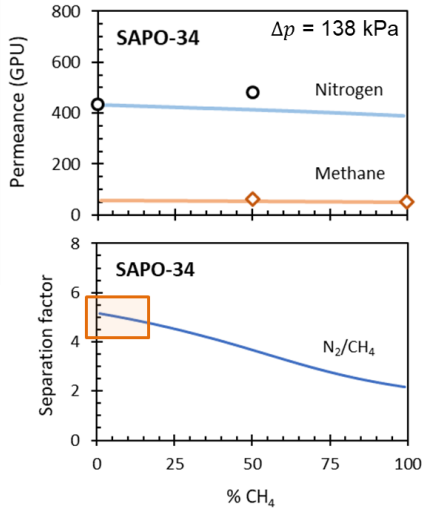
David Ursueguía, Eva Díaz, Aurelio Vega, Salvador Ordóñez*

Catalysis, Reactors and Control Research Group (CRC), Department of Chemical and Environmental Engineering, University of Oviedo, 33006, Spain

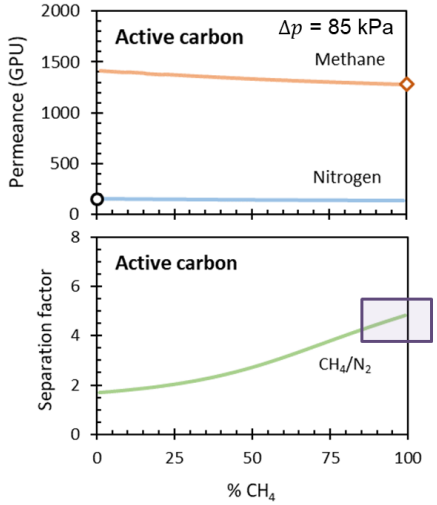
WP3. Membrane processes

- **Membrane module (SAPO-34)**

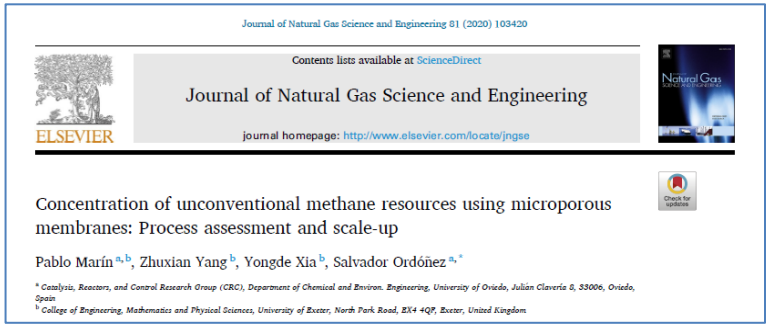




- Nitrogen permeates faster
- Higher selectivity at low CH_4 conc.



- Methane permeates faster
- Higher permeance than SAPO-34



Journal of Natural Gas Science and Engineering 81 (2020) 103420

Contents lists available at ScienceDirect

Journal of Natural Gas Science and Engineering

journal homepage: http://www.elsevier.com/locate/jngse

ELSEVIER

Concentration of unconventional methane resources using microporous membranes: Process assessment and scale-up

Pablo Marín [a, b], Zhuxian Yang [b], Yongde Xia [b], Salvador Ordóñez [a, *]

[a] Catalysis, Reactors, and Control Research Group (CRC), Department of Chemical and Environ. Engineering, University of Oviedo, Julián Clavería 8, 33006, Oviedo, Spain

[b] College of Engineering, Mathematics and Physical Sciences, University of Exeter, North Park Road, EX4 4QF, Exeter, United Kingdom

WP4. Thermal and catalytic regenerative oxidisers
Design and control strategies

Chemical Engineering & Processing: Process Intensification 135 (2019) 175–189

Contents lists available at ScienceDirect

Chemical Engineering & Processing: Process Intensification

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Reverse flow reactors as sustainable devices for performing exothermic reactions: Applications and engineering aspects

Pablo Marín, Fernando V. Díez, Salvador Ordóñez*

Department of Chemical and Environmental Engineering, University of Oviedo, Facultad de Química, Julián Clavería 8, 33006, Oviedo, Spain

Process Safety and Environmental Protection 134 (2020) 333–342

Contents lists available at ScienceDirect

Process Safety and Environmental Protection

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Control of regenerative catalytic oxidizers used in coal mine ventilation air methane exploitation

Pablo Marín, Aurelio Vega, Fernando V. Díez, Salvador Ordóñez*

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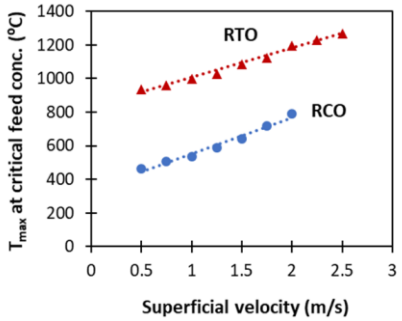
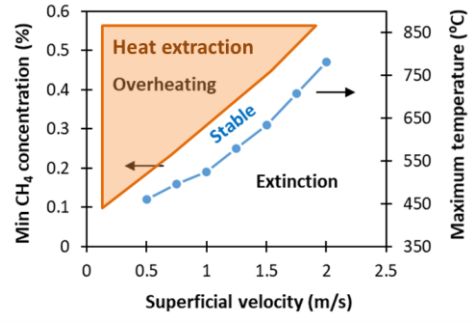
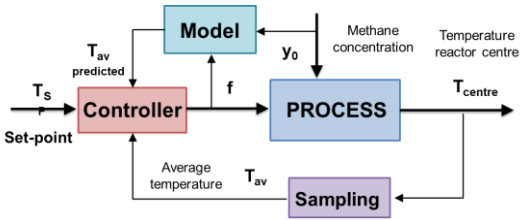
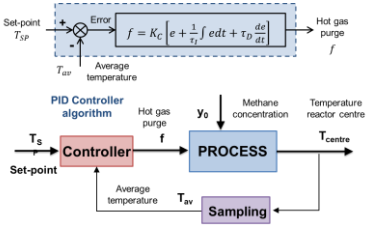


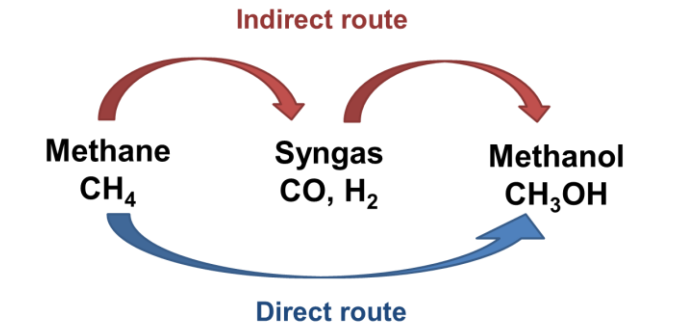


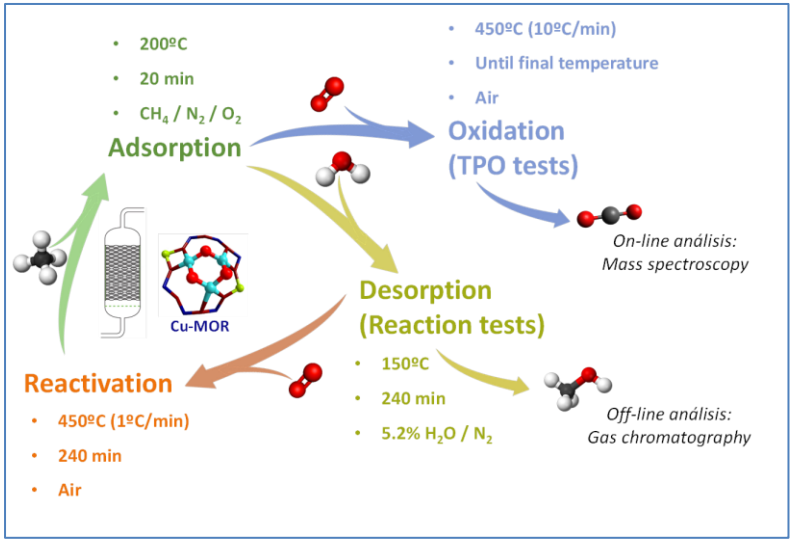


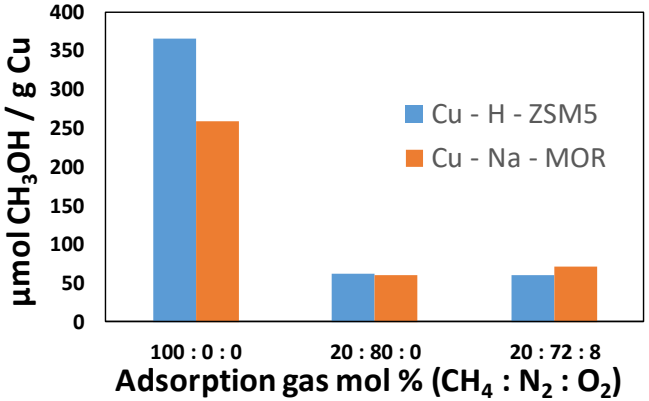


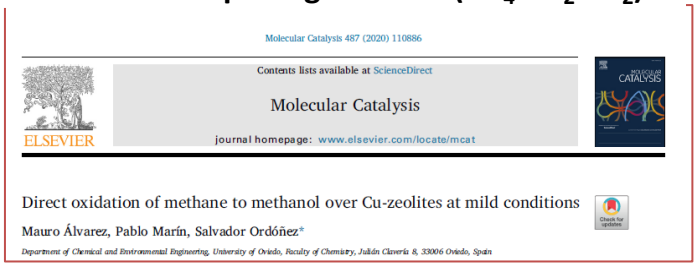
Negligible secondary effects detected (NOx)

WP5: methane upgrading (methane to methanol)








Molecular Catalysis 487 (2020) 110886

Contents lists available at ScienceDirect

Molecular Catalysis

journal homepage: www.elsevier.com/locate/mcat

Direct oxidation of methane to methanol over Cu-zeolites at mild conditions

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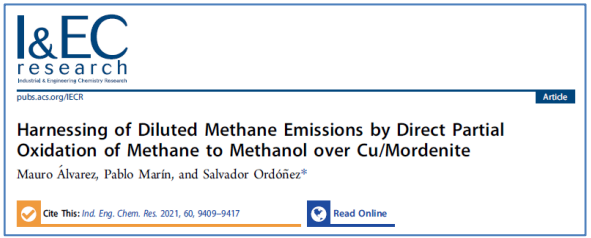
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Article

Harnessing of Diluted Methane Emissions by Direct Partial Oxidation of Methane to Methanol over Cu/Mordenite

Mauro Álvarez, Pablo Marín, and Salvador Ordóñez*

Cite This: Ind. Eng. Chem. Res. 2021, 60, 9409−9417

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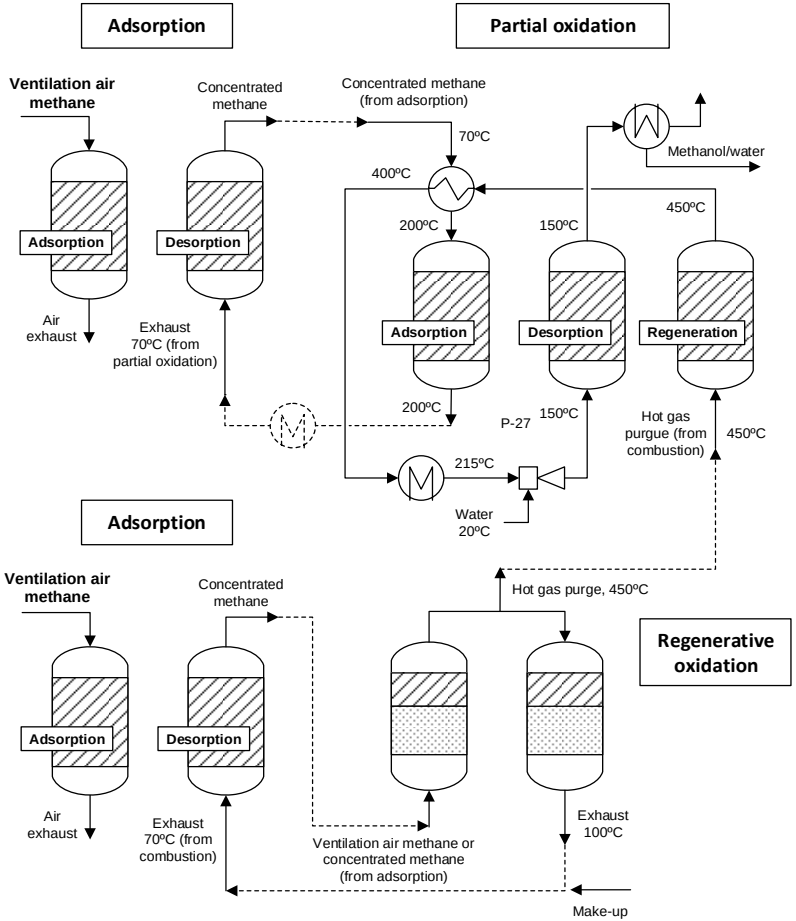
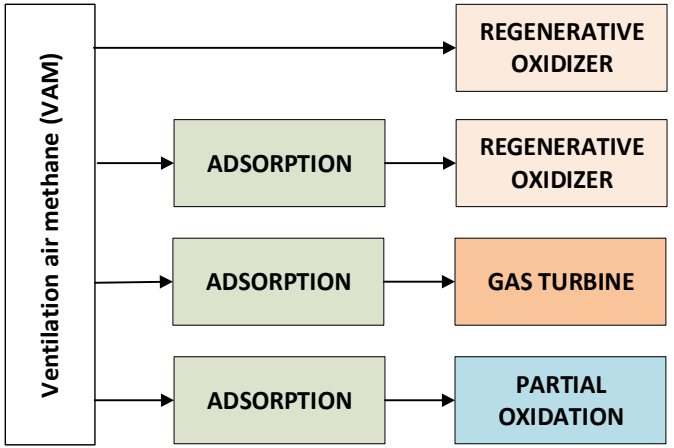
METHENERGY +

WP6. Process Integration





Journal of Natural Gas Science and Engineering 88 (2021) 103808

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Journal of Natural Gas Science and Engineering

journal homepage: http://www.elsevier.com/locate/jngse

A new strategy for upgrading ventilation air methane emissions combining adsorption and combustion in a lean-gas turbine

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Methane emissions management during post-mining period

Just Transition Platform Meeting

Alina Zuikovska

16 November 2021

DTEK Energy in action

DTEK's interaction with international organisations on methane emissions management

PRIORITIES

- **Safety**
- **Efficiency**
- **Environment**

Project and Initiatives

EURACOAL
European Association for Coal and Lignite
AISBL

Research Fund for Coal & Steel

UNECE

EXPRO: prevention and minimisation of damage to the mining infrastructure and equipment from methane explosions;

INESI: improving occupational safety and efficiency of the underground haulage systems.

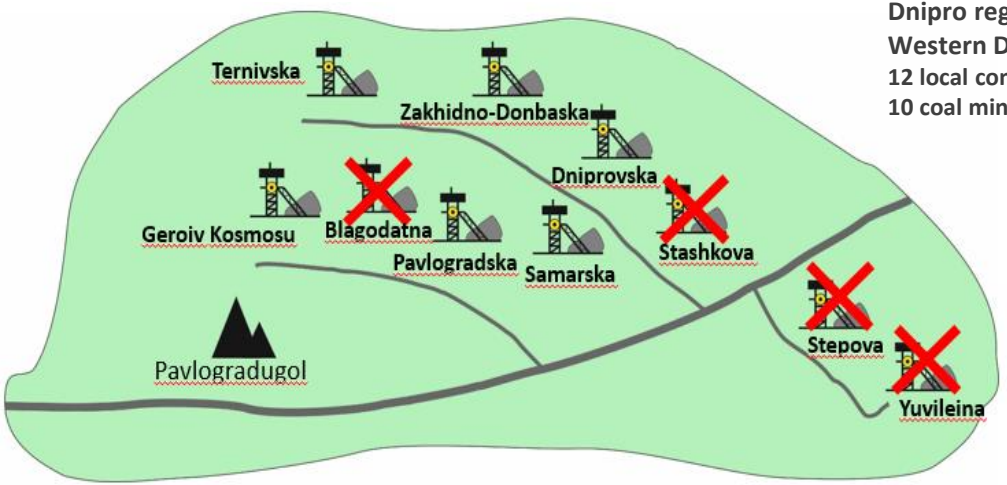
MINRESCUE: alternative uses of shut-down mines and mine waste management.

MONITORING: satellite-based monitoring of methane emissions and spread of gasses

UTILISATION of coal mine methane as a fuel for power generation

MEASURES: Development of measures and recommendations on how to mitigate coal mine methane's impact on coal production levels

Coal phase-out and gas flow rates*



Dnipro region
Western Donbass
12 local communities
10 coal mines

2021 Closure of the Blagodatna Mine	2021 Closure of the Stashkova Mine	2023 Closure of the Yuvileina Mine	2024 Closure of the Stepova Mine
CH4: 14.1 m3/min	**CH4: 14.3 m3/min**	**CH4: 50 m3/min**	**CH4: 112 m3/min**

*** The absolute gas flow rates are given for the operating mines**

Approaches

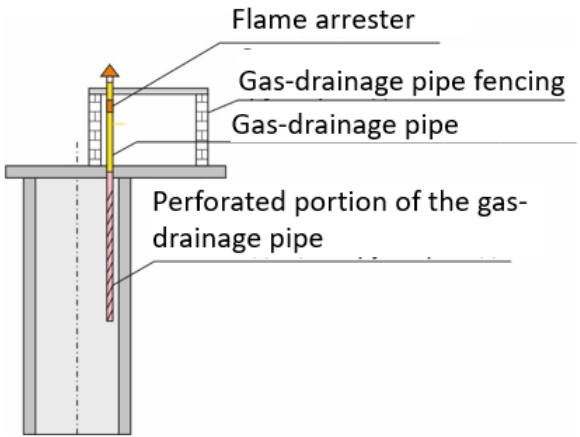
- Ukraine's coal producers are obliged to follow the *Coal Mine Shaft Closure Rules* developed for them.
- The shafts are backfilled in strict compliance with the Projects that have been scrutinised by the dedicated expert review teams.

2021 Q4

The horizontal workings were backfilled at the Stashkova Mine and the Blagodatna Mine.

The Stashkova Mine had also its vertical workings (shafts) backfilled.

The Blagodatna Mine's vertical workings are used to ventilate the Geroiv Kosmosu Mine.

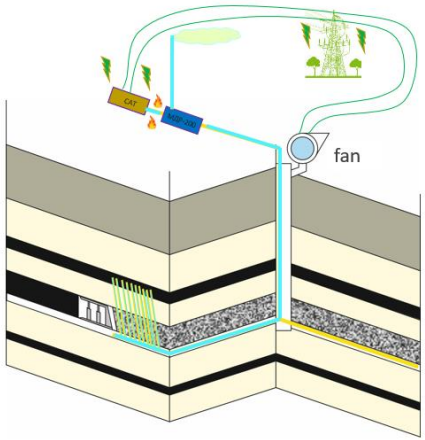


Methane releases from the closed mines are controlled by the following method:

1. The backfilled part of the shaft has a corrugated portion of a 5m-long gas-drainage pipe left in it.
2. On top of the borehole head, a 3m-long portion of the pipe 150 mm in diameter fitted with a screen-based flame arrester is installed.
3. Concentrations of methane released through the gas-drainage pipe are monitored in accordance with the Project.
4. As of November, the Stashkova Mine was not observed to release methane from the backfilled shafts.

Outlooks: the Stepova Mine as a pilot platform

1



COGENERATION

As is:

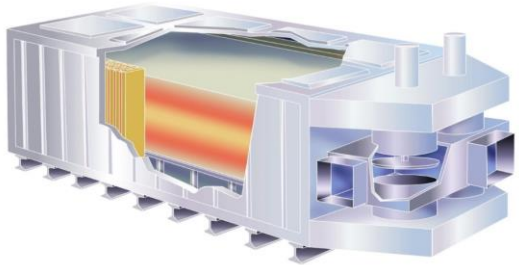
- Capacity 1.56 MW
- 1.2 million m3 of methane was utilized for 10 months 2020-2021
- 6 thousand kWh of electricity was generated to cover the needs of the Stepova mine

Next steps:

- By 2023 – to launch 3 units , 4.7 MW, at the Zakhidno-Donbaska mine
- By 2025 – to increase the number of units up to 6, expand the technology to the Geroiv Kosmosu mine.

Annual regional emission reduction by 300 thousand tons in CO2

2



Technical features and advantages of the VOCSIDIZER technology

- 1 m3/min of methane gives 1 MW of heat
- There is no combustion, which means no nitrogen oxides and other noxious gases are released into the air
- The entire oxidation process occurs in the chamber. The electrical start-up heating takes place at the centre of the ceramic casing.
- The thermal efficiency is self-maintained at low concentrations. (Methane> 0.2-1%)


Dive into DTEK

EURACOAL

European Association for Coal and Lignite

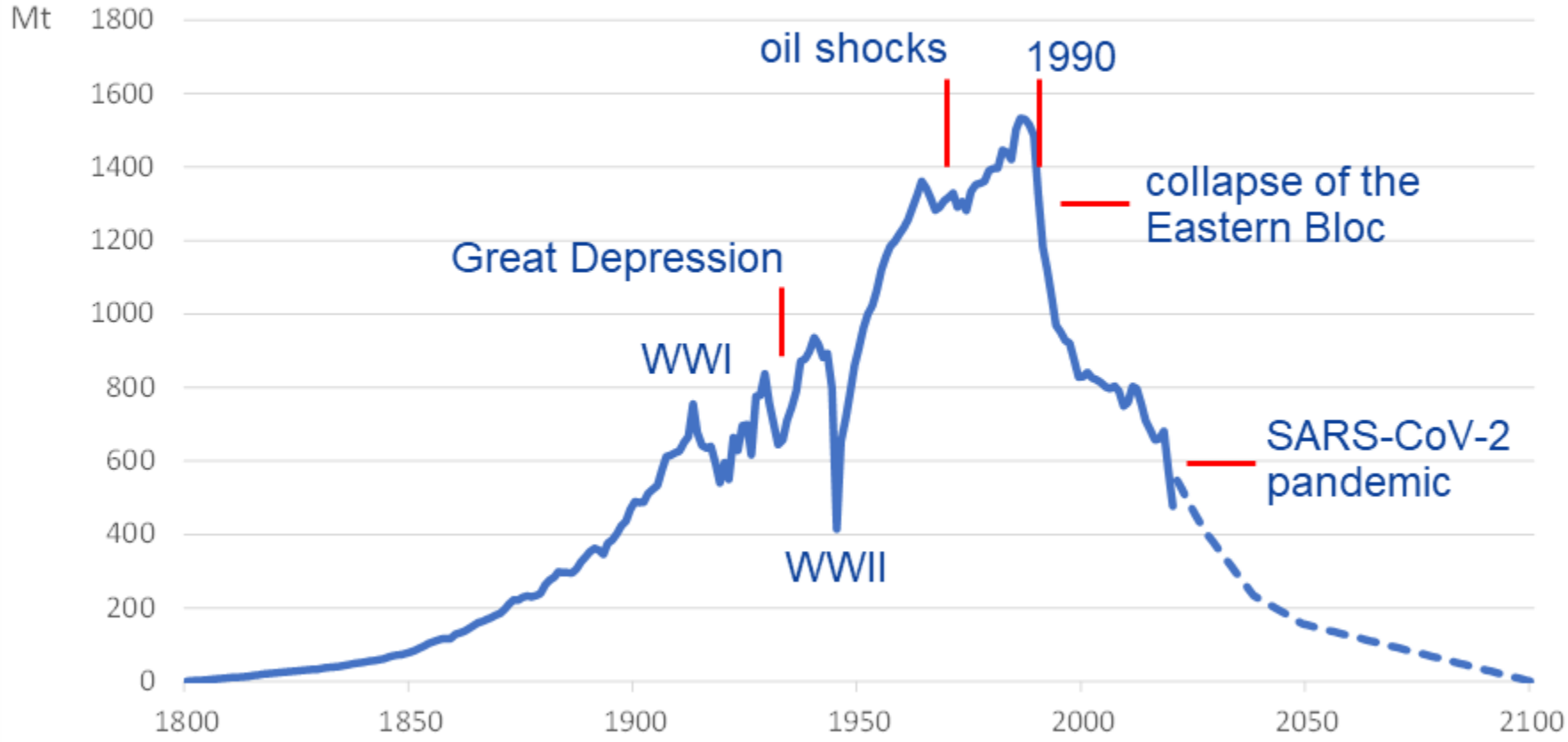
Coal Regions in Transition Platform
virtual week, 15-17 November 2021

EU Methane Strategy – tackling methane emissions from coal mines

Just Transition Platform meeting
16 November 2021, Brussels

Brian Ricketts
Secretary General

European coal production 1800-2020 and forecast to 2100



EU Methane Strategy COM(2020) 663, 14 October 2020

- Focuses on fugitive emissions from oil and gas production, supply infrastructure and end use.
- EURACOAL responded with a Position Paper:
  - Opencast mines emit little or no thermal methane.
  - Emissions from underground coal mines are now a fraction of past emissions.
  - Use of coal mine methane (CMM) is supported by EEG in Germany.
  - Promote CMM + ventilation air methane (VAM) use across the EU.
  - Pay attention to abandoned mine methane (AMM).
- European Commission will propose legislation in December 2021.
- UNEP International Methane Emissions Observatory has €100m support.

Need to allow State aid for methane emission reduction projects and offer relief from the EU ETS for heat and power projects using CMM.