



G.I. Dynamics

Coal Mine Methane Utilization Technologies

- **Introduction**
- **CMM Market Overview & Influencing Parameters**
- **CMM Drainage & Extraction**
- **Coal Mine Methane Processing**
- **Project Reference(s) & Case Study**
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Introduction

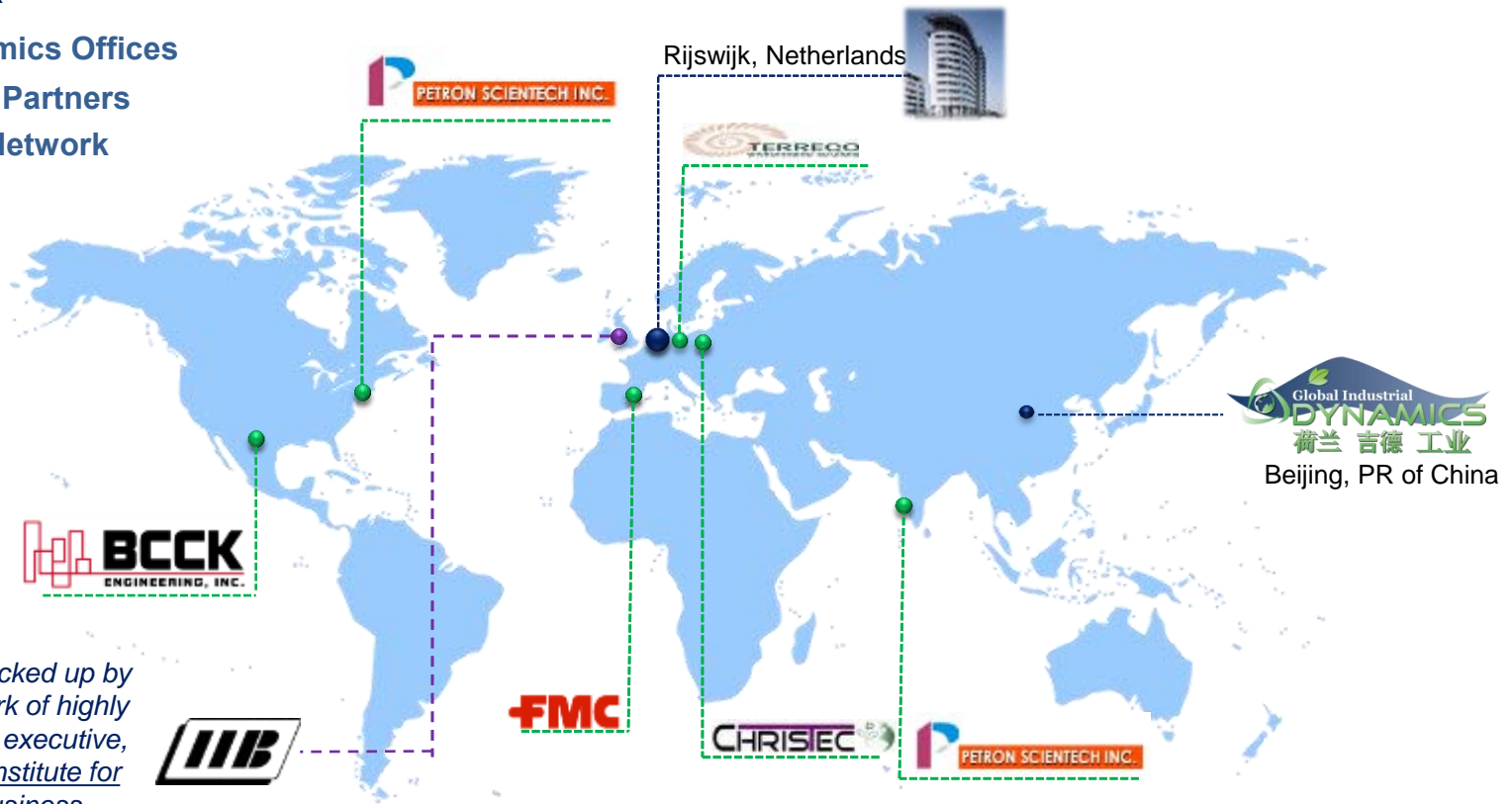
Introducing G.I. Dynamics

G.I. Dynamics is a company with hands-on industrial experience, operating together with specialists and niche business partners in order to **improve the performance** and **develop the sustainability** for our clients business.



Global Network

- G.I. Dynamics Offices
- Business Partners
- Support Network



G.I. Dynamics is backed up by an extended network of highly experienced senior executive, associated in the Institute for Independent Business

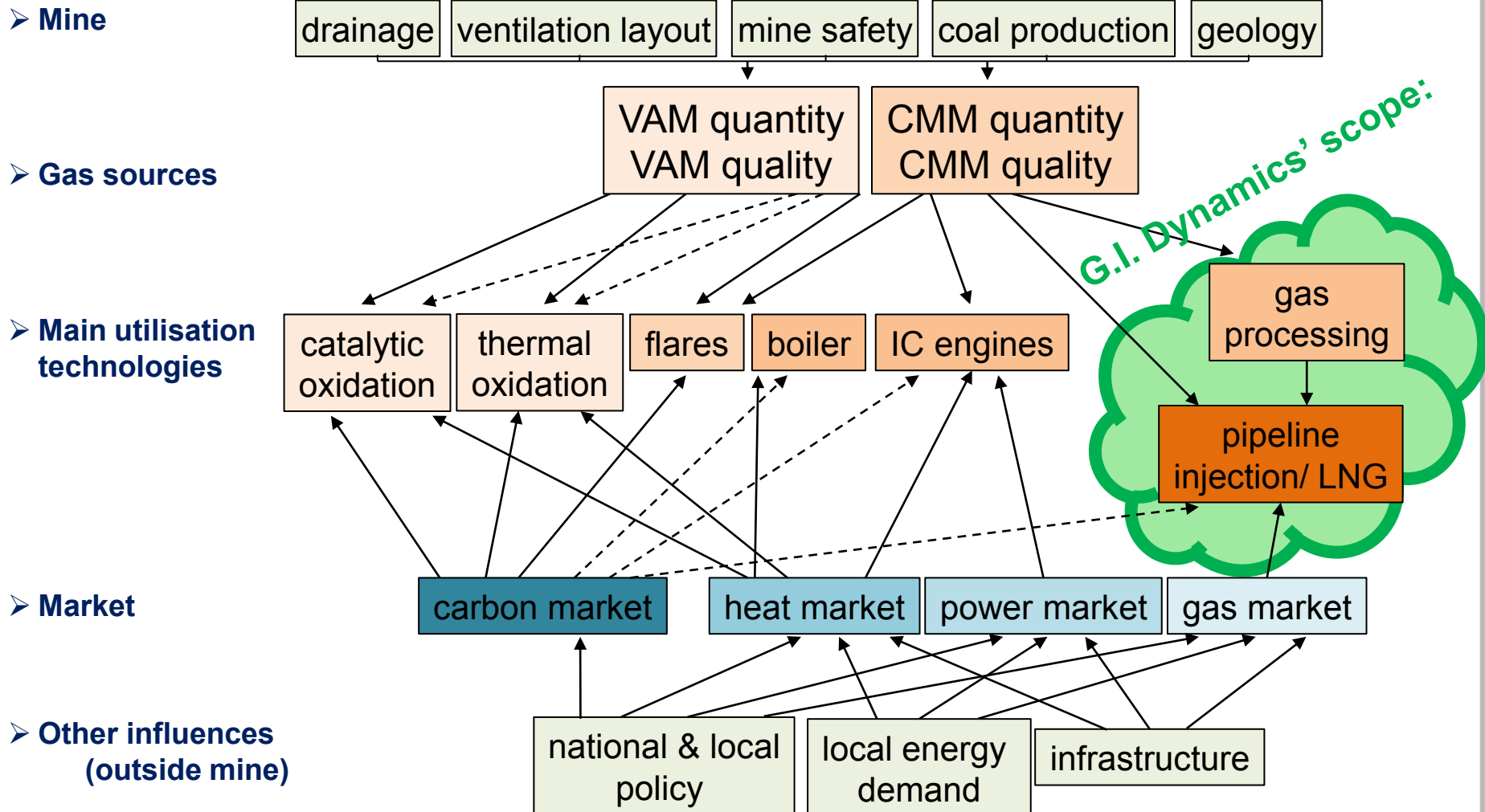


- **Understanding and experience of oil & gas business** and complete supply chain, economic and operational drivers of the industry, business partners and opportunities
- **Aligning and Bridging industries** between the different market sectors, and generating business opportunities to improve the overall business performance.
- **Core business focused on sustainability and environment** therefore our technologies are selected and our business orientation is in areas like unconventional gasses and carbon capture.
- **Providing proven and applied world-class gas processing/treatment technologies** to the oil & gas industry.
 - Cryogenic Nitech™ NRU (Nitrogen Rejection)
 - Helium Recovery
 - Ultra High CO2 Extraction and Sequestration
 - Liquefaction plants
- **Perform projects from licensing up to LumpSumTurnKey** based on above mentioned technologies, and operational support.
- **Supporting our clients** with a full committed team from cradle to grave to ensure an added value and the necessary innovation to the project at the right time.



CMM Market Overview

Market Overview & Influencing Parameters:



G.I. Dynamics provides together with BCCK: Coal Mine Methane Utilization Technologies for Methane Purification towards Pipeline/LNG



Process of Coal Mine Methane Utilization



**CMM extraction
planning**



**CMM
Extraction and
Recovery**



**CMM
purification and
compression**



**Pipeline injection
or LNG
transportation**

**Market Gas
(High Quality)**



**Carbon
Credits**



CMM Drainage & Extraction

What is there ?

low CMM concentrations
low CMM recovery rates



explosion risk

coal production limited by
CH₄ concentrations of
ventilation air

high mixture flow in
drainage system due to high
air content

high costs for CMM
processing

What has to be done?

improvement of:

- drilling scheme
- drilling technology
- borehole sealing
- underpressure
- borehole management
- pipeline network
- dewatering systems
- gas management

What is the benefit ?

high CMM concentrations
high CMM recovery rates



improved mine safety

higher coal production
feasible

lower mixture flow to be
transported by drainage
system

lower costs for CMM
processing (e.g. Nitech™)



Improvement of gas drainage

A minimum investment in improving the drainage and extraction of the CMM has a major impact on the investment costs of the CMM purification.

Actual state

Gas pump no./ Drainage system no.	Mixture flow	CH ₄ conc.	CO ₂ conc.	O ₂ conc.	N ₂ conc.	CH ₄ flow
	[m ³ /min]	[%]	[%]	[%]	[%]	[m ³ /min]
1	55	50,0	1,3	9,8	39,0	27
2	50	20,0	0,5	15,9	63,6	10

Improved state

Gas pump no./ Drainage system no.	Improvement reasonable	CH ₄ conc. medium term target	CO ₂ conc.	O ₂ conc.	N ₂ conc.	Mixture flow after improvement	Improvement
		[%]	[%]	[%]	[%]	[m ³ /min]	[%]
1	yes	60,0	1,5	7,7	30,8	45	20
2	no	-				-	-

Investment savings

- Costs for improvement of gas drainage system:
~ 150-200K euro
- Savings for gas purification unit
~500-2000K Euro



Create Synergy between Mine Operator and Project Developer

Mine Operator

- Ventilation and gas drainage are mainly carried out for mine safety
- CMM and VAM are usually seen as waste products of coal mining only
- Coal mining is core business, not gas production or utilization
- Value of CH₄ is considerable lower compared to value of produced coal

Project Developer

- Investment in gas utilization project
- Revenues from gas utilization and/ or CO₂ credits are basic
- Stable CH₄ quantities and qualities

Process of Coal Mine Methane Utilization



**CMM extraction
planning**



**CMM
Extraction and
Recovery**



**CMM
purification and
compression**



**Pipeline injection
or LNG
transportation**

**Market Gas
(High Quality)**

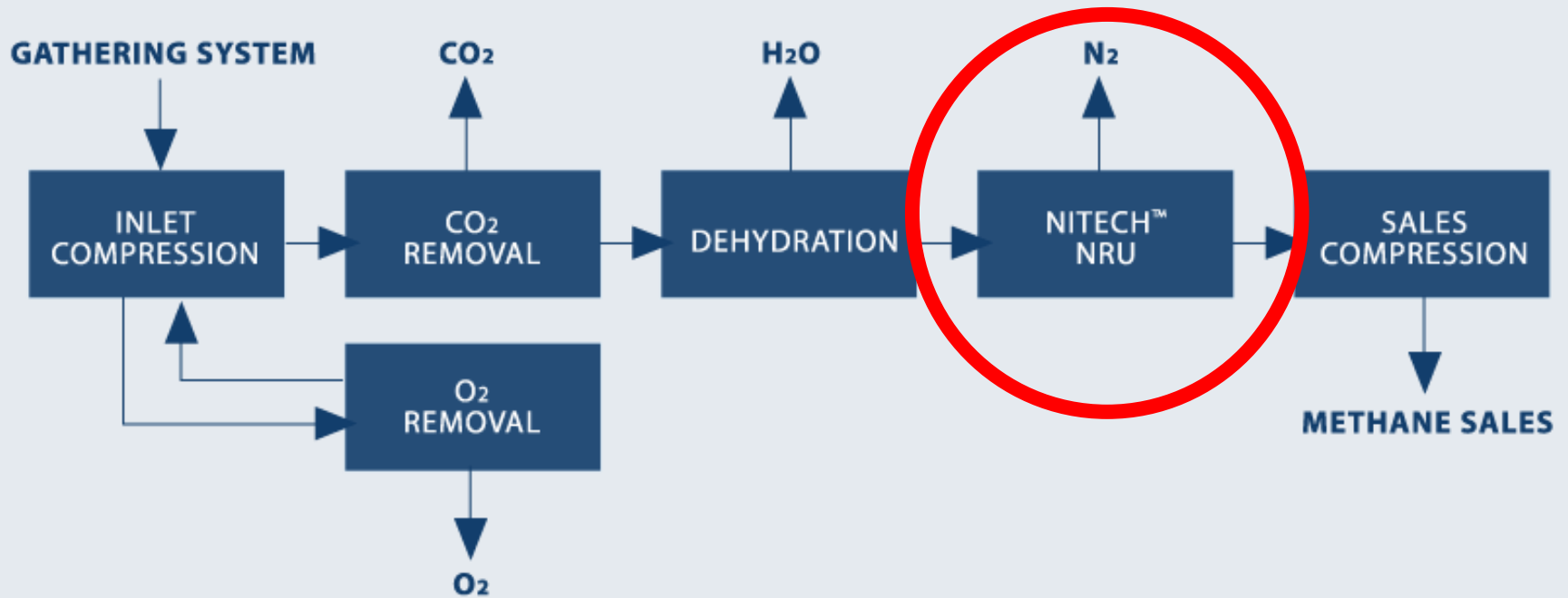


**Carbon
Credits**



G.I. Dynamics provides together with BCCK:
Coal Mine Methane Utilization Technologies for Methane Purification
towards Pipeline/LNG

Coal Mine Methane Gas Treating Configuration



The Cryogenic Nitech™ NRU Technology;

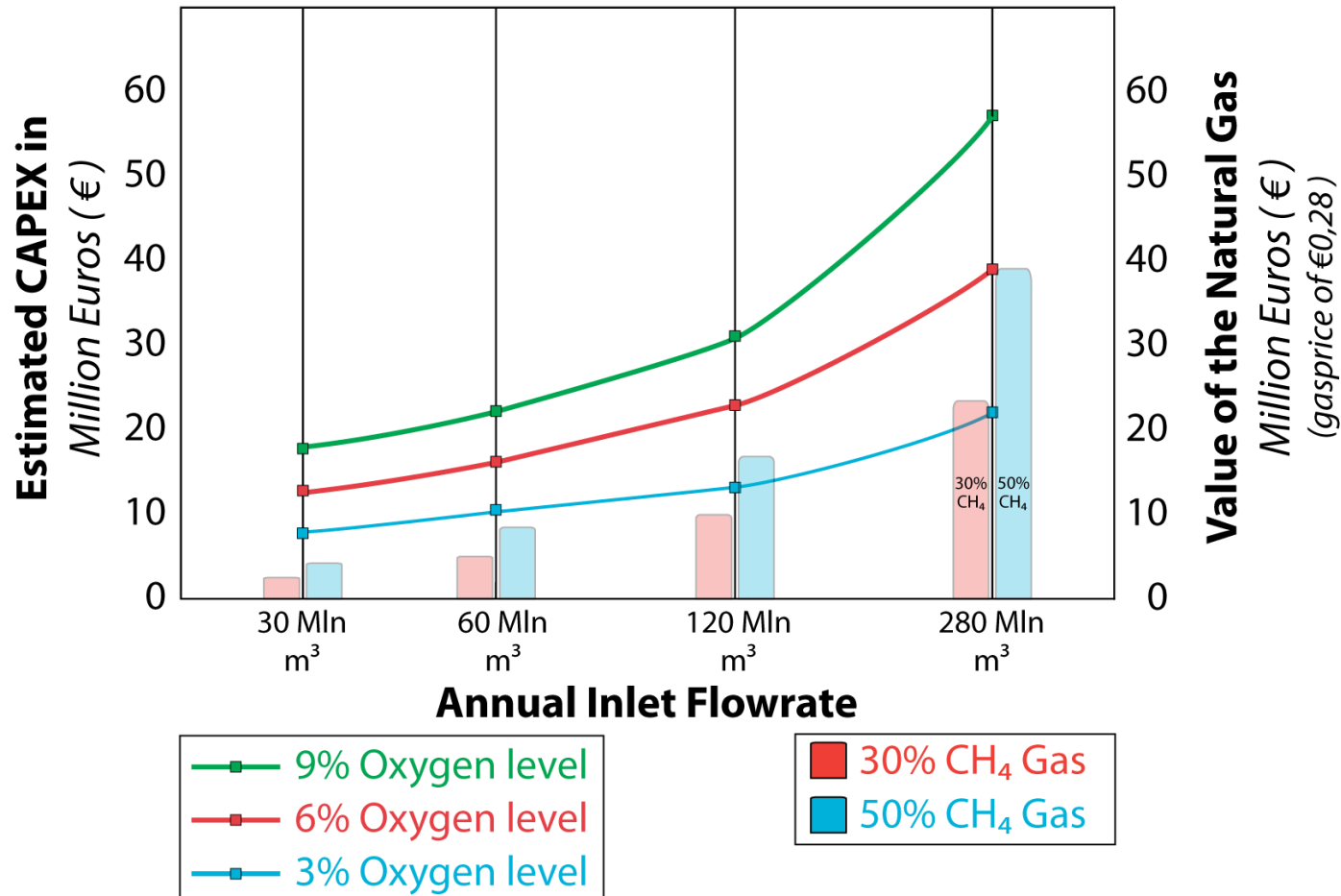
- **Nitrogen Rejection Units (NRU) selectively removes nitrogen from a gas stream.**
 - In practice, cryogenic plants have the highest methane recovery rate (approximately 99%) of any of the nitrogen rejection technologies
 - The units have become standard practice for large-scale projects.

- **Key figures;**
 - Nitech™ is the preferred choice NRU process in the USA. Almost all new NRU systems are build with the Nitech™ process;
 - More than **21 Nitech™ NRU systems have been installed**
 - There are currently **3 Nitech™ NRU systems under construction**
 - The first overseas Nitech™ will be build in Poland;
 - The Nitech™ NRU technology can be up to 15% less expensive on both OPEX and CAPEX in comparison to other cryogenic technologies.

- **Major technical advantages;**
 - Typically only three major components;
 - No cryogenic rotating equipment required;
 - High methane recovery in excess of 99%;
 - A less complex, more reliable and lower cost design.



Financial Estimates for CMM Utilization



* Excluding any usage of the extra heat available from the oxygen system. We can do several things (make heat for mine, make steam, or make steam and power).

Example data: CMM-to-Natural Gas

	<i>G.I. Dynamics' scope of delivery*</i>		
	Old CMM-to-NG	Improved CMM-to-NG	Savings
50 MM m3/yr	€ 12.375.000	€ 11.250.000	€ 1.125.000
120 MM m3/yr	€ 21.037.500	€ 19.125.000	€ 1.912.500
	11,8% O ₂	8,6% O ₂	

Example data: CMM-to-LNG

	<i>G.I. Dynamics' scope of delivery*</i>		
	Old CMM-to-LNG	Improved CMM-to-LNG	Savings
50 MM m3/yr	€ 16.545.000	€ 15.950.000	€ 595.000
120 MM m3/yr	€ 28.125.000	€ 26.970.000	€ 1.155.000
	11,8% O ₂	8,6% O ₂	

Drainage station no.	Mixture flow	CH ₄ conc.
	[m ³ /min]	[%]
1	155	45,0
2	800	35,0
3	235	30,0
4	140	50,0
5	635	30,0
6	500	45,0
7	155	45,0

Drainage station no.	Improvement reasonable	target
		[%]
1	yes	60,0
2	yes	50,0
3	yes	50,0
4	yes	60,0
5	yes	50,0
6	yes	60,0
7	yes	60,0

Note. G.I. Dynamics scope of Delivery: License, engineering, equipment and interconnecting piping systems



Waynesburg, Pennsylvania - Highlights

- **Plant in co-ownership** via Greene Energy, LLC.
- To date, we **continue to provide engineering and optimization services** for the plant.

Black Warrior Methane, Alabama – Highlights

- Ahead of mining operations, BWM sells approximately 500 million m³ per year of coal bed methane gas. **The addition of the Nitech™ NRU increased gas sales by 10%-15%.**
- The capture of this methane will allow producers to bank the carbon credits earned from capturing this methane and to trade the corresponding carbon credits with other businesses.

Illinois Methane NRU, Illinois – Highlights

- The Illinois Methane facility was placed on an **abandoned coal mine (AMM)** whereby active mining has been ceased for several years.

Experience

The Nitech™ process is already in operation across the country with coal mine methane enrichment facilities in;



PA, USA

120 million m³ annual
10% - 25% N₂



Alabama, USA

120 million m³ annual
15% – 30% N₂



Illinois, USA

120 million m³ annual
15% – 30% N₂

Our scope may vary from technology provider towards turn key project contractor up to co-ownership.

Case study of a Coal mine

- Coal production: 4 million T/ A
- Vented CH₄: 150 m³/min
- Drained CH₄: 75 m³/min

- Value of coal:
~ 500 million \$ / A

- Value of total emitted CH₄ (Carbon Credits):
~ 20-30 million \$ / A

- Value of natural gas from drained gas after purification:
~ 15 million \$ / A

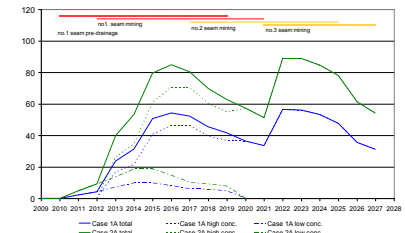
**Nevertheless significant
additional revenues from
CH₄ utilisation !**



Concluding

Benefits of Efficient Gas Drainage

- Main benefits for effective and correct drainage system will address the inherent risks associated with coal mines. By having an effective utilization process for the drained CMM, an additional revenue can be created. Main benefits for effective capture and utilization of CMM;
 - **Safe working environment** — decreases the risk of fire/explosion
 - **Environmental friendly** — methane, a dangerous greenhouse gas, is captured instead of vented to the atmosphere
 - **Cost-effective fuel source** — captured, processed gas can power mining equipment



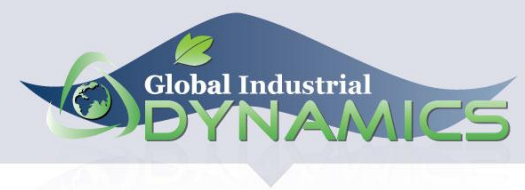
Benefits of Gas Purification for Pipeline/LNG

- Utilizing to the Nitech™ NRU technology, you can;
 - **Stop venting** coal mine methane to the atmosphere,
 - **Capture that waste gas** and
 - **Create a sellable methane** product or liquid natural gas (LNG).



coal mining and methane mining now go hand-in-hand!

Concluding



G.I. Dynamics' Gas Processing Group;

Provides proven and applied world-class gas processing / treatment technologies up to LS turnkey facilities to the oil & gas industry and align interested players/parties in the market. Our experience and capabilities cover gas processing activities in the area of;

- Conventional low-BTU Gas
 - Shale Gas
 - Tight Gas
 - **Coal Seam Gas / Coal Mine Methane**
 - Enhanced Oil Recovery
-
- **Some of the unique technologies we supply;**
 - Cryogenic Nitech™ NRU (Nitrogen Rejection)
 - Nitech™ Xpan
 - Ultra High CO2 Removal

 - **Scope of supply:**
 - Feasibility study
 - Technology plus extended basic engineering package
 - LS Turn key plant or
 - Proprietary equipment and start up assistance
 - Co-ownership/operations



Summary

- **We provide world-class technology for the CMM processing & utilization**
- **We cooperate with relevant business partners, able to cover the latest developments in;**
 - CMM Drainage & Extraction
 - CMM Utilization to up high quality Natural Gas or LNG
- **Successful with global players**
- **Supporting client to develop project and operating support**
- **Supporting in the business finance**



Thank you.



Contact Us

For more information about the technology and applications, don't hesitate to contact our business associates. We would be glad to help you in achieving sustainable business!

Anna Sutomo

Business Development Manager

M: +31 (0)6 125 76 602

E: a.sutomo@gidynamics.nl

Chris van der Zande

Business Development Manager

M: +31 (0)6 125 77 224

E: ccm.vanderzande@gidynamics.nl



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