Report

Fact Finding Mission
Colombia
March 2018

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**OBJECTIVES**

1. To conduct a fact-finding mission necessary for preparation of a capacity building workshop in Colombia (Summer 2018).

2. To explore the situation on the ground and learn about the actual problems and needs of all relevant stakeholders, i.e. the regulators (the Government and relevant state agencies), mine operators, project developers, and miners in Colombia

**MEETINGS AND SITE VISITS**

**Meetings:**

Meetings were held with all relevant Governmental Agencies involved in regulation, exploration, or extraction on Coal Mine Methane in Colombia, i.e.

- the National Hydrocarbon Agency (ANH) (13 March 2018) (see section 2.1.2 ANH, and Annex I - Presentation ANH),
- the Ministry of Mines and Energy (13 March 2018) (see Annex II - Presentation MINMINAS),
- the Unit for Mining and Energy Planning (UPME) (13 March 2018) (see section 2.1.4 UPME, and Annex III – Presentation UPME, and Annex IV – Presentation UPME – VAM),
- the Ministry of Environment (13 March 2018) (se section 2.1.5 Ministry of the Environment),
- the National Geological Service of Colombia (SGC) (13 March 2018) (see section 2.1.1 SGC, and Annex V - Presentation SGC),
- the National Mining Agency (ANM) (13 March 2018, plus additional meeting on 15 March 2018) (see section 2.1.3 ANM, and Annex VI - Presentation ANM),
During the meetings problems, needs, as well as ongoing and planned projects related to the field in question in Colombia were discussed.

Meetings were held with relevant private sector stakeholders, such as:

- Durmmond Ltd. (the only company running a CBM project in Colombia) (15 March 2018) (see section 3.4.1 Case study: Drummond).
- Argos (a cement company managing an abandoned coal mine) (14 March 2018) (see section 3.5.1 Case study: San Martin Mine Project by Argos, and Annex VIII Pictures section D. Cementos Argos abandoned mine)
- Uniminas (an operator of multiple mines across the country) (12 March 2018), providing insight into the private sector’s activities, needs, opportunities and difficulties in the field of CMM and AMM in Colombia (see Annex VII - Presentation UNIMINAS).

Site visits:

1. Casablanca coal mine operated by Uniminas (including visits to smaller mines conducting extractive activities based on the same concession) 12 March 2018 (see Annex VII - Presentation UNIMINAS, and Annex VIII – Pictures section A. Casablanca Mine);

2. Cementos Argos site in Boyacá, (including visit to the model abandoned mine project run by the company), 14 March 2018 (see section 3.5.1 Case study: San Martin Mine Project by Argos, and Annex VIII Pictures section D. Cementos Argos abandoned mine).

3. SGC laboratory responsible for determining the characteristic of coal (including its methane content, porosity, etc.) (see section 2.1.1 SGC, and Annex V - Presentation SGC).

All visits featured meetings with the management as well as high- and mid-level technical staff.

**OBSERVATIONS AND CONCLUSIONS**

**Observations**

1. **Coal Mining**

   - Coal mining activities in Colombia depend on the price of coal. If the price goes below 80 USD/tonne many small operators in the country stop production, as they cannot afford bringing coal to the coast (which is necessary for export).
   - An average underground mine in Colombia is small (2000-4000 t/month), located in the mountains, and not adequately equipped.
     - Particularly there are large deficiency in ventilation systems, both in terms of their efficiency and design (see below – section 3.2 Ventilation).
   - Oftentimes a single concession is developed by multiple operators under contract to a larger organization (each running a separate mine).
     - Usually the sub-contractors are under obligation to sell the extracted coal to the main operator who is the owner of the concession).
   - There is a problem of illegal underground mining.
     - Until detected, illegal mines are beyond control of state authorities, this is critical as they do not adhere to mine safety and health regulations, but mine rescue may still respond to accidents at these mines if needed
2. Regulatory Issues

2.1 Institutional confusion

- There are multiple Governmental agencies, with no clearly defined relative competencies related to CMM regulation and oversight.
  - E.g. Enriching through VAM, being a mining activity, is regulated by ANM, but degassing from the surface through vertical wells, not being considered as mining activity, is in the competence of ANH.
  - It is necessary to clearly establish what is gas recovery from mining activity and what is oil and gas issue.
- Relevant agencies need to coordinate their activities and exchange data.
  - Right now, however, they tend to compete with one another.

2.1.1 Servicio Geologico Colombiano (SGC)

- Works on CMM from 2010.
  - It provides technical information on the issue.
    - It focuses on where methane is located, and how it can be used for energy generation.
  - The SGC works on CMM mostly in the Centre of the Country
    - Since 2011 SGC explored 200 km2
    - The idea of the study is to drill very close to the anticline
    - Program has 4 phases:
      - Diagnosis of the information already possessed.
        - E.g. geological mapping, and evaluation of the coal seams.
      - Socialization (approach civil and military authorities as well as local communities), surface geology, and determination of the coal activity in the area (SGC seeks to drill boreholes 200 m from exploitation)
      - Evaluation of the subsurface geology.
        - The objective is to sample coal from the depth.
        - Some 100 and 200 m deep drills have already been performed.
      - Characterization of the coal potential by the SGC Laboratory
        - The laboratory use a “new” method allows for constant control of gas content in the sample and for keeping it in the “original” reservoir temperature. However, measuring gas at reservoir temperature is not new.
        - Isotherms are developed based on the desorption data by fitting the data to the Langmuir equations, this is a desorption isotherm, but industry standard adsorption isotherms are not performed in the laboratory due to lack of equipment. The current approach does not indicate if the reservoirs are saturated or undersaturated with gas.
        - Calculation of CBM resources and reserves are performed
          - Measured reserves
          - Indicated reserves
          - Potential reserves
        - Fifty 300 to 600 m deep boreholes were drilled over the last 7 years (2011-2017).
        - Results allowed to obtain further data on:
          - Rank of coal, and
          - Type of coal.
2.1.2 National Hydrocarbon Agency (ANH)

- Established in 2003.
- Related to the Ministry of Mining and Energy.
- It administers and regulates hydrocarbons (evaluation, exploitation, production).
- Its mission is to optimize the extraction and use of hydrocarbons in Colombia.
- Functions (among others):
  - To identify and evaluate the potential for hydrocarbons in the country.
  - To evaluate, design, and promote investor activities (exploration and production).
  - To promote, negotiate, and conclude contracts for R&D of hydrocarbons in the country.

2.1.3 National Mining Agency (ANM)

- Created in 2011 under the Ministry of Mines.
- Functions (among others):
  - Promoting mining activity.
  - Contracting (gives and authorizes contracts to be exploited).
  - Follow up and control of already titled mines.
  - Calculating and collecting royalties.
- Beyond ANM competence remain:
  - Illegal exploitation of mines.
  - Mine closure/AMM.
    - So far only 3 stages (exploration, exploitation, and construction) are regulated
    - There is a will to create a law on mine closure.
      - It would be the 4th stage determining obligations that need to be followed in the process of mine closure.
      - Cooperation with Ministries of Mines and the Ministry of the Environment is necessary, yet, particularly in the latter case, difficult.
- The only way to exploit mine in Colombia is to have a title that is on a production stage.
- ANM issued 6690 titles for all mineral at all stages of mining process.
- Around 1200 titles were issued for coal in the whole country.
- 3 main issues ANM needs a help with:
  - Ventilation of mines.
    - It is also necessary to raise awareness among miners of how ventilation improves security of work underground.
  - Degasification of mines.
  - Prevention and control of explosions (the most important of the 3).
    - There is a lack of research on how to deal with methane and coal dust in Colombia.
    - There is a necessity for training in this field.
    - There is a lack of capacity to deliver specialized training to miners.
    - There is a general lack of awareness of the broad range of information and data that is available from other coal mining countries and published literature
      - There is a potential for establishing an International Centre of Excellence on CMM in Colombia with focus on training and research.

2.1.4 Unit for Mining and Energy Planning (UPME)

- Function: to plan sustainable development of the country.
- Sub-direction of mines:
  - Brings support to the Ministry of Mines in policy making.
  - Studies on methane are relatively new as before there was no regulation on use and exploitation of CMM.
Only the Law 1886 of 2015 provided a framework to do so.
  - First study was conducted in 2016 with the aim to bring information to the stakeholders operating in the field in question.
    - The goal was to gather and consolidate all information on CMM available in the country (from ANH, Ecopetrol, Universities, Geological Service, etc.)
    - The study analyses technologies utilized in other countries as at that time there were none in Colombia.
    - At the time when the study was conducted there was no data on emissions.
      - IPCC emission factor was used to estimate them.
      - With new technology it turned out that the initial estimates were overestimated by 47%
  - Results:
    - The study determined:
      - Quality of coal,
      - Technology utilised in the facilities involved,
      - Methane content in coal.
    - For further studies other organizations will be invited.
    - There is a need for contribution by international experts, due to a lack of local expertise.
    - UPME seeks to develop a project integrating VAM and drilling.
      - As for now it is beyond UPME capabilities due to:
        - Lack of resources, and
        - Lack of expertise.

2.1.5 Ministry of the Environment

- Works to fulfill Colombia’s commitments under the Paris Agreement.
- CMM capture and use is a new field for the Ministry.
  - It is seen as an opportunity that could help the country to reduce its emissions.
  - It is important that all CMM activity is in compliance with law and environmental objectives of the country.
  - So far, no studies related to CMM capture and use were conducted by the Ministry.
- Ministry plans to give more attention to unconventional sources of energy, and CMM is a part of this plan.
- There was cooperation with the Ministry of Energy on some issues related coal exploration and exploitation, but it was 20 years ago.
  - There is a need to revive this cooperation.
- No environmental assessment of implementing CMM projects have been so far conducted.
  - There is a conviction that such projects would bring to the sector multiple benefits, such as:
    - GHG emission reduction,
    - Economic use of captured gas as a fuel,
    - Improvements of the working conditions underground (risk reduction).
- Currently there are no baselines that would indicate what the impact of the CMM projects could be.
  - First step is thus to work on modelling and developing such baselines.
- The ministry sees a need to limit the negative impact of mining at every stage of the coal-mining life cycle.
  - There is an awareness and a concern in the Ministry about abandoned mines that are not properly managed.

2.2 Lack of clarity in CMM definition

- Resolution 180742 of 18 May 2012 does not distinguish between non-conventional resources such as shale gas, oil sands, and CMM.
A base line distinction between CBM and CMM is necessary.
- In order to do so art. 59 was inserted to the Directive 1886.
- Technical regulations related to unconventional resources are set by the Ministry of Energy.
  - There are contract forms designed for unconventional resources.
  - In 2014 Ministry of Energy issued ToR on exploration of unconventional resources.
  - There are no ToR, or any other regulation on production of unconventional resources.
  - Such situation effectively inhibits development of any CMM/CBM projects

3. Specific Issues

3.1 Fatalities

Mining industry causes more fatalities that all other industries combined. There is a very high mortality rate in Colombian underground mines (in 2017 there were 113 accidents that caused 136 deaths. These accidents occurred in both, legal and illegal mines. The distribution was approximately half-half.).
- While these number have been relatively stable over the last decade (around 100 accidents and 100 deaths per year), over the last 3 years the number of casualties is gradually growing (from 92 to 136).
- As in 2014 illegal mining activity increased, so did also the number of accidents.
- From 2005 to 2018 there were 1073 emergency situations (not only accidents) causing death of 1283 people.
- Causes of emergencies:
  - 13% methane explosions,
  - 15% noxious atmosphere of the mines,
  - 35% landslides.
- Causes of fatalities:
  - 27% explosions of methane and coal ashes,
  - 16% noxious atmosphere of the mines (i.e. 43% of deaths are related to methane).
- Major causes of safety problems:
  - Illegal exploitation.
  - Most of title holders do not have resources to assure adequate safety conditions (why are the titles given?).
  - Nonfulfillment of obligations.
    - While equipment is oftentimes available, many mines do not technically assume the risk.
  - Lack of technological acknowledgment of safety engineering.
  - Lack of experts on ventilation.
- According to the standing regulation there are 3 categories of mines in Colombia:
  - With zero to very low methane concentration,
  - With up to 0.3% methane concentration,
  - With over 0.3 % methane concentration (which require special precautions).
- The above division is difficult to implement.
  - There is a not enough information about methane concentration in the title;
  - Strict adherence to the law and the resulting classification of many mines as category 3 mines would cause closure of many of them;
  - Gas concentration is measured during the follow up procedure for the titles. The procedure is not efficient, as mines specially prepare for it and thus in majority of cases manage to be classified as category 1 mines.
3.2. Ventilation

- There is a substantial deficiency in ventilation systems, in terms of their efficiency and design.
  - In some cases, while the quantity of air moved through the mine conforms with the regulation, not enough methane is removed in the process (due to faulty design of the ventilation system) thus allowing for accumulation of the gas in certain parts of the mine in eddies and blind roadways (“pockets”).
  - In some mines there is a twofold problem: on the one hand, the ventilation system is not sufficiently efficient to provide enough air to dilute methane concentration to safe levels (in particular methane is being collected in “pockets” which occur due to faulty design of the ventilation system); on the other hand, when more air is being provided it can cause spontaneous combustion of coal.
  - Companies/mine operators often lack personnel to deal with all the problem that they face (due to accumulation of tasks the personnel oftentimes do not have time to deal with inefficient ventilation).
  - In many cases there is not enough electricity available to secure efficient ventilation (as it is used for extraction purposes).
  - There is not enough data about the “gassiness” of mines. Without knowing how much methane is in the mine it is difficult to properly assess efficiency of the ventilation system.

3.2.1 VAM

- It is estimated that for an auto-generation VAM project is required 500,000 m³/h with concentration 0.7% of methane.
  - However, in Colombia such numbers are never present, i.e. VAM projects are not viable under the present conditions found at operating mines.
  - Potential alternative: oxidation of VAM.
    - If price of carbon in Colombia reaches the California’s level of 14.75 USD, such projects would be viable (carbon market with guaranteed minimum price is necessary).
    - According to local estimates break even cost is 10.31 USD for 10 years of carbon price and 4.36 USD after year 11.

3.3. Emissions

- One of Colombia’s international commitments is to lower methane emissions.
- One of the points of the national strategy is to provide energy from fossil fuels in a cleaner way.
- According to the local estimates there is 200,000 t of CMM emissions per year.
- If CBM is captured, Colombia will be able to register reduction of CMM emissions only with the first extracted tonne of coal, i.e. in 12 years.
  - According to local regulation coal extraction can start only 8 years after CBM gas capture.
- CMM is treated as a fugitive emission.

3.4. CMM/CBM

- There is lack of information about methane resources and reserves.
  - Determination of estimating resource and establishing proven reserves of methane should be a priority.
  - Over the last year UPME has been trying to coordinate activities of various Governmental agencies in order to develop such study.
- In Colombia there are 12 mine zones where CMM is present.
- Some coal seams in the country have good potential for CMM extraction.
- There are multiple regulatory issues preventing development of CMM/CBM projects in Colombia.
Directive 1886 of 2015 states that if there is a proven high concentration of methane, operators should drain it either before or during exploitation.

Resolution 90325 of 2014 provides a basis for use of CMM, being concerned mostly with security but also allowing for self-generation of energy.

According to the current regulation any mine that exceeds its energy capacity will be able to sell the surplus to the grid.

At the same time according to law 1715 of 13 May 2014, gases generated by mining industry are not considered as potential alternative sources of energy (art 11-14).

- There is a will to change it.
- The goal is to allow companies to capture CBM, assuring at the same time that the benefits of such activity would be distributed also to the miners.
- There is a lack of knowledge and regulation of how to simultaneously exploit conventional and non-conventional resources.
- There is an issue of ownership of methane between the owners of adjacent concessions.
- Mines interested in developing CMM projects (such as Casablanca) lack sufficient data (on volume of methane gas resources contained by the coal seams and surrounding strata, permeability, volatility of gas, gas release rate, etc.) what prevents them from certifying their concessions on international markets.
- Drilling necessary for determining viability of CMM projects is very costly (in Casablanca mine it is estimated to cost up to 3 million USD), thus in most cases beyond the reach of mine operators.
  - Consequently, local mine operators are looking for a support from international organizations and foreign states.
- The obligatory negotiations with indigenous people (Consulta Previa) on whose land a mine or a project is to be developed tend to be very lengthy and difficult.
  - Public hearings with local communities are obligatory.
  - Communities tend to have high demands for job opportunity, financial compensation, etc.

### 3.4.1 Case study: Drummond

- The company originally applied for a licence that included a large area.
  - The application was rejected.
- Then it applied for a smaller licence. It took 6 years to obtain it.
  - It is a very difficult and time-consuming process.
  - It has not yet obtained an environmental permit.
- The company degasses areas close to their open pit mines and covering part of the adjoining mine owned by Cerrejon, a partially state-owned and international joint venture.
- It is very difficult to develop a stable relation between two operators focused on the one hand on gas and coal and on the other hand with a company that is focused solely on coal extraction.
  - Drummond can do it because it covers both of these areas by itself. However, where there are two separate entities Drummond and Cerrejon, with two different objectives involved, it is very complicated
- Very few companies are still interested in CBM
  - There was much more interest in 1980’s.

### 3.5. AMM

- There are local environmental rules that needs to be follow during the process of mine closure in Colombia.
- New law requires all mines above 3000 m to be closed for environmental reasons (mostly water concerns).
3.5.1 Case study: San Martin Mine Project by Argos

- Argos bought the mine from Sator (which operated it from 2004 to 2012)
  - The company obtained 75 acres of mine title.
- On the basis of the results obtained from 12 drilled wells, Argos estimated production to reach 5000 tonnes/month.
- There were two coal seams – 2.20 m and 4.80m with a 20° dip angle.
- According to the study based on the drills, the company decided to build a tunnel parallel to the borderline established by the law.
  - The tunnel had 5m², and was 330 m long. It cut across the seams.
  - There was also another tunnel one built by the previous owner at 3200 m.
  - The company planned to extract coal by going up, in order to connect the tunnels, but the new law prevented such activity.
- Ventilation
  - A gravity ventilation (a natural air flow).
  - A number of 3 to 5 PS fans were installed as an auxiliary ventilation for dead spots.
  - There was also an additional ventilation shaft with 12 PS fan.
  - There were no problems with methane as such.
- Employment
  - 100 people were employed at the time of closure
- Closure
  - Rationale:
    - Licence expired in 2011 and since the large part of the mine was above 3000 m (only 30% of the title were below the limit set by the new law) the full licence could not be extended (the entry was at 3000 m but the majority of the coal deposit was at 3200 m) Consequently, the company decided to close the mine.
      - Program to close the mine started in 2013
  - Environmental issues – necessity to revegetate the area, i.e. to bring it to the environmental state as it used to be before the commencement of mining activities.
    - This requires restoring:
      - Physical and chemical stability;
      - Water situation;
      - Territory situation.
  - Social issues – necessity to take care of the workers and the communities affected by the closure.
  - Technical issues – necessity to fill up the tunnel.
  - In Colombia there is no established procedure of mine closure that needs to be followed.
    - However, there are certain rules and regulations (e.g. environmental) that need to be complied with.
      - Argos did much more than required.
  - Before the closure the company conducted number of studies to assess the cost of the process.
    - It assessed the risk for workers.
    - It assessed the risk of removing equipment.
      - The company removed steal arches from the tunnel and reused them in another mine.
        - In the first 50 m of the tunnel arches were left intact.
  - Physical closure
    - The tunnel, except of the first 50 m that were left intact, was filled with plastic bags filled with rocks.
    - The wall was built to prevent entry to the mine (also at the second entry utilized by the previous owner).
      - The wall is not a seal – it does not prevent gas escape.
• There is a pipe in the wall at the main entry to prevent gas accumulation.
  ▪ A pipe was built to drain the water.
    • Drained water is now cleaner that at the time when the company bought the mine.
      o There is no residue – no need to treat it any further.
  ▪ The ventilation shaft was covered with concrete
    • The fan was removed.
    • 2 m long pipe was left to prevent gas accumulation.
  ▪ The equipment was given to the company specialising in its disposal.
  ▪ The plants were restored on the terrain in the same proportion as originally encountered
  ▪ The terrain was donated to municipality.
    • Before donation, it was agreed what the municipality is going to use the terrain for (multifunctional sport centre).
  ▪ Previous owner had a dumping place for debris which Argos also revegetated.
    • The company stabilized it.
    • The company planted plants on it.
    • The company built ducts from cement bags to remove water.
  ▪ All exterior infrastructure, including the office building constructed by the previous owner, was removed.
  ▪ The terrain is monitored
    • There is a problem of theft of the monitoring infrastructure by the local population.
• Lessons learned:
  • It is necessary to have a detailed plan for mine closure and an adequate budgetary reserve to implement it.
    o Argos underestimated the costs of closure.
    o As it is required in certain states of the USA, Argos now keeps a special earmarked reserve for expenses related to mine closing (a fund for mine closure).
      ▪ The company requires the same from mine operators that it cooperates with.
      ▪ Argos does not have any more underground mines but it has open pit mines

Conclusions

– There is a need for capacity building activities in Colombia, as well as for technology transfer to the country.
– There is a will to improve the situation, which provides the Group of Experts with an opportunity to get actively involved and to share its expertise.
– A two-day-long capacity workshop is to be delivered this summer.
– The workshop is to be directed to policy-makers / regulators, mine operators, project developers and miners.
– There is an interest to host an International Centre of Excellence on CMM in Colombia.
  o A potential ICE-CMM should be focused on training trainers and on best practice dissemination activities

Follow-up

– Follow up with UPME and the Bureau of the Group of Experts to decide the content and logistics of the upcoming workshop in Colombia (Done; event scheduled for 24-25 July 2018; agenda – see annex IX).
– Follow up with Durmmond Ltd. on private sector’s involvement in the workshop (Done).
– Follow up with ANM on potential establishment of ICE-CMM in Colombia (Done; work in progress).
Annex I

Presentation ANH

Historia de la ANH Colombia

En el 2000, se creó la ANH como respuesta a una situación crítica debido a la escasez de petróleo (Decreto 1769 de 2003). Hoy es el organismo regulador del sector hidrocarburífero en Colombia, con el objetivo de garantizar el equilibrio económico del país.

La ANH adquirió la tarea de administrar y regular el sector hidrocarburífero de la nación, y comenzó la transformación de Colombia en un país rentablemente atractivo para inversionistas nacionales y extranjeros.

En 2004 se produjo otro cambio fundamental, y fue la adopción del nuevo contrato de regulación, impuestos y derechos, conocido como la "Advances System". Este modelo comercial (2 etapas: explotación y explotación) da a la ANH un 90% de la renta y a los Estados un 10%.

Por otro lado, se introdujo el instrumento de evaluación técnica (ITF). ANH se compromete a realizar trabajos y obtener mejor información. Se da una ventaja de hasta 50% a los Estados nacionales y a la participación del Estado, entre el 50% y 60%.

Los recursos se asignan mediante procedimientos transparentes. Atención para compañías grandes, medianas y pequeñas.

En la actualidad, la ANH es altamente competitiva y eficiente en sus procesos de alta calidad.

Misión

La ANH es la autoridad encargada de promover el aprovechamiento óptimo y sostenible de los recursos hidrocarburíferos del país, administrándolos integralmente y armonizando los intereses de la sociedad, el Estado y las empresas del sector.

Visión

ANH será reconocida como una entidad modelo en el mundo por:

- El conocimiento del potencial del subsuelo colombiano y el logro de su aprovechamiento.
- La eficiencia y transparencia en la administración de hidrocarburos y el trabajo conjunto con la industria y la comunidad.
- El profesionalismo de nuestro equipo, el alto nivel tecnológico y la eficiencia y agilidad en procesos clave.
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Funciones
Son funciones de la Agencia Nacional de Hidrocarburos (ANH), las siguientes:

1. Identificar y evaluar el potencial de hidrocarburos del país.
2. Diseñar, evaluar y promover la inversión en las actividades de E&P, con las mejores prácticas internacionales.
3. Promover, negociar, celebrar y administrar los contratos y convenios de E&P de propiedad de la Nación, así como hacer el seguimiento al cumplimiento de todas las obligaciones previstas en los mismos.
4. Aplicar los lineamientos para exploración y explotación con relación a las modalidades y tipos de contratación que la Agencia Nacional de Hidrocarburos (ANH) adopte para tal fin.
5. Ayudar al Ministerio de Minería y Energía en la formulación de la política gubernamental en materia de hidrocarburos, en la elaboración de los planes sectoriales y en el cumplimiento de los objetivos propuestos.
6. Fomentar los estudios en las áreas de GSG y generar nuevo conocimiento en las zonas sedimentarias con el objetivo de optimizar el aprovechamiento del recurso hidrocarburífero y generar interés explotatorio e inversión.
7. Coordinar, en los contratos de E&P los sucesos y condiciones climáticas; los casos, las compañías administrando programas de beneficio de las comunidades ubicadas en las áreas de influencia.
8. Apoyar al Ministerio de Minería y Energía a las autoridades en los asuntos relacionados con las comunidades, el medio ambiente y la seguridad en las áreas de influencia de los proyectos hidrocarburíferos.
9. Fijar los precios de los hidrocarburos, para efectos de la liquidación de regalías.

Funciones
10. Administrar la participación del Estado, (espécie o en dinero), de los vol. de HC que le correspondan en los contratos de E&P y demás contratos suscritos por la ANH, incluyendo las regalías.
11. Recaudar, liquidar y transferir las regalías y compensaciones por la explotación de hidrocarburos.
12. Adelantar las acciones necesarias para el adecuado abastecimiento de la demanda nacional de hidrocarburos.
13. Estar los volúmenes de producción de petróleo de concesión que los productores deben vender para la refinación interna.
14. Establecer el precio al cual se debe vender el petróleo crudo de concesión destinado a la refinería interna, y el gas natural que se utilice como materia prima en petroquímica.

Funciones
15. Administrar y disponer de los bienes muebles e inmuebles que pasen al Estado por finalización de contratos y convenios de E&P, o por reversión de concesiones vigentes.
16. Hacer seguimiento al cumplimiento de las normas técnicas relacionadas con la E&P de hidrocarburos dirigidos al aprovechamiento de los recursos de manera racional e integral.
17. Fijar los precios de exportación de petróleo crudo para efectos fiscales y cambiarios.
18. Dirigir y coordinar las liquidaciones por concepto del canon superficiario en los contratos de concesión.
19. Verificar las especificaciones y destino del material importado en el sector de hidrocarburos para aplicar las fracciones previstas en el Código de Petróleos o normas que lo modifiquen.
20. Supervisar las especificaciones y destino del material importado en el sector de hidrocarburos para efectos de aplicar las fracciones previstas en el Código de Petróleos.
Funciones misionales y Objetivos estratégicos en Relación con CBM

La ANH podrá llevar a cabo la investigación, estudio y caracterizaciones de proyectos de minería de CBM, y finalmente aplicar el diagnóstico a contratos.

La ANH será el encargado del riesgo de Autonomía en el Gas Natural (Renovable e Inelástico).

Tiene el compromiso de estar al servicio del medio ambiente y las comunidades.

Proyectos Realizados en la Agencia Nacional de Hidrocarburos – ANH con el CBM

- «Caracterización Geológica y Geoquímica de las Doce Cuenca Carboníferas de Colombia con Base en información existente y con Adquisición de Nuevos Datos Geoquímicos de los Carbonatos Colombianos para el Diseño de las Áreas de Exploración de CBM en Colombia». Agenda Nacional de Hidrocarburos - ANH 2013.

Proyectos a Realizar a corto y mediano plazo por la Agencia Nacional de Hidrocarburos

En los próximos meses la Agencia Nacional de Hidrocarburos - ANH proyecta iniciar su participación en el proyecto de colaboración internacional con el Departamento de Estado de Estados Unidos, el cual utiliza la capacidad operativa de la compañía americana ARI.

La referida compañía ARI, es el enlace operativo que tiene Colombia con el Gobierno de Estados Unidos para ejecutar este importante convenio.

De parte de Colombia, participará el Ministerio de Minas y Energía como cabeza principal y sus entidades adscritas, como la UPME, SGC, ANM y la ANH.

Objetivo principal del convenio: Investigar, estructurar la prefeactibilidad, factibilidad y desarrollar un proyecto piloto en Colombia de CBM y CMM en un plazo de tres (3) años.
Principales impedimentos para la realización de proyectos CBM

- Poco interés de los posibles inversores debido a la complejidad minera que presenta el país. (En todos las zonas prospectivas se encuentra en desarrollo minería artesanal).
- Los inversionistas que se encuentran en el país están enfocados en sus respectivos negocios (Gas y Petróleo convencionales, carbón etc.).
- Alta complejidad social en zonas mineras.
- Algunas zonas presentan alta complejidad de orden público.
- Legislación enfocada a este tipo de desarrollo no está clara.

Gracias por su atención.

Hugo Hernán Butragueño
1. Funciones de la entidad y estructura del sector minero energético.

2. Relación de las funciones con el gas metano de los mantos de carbón CBM/CMM.

3. Proyectos desarrollados relacionados con CMM - PIGCC.

4. Principales impedimentos para la realización de dichos proyectos.
1. **Funciones de la entidad y estructura del sector minero energético.**

De acuerdo con lo determinado por el Decreto 0381 de 2012, y sobre el subsector "minas". Las siguientes son competencia del Ministerio de Minas y Energía:

1. Articular la formulación, adopción e implementación de la política pública del sector administrativo de minas y energía.

2. Formular, adoptar, dirigir y coordinar la política nacional en materia de exploración, explotación, transporte, refinación, procesamiento, beneficio, transformación y distribución de minerales, hidrocarburos y biocombustibles.

3. Formular, adoptar, dirigir y coordinar la política sobre las actividades relacionadas con el aprovechamiento integral de los recursos naturales no renovables y de la totalidad de las fuentes energéticas del país.

4. **Funciones de la entidad y estructura del sector minero energético.**

4. Formular políticas orientadas a que las actividades que desarrollen las empresas del sector minero-energético garanticen el desarrollo sostenible de los recursos naturales no renovables.

5. Expedir los reglamentos del sector para la exploración, explotación, transporte, refinación, distribución, procesamiento, beneficio, comercialización y exportación de recursos naturales no renovables y biocombustibles.

6. Fiscalizar la exploración y explotación de los yacimientos, directamente o por la entidad a quien delegue.

7. Divulgar las políticas, planes y programas del sector.
1. Funciones de la entidad y estructura del sector minero energético.

2. Relación de las funciones con el gas metano asociado a los mantos de carbón

- CONPES 3517 de Mayo 12 de 2008.
  - Estructura general GMAC
  - Reglamento técnico
  - Comisión técnica para resolver superposiciones.
- Resolución 180742 de Mayo 18 de 2012 (Parte de la Res. 181495 de 2009)
  - Aspectos técnicos explotación YNC e inclusión GMAC en la categoría YNC.
  - Reglamentación sobre superposiciones de áreas
- Decreto 1886 de 2015 “Por el cual se establece el Reglamento de Seguridad en las Labores Mineras Subterráneas”
Regulación

Decreto 1886 de 2015:

Artículo 59. Extracción del gas Metano. En aquellos casos que el titular minero compruebe que en el área concesionada donde adelantará su proyecto minero de carbón subterráneo se encuentren volúmenes con altas concentraciones de metano, y considere que es viable su drenaje antes y/o durante el desarrollo de las labores de extracción del mineral, para autogeneración, uso o eliminación del mismo, éstas labores deberán ser incluidas dentro del Plan de Trabajos y Obras (P.T.O.) o Programa de Trabajos e Inversiones (P.T.I.) o modificaciones a estos, presentado ante la autoridad minera para su evaluación y aprobación, ajustándose a las mejores prácticas internacionalmente aceptadas. El gas extraído podrá ser utilizado en el proyecto minero o en caso de no ser utilizado el mismo, deberá ser quemado acorde con las estipulaciones técnicas que para este fin establezca la Autoridad Minera y ambiental.

Parágrafo. El seguimiento a la extracción y posterior uso del gas metano proveniente de la operación minera estará a cargo de la autoridad minera.

3. CMM y emisiones

Estudios sobre potenciales de mitigación:

<table>
<thead>
<tr>
<th>Cepillado cristalino</th>
<th>Otros laboratorios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mínimos USD 1015</td>
<td>1/4</td>
</tr>
<tr>
<td>0,24</td>
<td></td>
</tr>
<tr>
<td>Ante un corte parcial</td>
<td>Facultad registraba</td>
</tr>
<tr>
<td>Mínimos USD 2015</td>
<td>3/5</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

ANÁLISIS GLOBAL DE MEDICIÓN Y SU POTENCIA DENTRO DE LA LÍNEA ESTRATÉGICA

- Posición en ranking de la Fase estratégica: 1 de 5 medidas
- Participación en monto: 12.02%
3. Proyectos a realizar CMM - PIGCC.

4. Principales impedimentos para la realización de dichos proyectos.

Si el CMM - AMM fue considerado como una actividad que podía reducir emisiones ¿por qué no está considerada dentro del PIGCC?

1) Elementos técnicos

   1) En términos de CMM, y en la medida que el PIGCC tiene un horizonte de 12 años (20% de reducción de emisiones para 2030), se requiere certificar una tonelada de CO2 reducida para ese año y en la medida que los periodos de desgasificación son de 8 años en promedio, y no se ha iniciado ninguna perforación para CMM, en el mejor de los casos la primera tonelada de carbón “desgasificado” estaría el 2030-2031.

   2) En cuanto a VAM, los estudios desarrollados hasta el momento no han sido concluyentes y sólo han llevado a un mejor conocimiento de los factores de emisión. Asumiendo el inicio de proyectos piloto, para 2018, hay mucho camino por recorrer antes de que las emisiones reducidas tengan un impacto en el sector.

2) Elementos regulatorios:

   1) Falta regulación de la ANM respecto a las condiciones de explotación del CMM – VAM)

   2) Prevalencia la falta de acuerdo sobre las superposiciones entre minas y HC. Esto impide hacer un efectivo uso de los derechos.

3) Elementos políticos:

   1) No hay una línea clara por parte del sector privado sobre su interés en el desarrollo de este tipo de proyectos.

   2) No hay “masa crítica” para el desarrollo informado de regulación.
Presentación Institucional

Unidad de Planeación Minero Energética - UPME

Marzo 2018

¿QUIÉNES SOMOS?

La Unidad de Planeación Minero Energética UPME es una Unidad Administrativa Especial del orden Nacional, de carácter técnico, adscrita al Ministerio de Minas y Energía, regida por la Ley 143 de 1994 y por el Decreto número 1258 de Junio 17 de 2013.
NUESTRA ENTIDAD

MISIÓN
Planear de manera integral el desarrollo minero energético, apoyar la formulación de política pública y coordinar la información sectorial con los agentes y partes interesadas.

VISIÓN
"Consolidamos como un referente internacional de innovación para la planificación integral del desarrollo y aprovechamiento de los recursos minero energéticos, a través de estudios, análisis y proyecciones, brindando información de alto valor agregado para la formulación de políticas públicas y la toma de decisiones de sus grupos de interés, con criterios de sostenibilidad económica, social y ambiental."

ESTRUCTURA ORGANIZACIONAL
DECRETO 1238 Y 1259 DE 2013

CONSEJO DIRECTIVO

DIRECCIÓN GENERAL

SECRETARÍA GENERAL
Grupo de Gestión de Sistemas Integrados
Grupo de Reconocimiento
Grupo de Asesoría y Coordinación
Grupo de Servicio Administrativo
Grupo de Gestión de la Calidad

OFICINA DE GESTIÓN DE INFORMACIÓN - CIS

OFICINA DE GESTIÓN DE FONDOS

SUCEDIENCIA DE MINERA

SUCEDIENCIA DE ENERGÍA ELECTRICA

SUCEDIENCIA DE HIDROCARBUROS

SUCEDIENCIA DE HAYEDAS
ESTRUCTURA ORGANIZACIONAL
DECRETO 1258 Y 1259 DE 2013

SUBDIRECCIÓN DE MINERÍA

1. Asegura el MMPI en la ejecución de las políticas pública y ambiental en la competencia del sector, con el objetivo de establecer, regular y reorientar las leyes y reglamentos que se implementan.
2. Participa en el manejo de sus temas, proponiendo proyectos, programas y métodos almacena y sustentables para el desarrollo del sector.
3. Identifica y realiza estudios sobre el sector de hidrocarburos y sus potencialidades para el desarrollo del sector.

SUBDIRECCIÓN DE HIDROCARBUROS

1. Realizar estudios y análisis tendencias para determinar el potencial para la expansión de la industria de hidrocarburos.
2. Promover estudios conjuntos con las diferentes agencias del sector para la formulación de planes de desarrollo.
3. Identificar y analizar precios y costos de producción, de PCCH y su incidencia en la competitividad del sector para su integración en la matriz energética del país.
4. Realizar estudios conjuntos con la evaluación de formas relacionadas con la incidencia del sector hidrocarburos en el cambio climático.

¿QUÉ SE HA HECHO?

1. EVALUACIÓN DE LAS ESTRATEGIAS PARA EL APROVECHAMIENTO DE GAS METANO ASOCIADO A LOS MANTOS DE CARBÓN EN EXPLOTACIONES BAJA TIERRA

RESULTADOS

1. Línea base de CBM para el país
2. Avances internacionales sobre aprovechamiento de gas metano
3. Nueva metodología para cálculo de emisiones de gas metano - IPCC nivel II
4. Identificación de 4 áreas potenciales para proyecto piloto
¿QUÉ SE HA HECHO?

AREAS POTENCIALES PARA PROYECTO PILOTO

CONCLUSIONES

1. GUACHETA – Uniminas/Promincarg
2. CUCURIBA-SUTATAUSA – Minminer
3. SOCHA-SOCOTA – Colombiana de minerales Ltda.
4. CHINAVITA-UMBITA– Intercontinental de Carbones

¿QUÉ SE HA HECHO?

JUSTIFICACION

1. Área estructuralmente ubicada en el sínclinal Chiqui-Chuquiragua, donde aflora hasta 16 metros de carbón.
2. Espesores entre 0,4 y 1,2 metros, buceamiento entre los 45 y 65 grados, calados que alcanzan el rango bituminosos – coquizables
3. Estructuras geológicas amplias con baja complejidad tectónica especialmente en el flanco occidental
4. Primer Estudio Regional – ANH/EAFIT
¿QUÉ SE HA HECHO?

JUSTIFICACION

1. El área del Contrato de Concesión No 2503, tiene una extensión de 807 hectáreas, actualmente se extraen 26,000 toneladas de carbón mensuales con 750 personas vinculadas.

2. El área del Contrato de Concesión No 8677, tiene una extensión de 293 hectáreas, se extraen 15,000 toneladas de carbón mensuales con 420 personas vinculadas a la operación.

¿QUÉ SE HA HECHO?

JUSTIFICACION

1. Las mayores cantidades de gas metano se encuentran en la parte norte del área del contrato de Concesión No 2503 y hacia las parte sur y centro del área del Contrato de Concesión No 8677.

2. Las mediciones muestran que las minas más próximas de la Concesión 8677 en el año 2015 emitieron 373 toneladas de gas metano, es decir aproximadamente 7.830 tonCO₂e.
¿QUÉ SE HA HECHO?

2. CONSTRUIR UN MODELO PARA COLOMBIA DE APROVECHAMIENTO U OXIDACIÓN DE GAS METANO DE LOS DUCTOS DE VENTILACIÓN (VAM) DE LAS MINAS SUBTERRÁNEAS DE CARBÓN.

CONCLUSIONES

1. En las minas piloto no es viable implementar un proyecto de aprovechamiento VAM no se cumplen las condiciones:
   - volumen de aire de los ductos de ventilación de 500,000 m³/h
   - porcentaje de metano mínimo de 0.7%.

2. Se propone un proyecto de oxidación del metano producido en las minas piloto.

3. Lo más recomendable para posibilitar la implementación de proyectos VAM en Colombia, es hacer un proceso de reingeniería de los sistemas de ventilación.

4. Los costos de inversión son similares para los dos proyectos ya que los equipos deben tener las mismas características técnicas, igual sucede con los costos de mantenimiento, de transporte y de nacionalización. Esto podría ser aplicado otras minas colombianas similares.

¿QUÉ SE HA HECHO?

OTRAS CONCLUSIONES

3. Los VPNs resultantes para todos los casos son negativos, esto debido a que no hay fuentes de ingresos para un proyecto de destrucción de VAM en Colombia.

6. El valor mínimo que debería tener un bien de carbono por abatir una tonelada de CO₂ equivalente para minas con una producción de metano cercana a 1.8 mil toneladas de CO₂ por año es de USD$ 6.76.

   Para el caso de Colombia se sugiere que el bien de carbono sea igual o similar al de California, es decir USD$614.75.

7. El costo de abatir una tonelada de CO₂ equivalente mediante tecnología VAM y bajo los costos actuales de la tecnología, para una mina que produzcan cerca de 1.8 mil toneladas de CO₂ por año es variable hasta que se logra el punto de equilibrio, iniciando en USD$ 10.31 en el primer año, estabilizándose después de lograr el punto de equilibrio al año 13 y USD$4.36.
¿QUÉ SE PIENSA REALIZAR?

AÑO 2017
1. Calcular factores de emisión para cuencas, que no lo poseen y actualizar la emisión de gas metano por la extracción de carbón.
2. Convenir con la empresa para realizar pozos de prueba para definir la viabilidad de realizar CBM/CMM en Colombia.

AÑOS 2018 Y 2019
1. Determinar la viabilidad de realizar un proyecto de aprovechamiento de gas metano CBM/CMM en el país.

2. Construir un modelo para Colombia de aprovechamiento de oxidación de gas metano de los ductos de ventilación (VAM) de las minas subterráneas de carbón.

GRACIAS

www.upme.gov.co

@upmeofficial  Upme (Oficial)
Annex IV

Presentation UPME – VAM

CONTRACT C 011 – 2017

Build a Model for Colombia for the Utilization or Oxidation of Methane Gas from the Ventilation Ducts (VAM) of Underground Coal Mines.
LAW 1753 OF 2015 — National Development Plan 2014-2018

Art 170 Formulation of a green growth policy (Low Carbon Development) in the long term:
BY MINISTRIES.

They will formulate and implement sectoral climate change adaptations plans.

Sectoral mitigation action plans of the Colombian Low Carbon Mitigation Strategy, which will have quantitative sectoral targets for reducing greenhouse gas emissions in the short (year 2020) and medium term (2025 or 2030).


When volumes with high methane concentrations are found in the mining project area and it is considered feasible to drain them before and/or during the development of the extraction of the mineral. For self-generation, use or elimination of the same, these tasks must be included in the Work Plan (P.T.O.) or Work and Investment Program (P.T.I.) or modifications to them.

Resolution 90325 of 2014

The Ministry of Mines and Energy adopts the criteria for mitigation plans in the Energy, Mining and Hydrocarbon sector. For the mining sector one of the two lines of the proposed emission reduction policy is the promotion of the use of methane gas from mining operations, managed for safety reasons, for self-generation purposes.
PROJECT STRUCTURE

- Methodology and aschedule activities

- Diagnosis of oxidation exploitation Project in different countries.
- Mining diagnosis of the pilot area.
- Strategies that facilitate the start-up of a Project to use or burn CH4.

- Two proposals to use methane gas from the ventilation ducts in Self-generation or oxidation adapted to the technical conditions of the selected mines.
- Proposal regulation of greyout mines and methane gas recovery from VAM ventilation ducts.
- Integral Document.
- Utilization guide for Self-generation or oxidation.
DIAGNOSIS OF METHANE GAS EXPLOITATION PROJECTS IN DIFFERENT COUNTRIES

SUCCESSFUL PROJECTS
INTERNACIONAL

United States

China

Australia
## COSTS OF VAM PROJECTS ACCORDING TO SOME COMPANIES IN THE WORLD

<table>
<thead>
<tr>
<th>License</th>
<th>Install Capacity</th>
<th>Investment by Unit (Million USD)</th>
<th>Proportion: Annual Operating Cost/Total Investment</th>
<th>Investment by Unit (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yima (Group) Co., Ltd.</td>
<td>13MW</td>
<td>7.96</td>
<td>9.18%</td>
<td>$1,194,000</td>
</tr>
<tr>
<td></td>
<td>1 VAM oxidizer</td>
<td>15.106</td>
<td></td>
<td>$2,250,000</td>
</tr>
<tr>
<td>Pingdingshan Coal (Group) Co., Ltd.</td>
<td>29MW</td>
<td>5.71</td>
<td>20.07%</td>
<td>$856,500</td>
</tr>
<tr>
<td>Province Henan, China</td>
<td>4 VAM oxidizers</td>
<td>15.106</td>
<td></td>
<td>$2,250,000</td>
</tr>
<tr>
<td>Zhengzhou (Group) Co., Ltd.</td>
<td>8MW</td>
<td>8.91</td>
<td>9.59%</td>
<td>$1,336,500</td>
</tr>
<tr>
<td></td>
<td>7 VAM oxidizers</td>
<td>14</td>
<td></td>
<td>$2,100,000</td>
</tr>
<tr>
<td>Jeda Coal Mine CMM and VAM Utilization Project</td>
<td>3MW</td>
<td>7.66</td>
<td>10.82%</td>
<td>$1,149,000</td>
</tr>
<tr>
<td></td>
<td>3 VAM oxidizers</td>
<td>8.79</td>
<td></td>
<td>$1,050,000</td>
</tr>
</tbody>
</table>
In 2014, 46 new laws and policies were enacted by 34 of the 99 countries. 17 developed countries and 17 developing countries approved laws and policies related to climate in 2014. 21 were legislative (approved by the parliaments) and 25 were executive (promulgated by the governments).

LAW 1715 OF MAY 13, 2014: CHAPTER III INCENTIVES TO THE INVESTMENT IN PROJECTS OF NON-CONVENTIONAL SOURCES OF ENERGY.

Article 11: Income Tax. Right to reduce annually from your income 50% of the total value of the investment made, for the 5 years following the taxable year in which you have made the investment.

Article 12: Tax incentive VAT (IVA) imported equipment, elements, machinery destined for pre-investment and investment, for the production and use of energy from non-conventional sources, will be excluded from VAT (IVA).

Article 13: Tariff incentive. Exemption from the payment of import tariffs on imports of machinery, equipment, materials and supplies destined exclusively for pre-investment and investment projects.

Article 14: Accounting incentive. Accelerated depreciation of assets. Accelerated depreciation will be applicable to the machinery, equipment, and civil works necessary for the pre-investment, investment and operation of the generation with FRES, which are acquired and/or constructed, exclusively for this purpose, the annual depreciation rate will be no more than twenty percent (20%) as the annual global rate. The rate may be varied annually by the Project owner, prior communication to the DIAN.
CLIMATE CHANGE NATIONAL POLICY

The objective of the National Climate Change Policy is to incorporate climate change management into public and private decisions to advance a climate-resilient and low-carbon development path that reduces the risks of climate change and takes advantage of the opportunities that climate change generates. The aspiration for the long term, and to which this general objective contributes, is to make the country carbon neutral.

Figura 3. Componentes de la Política Nacional de Cambio Climático

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CH4-COAL

It is part of the instruments that will guide the necessary actions to manage the adaptation to the climate change of the territories and the mitigation of emissions of greenhouse gases according to the PDN.

PROJECT OF THE LAW NUMBER 73 OF 2017 SENATE, whereby guidelines for the management of climate change are established.

Through this Law, new institutional arrangements are also defined and different existing instruments are articulated that will allow to expand and strengthen the institutional design of the State, which will be responsible for the management of climate change, defining functions and creating instruments for this purpose.

This Law defines the recently established Climate Change Policy as the national reference and also locates national strategies within the instrument landscape.

It institutionalizes the Integrated Climate Change Management Plans, both territorial and sectoral, and makes them the guide to be followed by territorial entities, autonomous regional corporations and national level entities for the implementation of their actions.

It provides for the creation of economic and financial instruments for the management of climate change, (national program of tradable quotas, an emissions market will be generated).
TECHNICAL DIAGNOSIS OF THE MINES LOCATED IN THE PILOT AREAS.

The two (2) areas are contiguous, the Promincarg (Title 8677) to the north and the Uniminhas (Title 2595) to the south.
### DIAGNOSIS – MINES DESCRIPTION

The highest concentrations of methane gas occur in the adjoining areas (mines) of the two (2) titles, the northern area of the title that houses Unimin and the central area - south area of the title that houses Promincarg.

<table>
<thead>
<tr>
<th>ZONE</th>
<th>UNIMINAS S.A.S</th>
<th>PROMINCARG S.A.S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NORTH ZONE</strong></td>
<td><strong>Carbonera Cnum</strong></td>
<td><strong>Carbonera Cnum</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Mina Ing. 1</strong></td>
<td><strong>Mina al Norie</strong></td>
</tr>
<tr>
<td></td>
<td>Mina El Salvador</td>
<td>Mina El Salvador</td>
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<td></td>
<td>Mina El Salvador</td>
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</tr>
<tr>
<td></td>
<td>Mina El Salvador</td>
<td>Mina El Salvador</td>
</tr>
<tr>
<td><strong>CENTRAL ZONE</strong></td>
<td><strong>Mina La Chonta</strong></td>
<td><strong>Mina La Chonta</strong></td>
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<td></td>
<td><strong>Mina La Chonta</strong></td>
<td><strong>Mina La Chonta</strong></td>
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<td></td>
<td><strong>Mina La Chonta</strong></td>
<td><strong>Mina La Chonta</strong></td>
</tr>
<tr>
<td><strong>SOUTH ZONE</strong></td>
<td><strong>Mina La Chonta</strong></td>
<td><strong>Mina La Chonta</strong></td>
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<td></td>
<td><strong>Mina La Chonta</strong></td>
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<td></td>
<td><strong>Mina La Chonta</strong></td>
<td><strong>Mina La Chonta</strong></td>
</tr>
</tbody>
</table>

### TECHNICAL DESCRIPTION UNIMINAS S.A.S

#### PERIOD PRICE

<table>
<thead>
<tr>
<th>MINING WORK</th>
<th>TRANSPORTATION SYSTEM</th>
<th>SOBST</th>
<th>VENTILATION PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>647</td>
<td>5.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- As a general rule, the mining is divided into three areas: production, access, and loading / unloading areas. In the production area, the miners use explosives and drilling equipment to extract coal. The coal is then transported to the surface using conveyor belts and trucks.

- The ventilation system is crucial for ensuring a safe working environment. It involves the installation of fans and ventilation systems to remove dust and other hazardous materials from the mine. The ventilation system must be designed to ensure that the ventilation circuit is effective and that the concentrations of hazardous gases are kept within safe limits.
**Flows and Volume of Methane Uniminas S.A.S.**

<table>
<thead>
<tr>
<th>Mines Name</th>
<th>%CH4</th>
<th>Q(outflow) m³/hour</th>
<th>CH4 Production (m³/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YACIMIENTO SAN MIGUEL</td>
<td>0.57</td>
<td>18780</td>
<td>106.5</td>
</tr>
<tr>
<td>INVERSIONES SIATOA</td>
<td>0.6</td>
<td>9140.4</td>
<td>62.8</td>
</tr>
<tr>
<td>MINA LA CEI</td>
<td>0.4</td>
<td>16132.56</td>
<td>59.9</td>
</tr>
<tr>
<td>LA VIRGINI</td>
<td>0.7</td>
<td>1371.2</td>
<td>36.9</td>
</tr>
<tr>
<td>RINCÓNITO S.A.S.</td>
<td>0.2</td>
<td>14940</td>
<td>28.5</td>
</tr>
<tr>
<td>FUTURO DOS</td>
<td>0.4</td>
<td>5616</td>
<td>22.2</td>
</tr>
<tr>
<td>EL CURUBO</td>
<td>0.15</td>
<td>7642.8</td>
<td>22.1</td>
</tr>
<tr>
<td>RUBI EL CALLEJON</td>
<td>0.25</td>
<td>2912.4</td>
<td>10.1</td>
</tr>
<tr>
<td>TIERRA ALTA</td>
<td>0.2</td>
<td>4363.2</td>
<td>8.6</td>
</tr>
<tr>
<td>ESPERANZA 8</td>
<td>0.05</td>
<td>1076.4</td>
<td>5.3</td>
</tr>
<tr>
<td>LOS PINOS</td>
<td>0.05</td>
<td>7128</td>
<td>1.6</td>
</tr>
<tr>
<td>JABONERA 1</td>
<td>0.6</td>
<td>11188.8</td>
<td>0.6</td>
</tr>
<tr>
<td>JABONERA 2</td>
<td>0.0</td>
<td>6350.4</td>
<td>0</td>
</tr>
<tr>
<td>ESPERANZA 2</td>
<td>0</td>
<td>3733.2</td>
<td>0</td>
</tr>
</tbody>
</table>

**PROMINCARG S.A.S.**

**Technical Description**

<table>
<thead>
<tr>
<th>Product</th>
<th>Mining Work</th>
<th>Transportation System</th>
<th>SGST</th>
<th>Ventilation Plan</th>
</tr>
</thead>
</table>
| In 50-50% issues, all miners  
At a general level, the mines' level system works in isolated personnel trained in the area, such as development following, along the structures. They have all  
and access work, performed by the miners. The only exception is in the process of  
coal face extraction, where a drillhole is used to blast the coal face.  
Explosive method is used throughout, until the gas is extracted (CO, CH4,  
cutting and open mines methodology) method from these XCO, CO2, and H2S, it has  
of drums. They are transported by road, and the coal is then  
ventilation channel is cleared. |
**Flows and Volume of Methane Promincarg S.A.S.**

<table>
<thead>
<tr>
<th>MINE NAME</th>
<th>%CH₄</th>
<th>Q (outflow) m³/hour</th>
<th>CH₄ Production (m³/Hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINA EL VOLCÁN-EL MORTIÑO</td>
<td>0.7</td>
<td>13392</td>
<td>92.5</td>
</tr>
<tr>
<td>LA MANA</td>
<td>0.25</td>
<td>16020</td>
<td>49.7</td>
</tr>
<tr>
<td>PIEDRO Y BOLAS</td>
<td>0.3</td>
<td>4860</td>
<td>14.4</td>
</tr>
<tr>
<td>CANALES</td>
<td>0.35</td>
<td>3339</td>
<td>11.6</td>
</tr>
<tr>
<td>BOCATOMA</td>
<td>0</td>
<td>3240</td>
<td>0</td>
</tr>
</tbody>
</table>

**METHANE GAS EMISSION BASE LINE IN THE PILOT AREA**

The calculation of methane emissions is made according to the amount of coal produced and an emission factor that depends on the amount of CH₄ coming from the activity.

To determine the CH₄ emissions, the following equation is used:

\[
\text{Emissions CH}_4 = \text{Coal production} \times \text{EF}_\text{em} \times \text{FConv}
\]

Where:
- Emissions CH₄: emission of CH₄ (Gg)
- Coal production: Coal production (Ton)
- EFₘ: Emission factor for coal (m³CH₄ / t coal)
- FConv: conversion factor (0.67 Gg / 10⁶ m³).

Fuente: D. Cifuentes 2 del Informe de impacto ambiental para el FCPRM.
### METHANE GAS EMISSIONS BASE LINE IN THE EPilot AREA

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>MBIE</th>
<th>CH4 Production (m³/year)</th>
<th>Coal Production Ton per year</th>
<th>Emission Factor CH4 (%)</th>
<th>Conversion Factor (CH4 to CO₂)</th>
<th>Total Emission Gg/Meq H₂O</th>
<th>TON EMMITTED EMISSIONS GgCO₂eq /Mo</th>
<th>TON EMMITED EMISSIONS GgCO₂eq /Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>URUMÍNAS S.A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SACREDOMO</td>
<td>40</td>
<td>345,016</td>
<td>2,352</td>
<td>63,35</td>
<td>0,196</td>
<td>0,00000068</td>
<td>10,62</td>
<td>15,824</td>
</tr>
<tr>
<td>EL CARACOLO</td>
<td>617,976</td>
<td>2,069</td>
<td>172,22</td>
<td>0,00000067</td>
<td>0,37</td>
<td>7,17</td>
<td>7,599</td>
<td></td>
</tr>
<tr>
<td>CANTIGAS CYD</td>
<td>543,862</td>
<td>59,160</td>
<td>52,07</td>
<td>0,00000067</td>
<td>0,37</td>
<td>9,45</td>
<td>10,62</td>
<td></td>
</tr>
<tr>
<td>MINAS LA GORGA</td>
<td>477,418</td>
<td>11,520</td>
<td>77,15</td>
<td>0,00000067</td>
<td>0,37</td>
<td>7,17</td>
<td>7,599</td>
<td></td>
</tr>
<tr>
<td>BMR ENFOQUE 1 Y 2</td>
<td>685,590</td>
<td>22,14</td>
<td>89,70</td>
<td>0,00000067</td>
<td>0,37</td>
<td>9,45</td>
<td>10,62</td>
<td></td>
</tr>
<tr>
<td>LA VICTORIA</td>
<td>337,078</td>
<td>40,69</td>
<td>79,51</td>
<td>0,00000067</td>
<td>0,37</td>
<td>9,45</td>
<td>10,62</td>
<td></td>
</tr>
<tr>
<td>MINROCITO S.A.S.</td>
<td>258,163</td>
<td>30,10</td>
<td>91,03</td>
<td>0,00000067</td>
<td>0,37</td>
<td>9,45</td>
<td>10,62</td>
<td></td>
</tr>
<tr>
<td>FUTURO DOS</td>
<td>194,008</td>
<td>28,68</td>
<td>43,25</td>
<td>0,00000067</td>
<td>0,11</td>
<td>5,23</td>
<td>5,740</td>
<td></td>
</tr>
<tr>
<td>LOS HERAS</td>
<td>513,393</td>
<td>24,02</td>
<td>49,74</td>
<td>0,00000067</td>
<td>0,08</td>
<td>2,00</td>
<td>2,00</td>
<td></td>
</tr>
<tr>
<td>JUJUY ENFOQUE</td>
<td>237,086</td>
<td>35,10</td>
<td>11,12</td>
<td>0,00000067</td>
<td>0,05</td>
<td>1,48</td>
<td>1,48</td>
<td></td>
</tr>
<tr>
<td>TOTAL URAMINAS S.A.S.</td>
<td>919,988</td>
<td>91,988</td>
<td>42,83</td>
<td>0,00000067</td>
<td>2,04</td>
<td>35,075</td>
<td>69,364</td>
<td></td>
</tr>
<tr>
<td>PROMECARB S.A.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIPANIL</td>
<td>570,684</td>
<td>15,94</td>
<td>26,59</td>
<td>0,00000067</td>
<td>0,24</td>
<td>5,94</td>
<td>8,442</td>
<td></td>
</tr>
<tr>
<td>LA MAMÁ</td>
<td>423,263</td>
<td>14,10</td>
<td>25,30</td>
<td>0,00000067</td>
<td>0,28</td>
<td>7,09</td>
<td>7,09</td>
<td></td>
</tr>
<tr>
<td>CARAVELI</td>
<td>180,386</td>
<td>7,36</td>
<td>31,65</td>
<td>0,00000067</td>
<td>0,31</td>
<td>3,15</td>
<td>3,15</td>
<td></td>
</tr>
<tr>
<td>TOTAL PROMECARB S.A.S.</td>
<td>1,175,351,80</td>
<td>19,34</td>
<td>23,46</td>
<td>0,00000067</td>
<td>0,79</td>
<td>19,69</td>
<td>25,095</td>
<td></td>
</tr>
<tr>
<td>PROMECARB S.A.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAPASA</td>
<td>3,054,018,77</td>
<td>83,35</td>
<td>83,35</td>
<td>0,00000067</td>
<td>3,39</td>
<td>189,22</td>
<td>189,302</td>
<td></td>
</tr>
</tbody>
</table>

### PROPOSALS FOR USE OR OXIDATION OF METHANE GAS.
PROPOSAL 1: to integrate the San Miguel Mines (Uniminas) - Canales (Promincarg) and the inclined Darmante 7, as a methane production unit, for the following reasons:

- Because of its location and progress of the work, the mines can make adjustments or redesigns ventilation systems.
- The production of coal from the San Miguel mine is 1,216 tons/month and Canales is 103.8 tons/month, which would be 1,318.8 tons/month (Plan). At the San Miguel Mine, 32 people currently work, and at the Canales mine 12, there would be a total of 44 people who are improving the safety conditions by implementing a project of this type because they must have more control, strict methane and ventilation conditions and their equipment.

They have a permanent mine engineer in charge of the operation of the mine.

The VAM of the selected mines is as follows:

<table>
<thead>
<tr>
<th>Mine</th>
<th>Q (m³/year)</th>
<th>%CH₄</th>
<th>VOL (CH₄/Year) (m³/year)</th>
<th>Ton CO₂ Eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Miguel</td>
<td>214779742</td>
<td>0.57</td>
<td>15238256</td>
<td>109248</td>
</tr>
<tr>
<td>Canales</td>
<td>292295424</td>
<td>0.35</td>
<td>102446</td>
<td>71896.47</td>
</tr>
<tr>
<td>TOTAL CO₂ EQ</td>
<td></td>
<td></td>
<td></td>
<td>181110.57</td>
</tr>
</tbody>
</table>

PROPOSAL 2: El Volcán – Mortiño (Promincarg S.A.S)

- The El Volcán - El Mortiño mine is a mining production unit that despite having different operators are communicated, which facilitates the redesign of the ventilation systems.
- By implementing a project like this one, safety conditions for 15 people working underground would improve because it would have a stricter control of methane, ventilation conditions and equipment, this mine in the past has registered work accidents due to the presence of methane.

The VAM of the mines is as follows:

<table>
<thead>
<tr>
<th>Mine</th>
<th>Q (m³/year)</th>
<th>%CH₄</th>
<th>VOL (CH₄/Year) (m³/year)</th>
<th>Ton CO₂ Eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLCAN MORTINO</td>
<td>211791765.90</td>
<td>0.70</td>
<td>1699458.10</td>
<td>8840.07</td>
</tr>
</tbody>
</table>
STRATEGIES THAT FACILITATE THE COMMISSIONING OF THE PROJECT

INTERNAL STRATEGIES

Mining Design and Organizational Capacity

Adapt the ventilation systems of the pilot mines according to the technologies to be implemented, so that the ventilation ducts conduct the air without losses to the oxidation equipment.

For the pilot proposal of San Miguel-Canales-Diamante 7 it is proposed as a strategy to establish, as much as possible, commitments between the two companies in order to establish and execute the proposed design, unity economic, technical, technological, administrative and financing criteria to carry out the project.

It is necessary to establish new business perspectives, towards new goals and objectives (clean low carbon production) that will ensure the operational continuity of the company along with the implementation of these projects.
INTERNAL STRATEGIES

Mining Design and Organizational Capacity

- Highlight the positive aspects and benefits of clean low carbon production, including the reduction of risks due to the presence of methane gas.
- Implement technological changes especially in the ventilation system in underground coal mines in such a way as to allow the implementation of this type of projects.
- Training of professional, technical and operational personnel in projects for the use or oxidation of methane gas.

Promote good international practices related to CER within underground coal mining.

Promote the use or oxidation of methane gas as a new business alternative (based on the proposal to create a national carbon market).
EXTERNAL STRATEGIES

Technical, Economic, Financial and Legal Capacity

- Coordinate with State entities and institutions the execution of the implementation of these projects in a way that contributes to the social, economic and environmental development of the region.
- To adapt the Colombian legal apparatus for the implementation of this type of projects.

Manage international agreements that allow the exchange of experiences and knowledge about the implementation of VAM projects for the implementation of the best administrative, technical and technological practices for the improvement of these aspects in the pilot area and likewise Train personnel for the implementation of this project.

Manage the search of national and international financing and technical and technological assistance for the implementation of these projects taking advantage of the commitments that the richest countries have acquired in the reduction of GHG and the commitments acquired at environmental level by Colombia.

EXTERNAL STRATEGIES

Environmental and Incentive Policies:

Define a clear and precise regulation for the promotion of this type of projects.

For the implementation of an experimental VAM project like the one proposed in this study and without the experience in the national environment, it is necessary to request the participation of professionals from those countries where these technologies have already been implemented.

For mining companies to "motivate" themselves to invest, the implementation of economic incentives is necessary. These are not simple to apply, since for these to be tangible and visible, instruments of application, they must incorporate, in addition to an economic benefit, a series of rights and obligations, also taking into account the need for a State policy that protect these projects.
TECHNOLOGIES APPLICABLE TO PROPOSED PROJECTS

SELF-GENERATION
- The minimum air volume of the ventilation ducts should be: 500,000 m³/h.
- The methane concentration should be 0.7%

OXIDATION
According to the characteristics of the VAM of the pilot mines, a methane oxidation project is proposed.

In the opinion and recommendation of the international experts, the Regenerative Thermal Oxidants - RTO - (for its acronym in English) are the most appropriate for this type of project.
All RTOs work in a similar way, using an auxiliary fuel (such as natural gas) to initially heat the ceramic chambers where methane oxidation will occur. Depending on the heat generated by the methane, the process can be continued without the addition of auxiliary fuel.

The RTOs are operated as independent units, in general they are installed near the ventilation, or evasion (bell output-capture air-VAM).

The evasion is an integral part of the ventilation system of the mine and should not be obstructed by any part of the RTO system. The evasion is an element that can become a high risk due to its proximity to the main surface fans and the high speed of the air that comes out of it to reach the RTO.

The main risk if the connection between the evasion and the RTO is direct, is that of causing an obstruction in the ventilation, just as the direct connection could also cause a pressure drop and reduce the extraction efficiency of the ventilation system.
**OPERATIONAL RISK**

- Methane gas is an explosive gas and represents a permanent hazard at the time of capture, storage and use.

- Overheating of the chambers is possible, if unexpected higher than normal concentrations of methane are emitted into the VAM destruction unit. However, technologies such as the one developed by ANGUIL allow through internal controls to stabilize the equipment when these unexpected increases occur.

---

**SECURITY MEASURES IN OPERATION**

A “risk zone” or zone of exclusion of (for) security must be established around the point of discharge and smoking prohibited, use of unsafe equipment, use of flameproof equipment, prohibition of open flame equipment and all personal equipment such as telephones, watches and others with similar characteristics and that use batteries that can generate some kind of spark.

Visits to the area where the RTO system is located should be prohibited, except for those that are related to prolonged shutdowns of fans or equipment maintenance or due to a serious underground emergency, that is, by a significant gas explosion.

The area where the system is located must be protected and a fence must be installed and an exclusion zone must be delimited with their respective “danger” warning notices for visitors around the area.

To avoid these unexpected increases in methane concentrations, it is necessary to perform periodic and rigorous measurements and monitoring of methane concentrations, especially in the final sections of the ventilation system (in the mine).
OTHER CONDITIONS

<table>
<thead>
<tr>
<th>INSTALLATION PLACE</th>
<th>WATER SUPPLY</th>
<th>ENERGY INFRASTRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The site should be as flat as possible on it a load platform should be built in level and stable concrete, with enough area to allow the VAM system, its equipment and the control room to be installed without the other activities interfering with the system.</td>
<td>For the operation of the 9000-gallon three-phase power supply, RTO system of oxidation is the common power system. The water requirement, but the specific needs are minimal. The requirements for a specific water use are needed only for power supply will be determined, which can be supplied by a tank car VAM destruction equipment.</td>
<td></td>
</tr>
</tbody>
</table>

PILOT PROJECT
### POSSIBLE VAM TECHNOLOGIES FOR COLOMBIAN CONDITIONS

<table>
<thead>
<tr>
<th>Company</th>
<th>Minimum requirement for ventilation airflow (m³/hr)</th>
<th>Minimum methane concentration requirement in Ventilation ducts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANMET</td>
<td>900</td>
<td>0.15</td>
</tr>
<tr>
<td>DÜRR</td>
<td>6,287</td>
<td>0.20</td>
</tr>
<tr>
<td>DÜRR</td>
<td>101,952</td>
<td>0.20</td>
</tr>
<tr>
<td>GULF COAST ENVIRONMENTAL SYSTEMS</td>
<td>8,496</td>
<td>0.23</td>
</tr>
<tr>
<td>SHENGII SHANDONG</td>
<td>60,000</td>
<td>0.25</td>
</tr>
<tr>
<td>BIOITÉRMICA</td>
<td>16,692</td>
<td>0.20</td>
</tr>
<tr>
<td>MEGTÍC</td>
<td>125,000</td>
<td>0.20</td>
</tr>
<tr>
<td>ENER-CORE</td>
<td>6,796</td>
<td>1.50</td>
</tr>
<tr>
<td>ANGLIL</td>
<td>5,000</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Of these technologies, compared with their technological peers, the ANGLIL has the capacity to process the lowest amounts of VAM (5000 m³ / h, with percentages of around 0.2% methane). This means that the production of VAM and the methane concentration of the selected mines meet the minimum operating conditions of ANGLIL.

### COMPARISON OF THE VENTILATION PARAMETERS OF THE COAL MINES WITH THE FUNCTIONING SPECIFICATIONS OF THE VAM TECHNOLOGY

[Diagram showing ventilation parameters comparison]

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DESCRIPTION OF THE PROPOSED EQUIPMENT

ANGUIL ENVIRONMENTAL SYSTEMS, INC., Based in Milwaukee, Wisconsin, USA, Delivered the main features of its RTO system that is listed below:

**Standard base system of the RTO model 50:**
- Design flow - 5,000 SCFM
- 98% destruction efficiency
- 20% thermal energy efficiency
- Oxidation temperature design of 1550°F
- Skid-mounted design
- Two-chamber carbon steel reactor
- High temperature ceramic fiber insulation
- Ceramic heat transfer media structured at high temperature
- Two (2) vertical pneumatic seat valves with compressed air accumulation tank
- Forced draft system fan
- System motor (TEFC, 460V / 3ph / 60Hz)
- Variable frequency unit
- Burner (natural gas or propane ignited) and fuel train (FM design)
- Exhaust stack
- Digital data recorder and data logger
- Remote communication via modem and Ethernet connectivity
- Execution and factory quality test before shipment
- Operation and maintenance manuals

**Additional features and capabilities:**
- Start-up and operator training services
- Improvement to a higher thermal energy efficiency
- Upgrade to a higher destruction efficiency rating
- Supplementary fuel injection (SFI)
- Hot or cold side bypass
- Isolated draft systems
- Halogenated systems with customized metallurgy
- Methane monitoring
- Dust capture hood
- Installation of the system (turnkey or only supervision)
- Preventive maintenance programs
- Recommended spare parts

ADEQUACY NECESSARY FOR THE SELECTED PROJECTS

The resistance of the mine increases due to a more extensive development, the heat and the gases of the mine increase, which makes it difficult to keep the mine ventilated. In these mines, the volumetric efficiency of the ventilation system is often low, and high pressure main fans with large volumetric flow capacity are needed to achieve adequate air flow.

In Colombian mines, even with good technical conditions, current ventilation systems could be overwhelmed by sudden gas flows from coal beds, fires or explosions, for this reason the pilot project should include a ventilation system more reliable to ensure safety and allow the VAM destruction unit to demonstrate its effectiveness.

**Proposal 1.** San Miguel-Canales-Diamante

**Proposal 2.** Volcán Mortiño
TECHNICAL ASPECTS TO TAKE INTO ACCOUNT

It is recommended to exercise the maintenance plan, making a strict control of the cavities to prevent the VAM from escaping there. Adequate lining of the tracks is recommended in order to generate less air resistance.

The exploited areas and abandoned roads must be hermetically sealed leaving pipe for measuring methane and draining if necessary.

The ventilation routes must be maintained under constant maintenance and free of obstacles that may generate resistance to the flow of air circulating in the mine.

carry a continuous methane monitoring system with several control stations with surface communication and a monitoring system for fans that measure at least pressure, temperature, vibrations with surface control. These controls are essential to identify shortcomings in the amount of air flow and correct them in time.

It is recommended that the electrical expert of the mine design an electrical system in such a way that in case of shorts or overloads it is ensured that the fans continue to function correctly.

ECONOMIC EVALUATION
The cash flow model for coal mine methane projects designed by the US-EPA was used, which uses data specific to the methane industry, and was also compared to a financial cash flow based on the quotes requested for the VAM projects of the pilot areas of the ANGUIL and GCES companies and data estimated by the consultant.

**GAS AVAILABILITY**

| What is the methane concentration in the ventilation air? | (%) |
| What is the ventilation airflow you suggest on an annual basis? | 1000 vol/yr |
| Entry Size Defined by the User? | Units |
| What is the operational life time planned for the project? | Year |
| What are the risks? | Unit |
| What is the interest rate applied to the loan? | (%) |
| What is the capital share of the Project promoter? | (Unit) |
| What is the site price of the carbon credit unit? | US $/ton CO2e |
| What is the discounted value of the VAM oxidation system? | US $/kW-h |
| What is the annual operation and maintenance cost of the VAM oxidation system? | US $/m³-year |
| What is the frequency with which the VAM oxidation system will be relocated? | Year |
| What is the asbestos cost of the VAM Oxidation System (including the preparation of the new site)? | US $/kW-year |
| What is the electrical charge of the load? | kW-h/1000 m³ |
| What is the cost of the electricity power used by the Project? | US $/kW-h |

**DEFAULT PARAMETERS**

| What is the inflation rate? | (%) |
| What is the actual discount rate? | (%) |
| What are the royalties and severance taxes? | (%) |
| What is the contingency factor? | (%) |
| How many years per year will the VAM Oxidation System be in operation? | Hours/year |
| What are the indirect costs of the Project? | US $/Flow CO2 |

The information of the ventilation flow and methane concentration collected for each of the three mines, Canales, San Miguel and El Volcán, as well as a hypothetical mine were used as inputs in the model.  

<table>
<thead>
<tr>
<th>Mine</th>
<th>Scenario</th>
<th>CH4 Conc. Total Flow (m³/yr)</th>
<th>CAPEX - Low Case (1,000 USD)</th>
<th>CAPEX - High Case (1,000 USD)</th>
<th>Net Present Value - Low Case (1,000 USD)</th>
<th>Net Present Value - High Case (1,000 USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Miguel</td>
<td>Base Case</td>
<td>0.57%</td>
<td>0.155</td>
<td>$267</td>
<td>$301</td>
<td>$334</td>
</tr>
<tr>
<td>San Miguel</td>
<td>GCES price</td>
<td>0.57%</td>
<td>0.163</td>
<td>$302</td>
<td>$349</td>
<td>$384</td>
</tr>
<tr>
<td>Canales</td>
<td>Base Case</td>
<td>0.17%</td>
<td>0.065</td>
<td>$43</td>
<td>$51</td>
<td>$57</td>
</tr>
<tr>
<td>El Volcán – El Martillo</td>
<td>Base Case with CARB price @544.7</td>
<td>0.69%</td>
<td>0.273</td>
<td>$316</td>
<td>$325</td>
<td>$328</td>
</tr>
<tr>
<td>N/A</td>
<td>Base Case</td>
<td>0.25%</td>
<td>0.094</td>
<td>$72</td>
<td>$84</td>
<td>$90</td>
</tr>
<tr>
<td>N/A</td>
<td>Base Case</td>
<td>0.50%</td>
<td>0.164</td>
<td>$73</td>
<td>$85</td>
<td>$90</td>
</tr>
<tr>
<td>N/A</td>
<td>Base Case</td>
<td>0.75%</td>
<td>0.268</td>
<td>$73</td>
<td>$84</td>
<td>$90</td>
</tr>
<tr>
<td>N/A</td>
<td>Base Case</td>
<td>1.00%</td>
<td>0.384</td>
<td>$72</td>
<td>$84</td>
<td>$90</td>
</tr>
</tbody>
</table>
The economic exercises carried out for a scenario in which there is no carbon market (or government incentive) that allows income to the project, show negative VPN results in all cases, as it will not have any income. The resulting NPVs for all scenarios are negative, this is because there are no sources of income for a VAM destruction project in Colombia.

The exercise was done for the Volcan - Mortiño mine, in a market that traded carbon equally or under similar conditions (for example), with the "California Air Resources Board" market, this exercise resulted in Net Present Values (VPN) positive. A value of carbon bonds between US $ 14 and 15 dollars would be ideal for VAM projects in Colombia, allowing a positive cash flow in year 3.

if the carbon price were set at 14.75 USD, which is the last auction price in the Cap and Trade market in California (CARB), an RTO project at the El Volcán - El Mortiño mine would result in a Net Present Value VPN of 490,000 USD and an internal TIR return rate of 48%.
Based on the value of the carbon credits, the exercise was done to find the value that the carbon credits must have to reach the break-even point. The Figure shows the price of carbon (expressed in USD per tonne of CO2e) for each of the scenarios evaluated for a ten-year profitability project (where the internal rate of return TIR would be equal to the discount rate, which in this analysis is 10%).

---

EVALUACIÓN ECONÓMICA Y FINANCIERA (DATOS COLOMBIA)

For each of the proposals, two scenarios are proposed based on the quotes delivered by the companies ANGUIL and Gulf Coast Environmental Services (GCES), including the information provided by the contractor.

For the development of the scenarios, it was taken into account that:

- The duration of the project was arbitrarily set for fifteen (15) years of operation.
- The cost of Capital includes: a minimum of ventilation ducts, fans of the ventilation ducts and the VAM oxidation system.
- Annual costs include, the operation and maintenance of the VAM oxidation system, electricity for the duct fans, and a periodic relocation of the VAM oxidation system.
- The fans work 24 hours a day, seven days a week for 8,000 hours a year, with minimal setbacks.
- If there are costs in the model associated with the purification of the ventilation air.
- If there are costs in the model associated with making the necessary modifications to the existing ventilation systems to accommodate the RTD systems.
- If are included import tariffs and taxes of nationalization and additional expense.
- If local operational expenses are included.
- Capital interest of 4% was taken.
- The amortization costs are 10% per year of the total loan.
- The destruction efficiency of the VAM oxidation systems for the purpose of carbon credits is 100%.
Breakeven Point Volcán-Mortillio Mine

Breakeven Point San Miguel-Canales-Diamante 7

Minimum Price Necessary Carbon Credit

Minimum Carbon bonus price needed to reach breakeven point in the Mortillio Volcano Mine implementing ANGUI technology, being the most economically viable.

Minimum carbon bonus price necessary to reach equilibrium point at the San Miguel - Canales - Diamante 7 Mine, implementing the ANGUI technology, being the most economically viable.
Costs of ton CO2e / Year Technology GCES

<table>
<thead>
<tr>
<th>Year</th>
<th>Proyecto 1: San Miguel-Canales-Diamante</th>
<th>Proyecto 2: Volcon-Merende</th>
<th>USD / ton CO2e/año</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22,946.07</td>
<td>38,855.11</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>22,701.6</td>
<td>28,303.2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>27,627.0</td>
<td>27,764.4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>52,310.8</td>
<td>27,278.6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>51,955.5</td>
<td>26,664.7</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>51,720.1</td>
<td>26,129.3</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>31,471.8</td>
<td>25,573.0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>51,284.1</td>
<td>25,037.2</td>
<td></td>
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<tr>
<td>9</td>
<td>50,940.4</td>
<td>24,488.3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>39,789.7</td>
<td>23,933.5</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>43,593.2</td>
<td>9,715.6</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>43,593.2</td>
<td>9,715.6</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>43,593.2</td>
<td>9,715.6</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>43,593.2</td>
<td>9,715.6</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>43,593.2</td>
<td>9,715.6</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSIONS
In the pilot mines, it is not feasible to implement a power generation project because the VAM production does not meet the required minimum requirements:

- Air volume of the ventilation ducts is at least 500,000 Nm3 / h
- Minimum methane percentage of 0.7%

Consequently, a methane oxidation project produced in the pilot mines is proposed since they are insufficient to implement a power generation project.

The most advisable to enable the implementation of VAM projects in Colombia, is to do a reengineering process of the ventilation systems that allows an uninterrupted flow and where a continuous methane gas monitoring system and a continuous monitoring system of the fans with connection to surface.

Because the two proposed projects have similarities in their mining characteristics and although they present differences in the production of VAM, the investment costs are similar for the two projects since the equipment must have the same technical characteristics, the same happens with the costs of maintenance, transport and nationalization. This could be applied to other similar Colombian mines.

The economic exercises carried out for a scenario in which there is no carbon market (or government incentive) that allows income to the project, show negative NPV results in all cases, due to the fact that there are no sources of income for a project destruction of VAM in Colombia.

According to the economic simulation exercises to implement the VAM technology in Colombia, the minimum value that a carbon bonus should have for reducing one tonne of CO2 equivalent for mines with methane production close to 18 thousand tons of CO2 per year is USD $ 8.70.

However, taking into account that mines with methane production close to 18 thousand tons of CO2 per year are scarce in Colombia. It is strongly suggested that the carbon bonus for reducing one ton of CO2 equivalent is equal to or similar to that of California, ie USD $ 14.75.

The cost of reducing a tonne of CO2 equivalent through VAM technology and under current technology costs, for a mine that produces close to 18,000 tons of CO2 per year is variable until the breakeven point is reached, starting in USD $ 10.31 in the first year, stabilizing after achieving the equilibrium point at year 11 to USD $ 4.36.
RECOMENDATIONS

In order to evaluate the technical and economic feasibility to implement a VAM project, it must have a mine that complies with all the technical and safety features required by Colombian legal regulations, and must have certain minimum conditions that guarantee the stability of the methane content and air flow.

One of the main risks is that the ventilation is obstructed, which will cause a variability in the flow and concentration of VAM which can significantly impact the efficiency of the oxidation systems; In addition, these systems can not start quickly or have unscheduled stops, which means, the mining operator must keep in mind that the equipment must operate almost 24 hours a day.

The collection and recording of methane data must be systematic, underground coal mines must improve these aspects and the mining authority must be strict in these inspections. This is important for mining safety and for making decisions about future projects for the use or disposal of methane gas.
The ventilation systems must have the best technical conditions, they must have a maintenance plan, speed measurement, fault identification (mechanical, electrical and general operation) and with intrinsically safe switches. Ventilation must be systematized to know its status in real time. In the same way, the plan must have specified what to do in case any element of the system fails.

If the country wants to advance in the implementation of the use or elimination of the methane gas inherent in coal, it is necessary to define a regulation and an incentive system that allows reducing the costs of this implementation and generates not only environmental benefits, but also, an economic returns that make this sector have a development (growth) low in carbon.

It is recommended that the Colombian government create agreements with international financial institutions to provide Colombian mining companies with access to financing options for oxidation or methane development projects.

THANK YOU
TEMAS

1. ANTECEDENTES

2. AVANCES ALCANZADOS

3. METODOLOGIA DE TRABAJO

4. PROYECCIONES
1. ANTECEDENTES

- **LEGAL**: En el documento Conpes 3517 de Mayo 12/2008, cuyo objetivo es fijar "lineamientos de política para la asignación de los derechos de exploración y explotación de gas metano en depósitos de carbón y el desarrollo de las normas técnicas para su explotación", se recomienda que el Ministerio de Minas y Energía apoyado por la ANH e INGEominas (Hoy SGC) expida normas técnicas para la explotación y producción de este recurso y coordine el manejo y suministro de la información técnica.

- **SEGURIDAD MINERA**: Accidentes registrados en minas de carbón ocasionados por explosión de gas metano, especialmente en los departamentos de Boyacá, Cundinamarca, Norte de Santander y Antioquia.

- **MEDIO AMBIENTE**: El gas metano se considera un gas de efecto invernadero, 21 veces más potente que el CO₂ y a la vez un gas que influye en el calentamiento global del planeta.

- **CONOCIMIENTO GEOCIENTÍFICO**: El SGC, desde el año 2010, adelanta estudios de exploración de CBM, para obtener información sobre el origen, acumulación y potencialidad de este recurso, como otra fuente de energía para el país, caracterizándose mantos de carbón en cuanto a su contenido de CBM.
Consideraciones

- El carbón, es considerado como roca generadora y reservorio del gas metano.

- Las grandes reservas de carbón con que cuenta Colombia, indican que puede existir un buen potencial de CBM.

- Aportar información que pueda brindar conocimiento para proyectar usos del gas metano presente en mantos de carbón y reducir las emisiones de gases de efecto invernadero

- Contribuir con información para planear proyectos mineros que minimicen accidentes ocasionados por concentración de metano en las minas de carbón.

2. AVANCES ALCANZADOS
Áreas evaluadas para CBM

- 2011 Checua – Lenguazaque (Cundinamarca)
- 2012 Checua – Lenguazaque (Boyacá)
- 2013 Tasco – Socotá (Boyacá)
- 2014 Umbita – Rondón (Boyacá)
- 2015 Carmen de Chucurí (Santander)
- 2016 Landázuri – Vélez (Santander)
- 2017 Guaduas Caparrapí (Cundinamarca)
Exploración

Localización áreas de estudio GMAC

Localización áreas de estudio en Exploración de Gas Metano Asociado al carbón por parte del Servicio Geológico Colombiano.
1. Diagnóstico de información geológica de carbones

Revisión de estudios geológicos de exploración de carbones en los sectores de interés.

- Cartografía geológica
- Estratigrafía
- Mantos de carbón
- Calidades
2. Socialización del proyecto

- Autoridades civiles
- Autoridades militares
- Comunidades

2. Geología de superficie y Minería

- Revisión cartográfica en campo. (continuidad en los mantos, ángulos de inclinación de las capas).
- Actualización de inventario minero. (mediciones de CH4 [%] en frente de mina). Avance de explotaciones mineras
- Evaluación de las características topográficas del sector (vías de acceso, fuentes hídricas presentes, etc).
- Determinación de puntos de perforaciones
3. Geología del subsuelo

- Realización de perforaciones con recuperación de núcleos
- Muestreo para mediciones y análisis fisicoquímicos

Pozo Carmen de Chucurí-1, Santander

Pozo Landazuri-1, Santander

Registros de pozo
- Gamma Ray
- Resistividad
- Densidad
- Temperatura

4. Caracterización y Cálculo del Potencial

Muestreo y mediciones de contenidos de CBM

a. Preparación de canister
b. Muestreo
c. Sellado, cierre hermético
d. Medición gas perdido y desorbido en campo
e. Mediciones de gas desorbido y residual en laboratorio
Muestreo y mediciones de contenidos de CBM

5. Preservación y almacenamiento de núcleos

Recuperación de núcleos para muestreo

Empacado y protección de núcleos

Almacenamiento de cajas para traslado

El destino final de los núcleos es la vitrina del SGC.

Muestreo y mediciones de contenidos de CBM

6. Procesamiento de información - software Terramazon

Introducción de datos básicos sobre el pozo y las muestras

Diligenciamento de datos de medición para cada muestra, Gas perdido y desorbido.

Obtención de gráficas de desorción y valor de gas perdido más desorbido.
Caracterización fisicoquímica de carbones

- Análisis próximo (humedad residual, materia volátil, cenizas y carbono fijo).
- Análisis elemental (carbono, hidrógeno, nitrógeno y azufre total).
- Químico de cenizas (diez elementos mayores).
- Elementos menores.
- Poder calorífico.
- Mercurio
- Índice de Hinchamiento
- Plastometría
- Petrografía
- Cromatografía

- Termocronología - huellas de fisión e isotopos estables (grupo de investigación y aplicaciones nucleares y geocronológicas)

Cálculo de Recursos de CBM

Determination de áreas de cálculo

Mapa de Contornos Estructurales. Sector GMAC Carmen de Chucuri. 2015
Resultados Principales

- Realización de 15 perforaciones exploratorias en Cundinamarca, Boyacá y Santander, con profundidades entre 300 a 600 m. En total se han perforado 7235 m con recuperación de núcleos.
- Caracterización de carbones y evaluación de potencial de CBM.
- Obtención de muestras de carbón con contenidos de gas metano de hasta 350 plesg/ton. Los mayores valores de CBM se registraron hacia el área de Tasco – Socotá y Umbita – Rondón, en carbones tipo Subbituminosos a Bituminosos con alto volátil A, B, C.

<table>
<thead>
<tr>
<th>AÑO</th>
<th>AREA</th>
<th>POZOS</th>
<th>Metros</th>
<th>POTENCIAL [Btu]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Chirca – Linguatique</td>
<td>Sutatausa 1</td>
<td>400</td>
<td>8.48</td>
</tr>
<tr>
<td></td>
<td>(Taus – Cucumbe)</td>
<td>Cucumbe 3</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Chirca Linguatique</td>
<td>Ráquira 1</td>
<td>400</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td>(Gachetá – Samacá)</td>
<td>Samacá 2</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Tasco – Socotá</td>
<td>Socotá 1</td>
<td>425</td>
<td>8.15</td>
</tr>
<tr>
<td></td>
<td>Socotá 2</td>
<td>510</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Umbita – Rondón</td>
<td>Umbita 1</td>
<td>520</td>
<td>122.7</td>
</tr>
<tr>
<td></td>
<td>Chinavita 1</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>El Carmen de Chucurí</td>
<td>Carmen de Chucurí 1</td>
<td>600</td>
<td>17.3</td>
</tr>
<tr>
<td></td>
<td>Carmen de Chucurí 2</td>
<td>600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>Landázuri – Vélez</td>
<td>Landázuri 1</td>
<td>600</td>
<td>305.2</td>
</tr>
<tr>
<td></td>
<td>Landázuri 2</td>
<td>600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>Guadual – Caparral</td>
<td>Caparral 1</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caparral 2</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guadual 1</td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Resultados obtenidos

A partir del análisis realizado a los diferentes estudios de GMAC, adelantados por el SGC, en relación a las variables que controlan la generación de gas metano en los mantos de carbón en zonas con buenas perspectivas, se considera hasta el momento, que:

- Rango del carbón
- Tipo de carbón. Análisis Maceral.
- Contenido de materia mineral. Determinación de cenizas y azufre.
- Espesor de la cobertura e historia del enterramiento.

Cortes geológicos. Sector Landázuri – Vélez, 2015
Productos

- Metodologías y estándares (compartidos con ANH y UPME)
- Informes técnicos y cálculos de recursos de CBM
- Mapas geológicos
- Mapas de contornos estructurales
- Columnas estratigráficas
- Informes de perforaciones
- Registros eléctricos y de temperatura
- Entrega de núcleos de perforación a Litoteca SGC

INFORMACIÓN:

- Almacenada en base de información EXPLORA de la DRM
- Disponible para consulta en línea WWW.SGC.GOV.CO

3. PROYECCIONES

Áreas proyectadas para estudio de CBM.
COMPETENCIAS QUE NO LE PERTENECEN A LA ANM

- No tiene competencia sobre minería ilegal
- No cumple funciones de carácter policial (Cierre de minas)
- No tiene injerencia en la enajenación de predios o uso de los mismos

LA GERENCIA DE SEGUIMIENTO Y CONTROL

Vicepresidencia de Seguimiento, Control y Seguridad Minera

GERENCIA DE SEGUIMIENTO Y CONTROL

GERENCIA SEGURIDAD Y VALORAMIENTO MINERO

GERENCIA REGULATIONS Y COMPROMETIDORES ECONÓMICOS

1. Bogotá - Sede central
   Calle 24 No. 50-12 Torre 4 Pisos 8, 9 y 10

2. Punto de Atención Regional Medellín
   Calle 74 No. 70-20

3. Punto de Atención Regional Cali
   Calle 46 No. 16-50

4. Punto de Atención Regional Itagüí
   Calle 8 No. 13-35, Bule, intersección

5. Punto de Atención Regional Bucaramanga
   Calle 26 No. 24-70

6. Punto de Atención Regional Valledupar
   Calle 30 No. 11-11, Fracc. Centro

7. Punto de Atención Regional Cúcuta
   Avenida 5 No. 10-55, Piso 5

8. Punto de Atención Regional Neiva
   Calle 10 No. 10-70, Fracc. Sabaneta

9. Punto de Atención Regional Cartagena
   Calle 28 No. 14-32, Fracc. Centro

10. Punto de Atención Regional Pasto
    Calle 27 No. 95, Bule, La Carolina

11. Punto de Atención Regional Manizales
    Calle 21 No. 20-16, Fracc. 504

12. Punto de Atención Regional Chocó
    Calle 6 No. 30-18, Fracc. 1 - Guadalupe
De acuerdo con Artículo 58 de 2015 la Agencia Nacional de Minería tiene a su cargo la Clasificación de las labores mineras subterráneas de carbón. Para todos los aspectos relacionados con el presente Reglamento, las labores mineras subterráneas de carbón se clasifican en tres (3) categorías:

<table>
<thead>
<tr>
<th>CATEGORÍA</th>
<th>DESCRIPCIÓN</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Minas o hornos subterráneos produciones</td>
<td>Son aquellas labores o extracciones subterráneas que les otorga la concentración de metano en cualquier uno de los hornos superiores al 0,4%</td>
</tr>
<tr>
<td>II. Minas o hornos subterráneos produciones</td>
<td>Son aquellas labores o extracciones subterráneas que les otorga la concentración de metano en cualquier uno de los hornos superiores al 0,4%</td>
</tr>
<tr>
<td>III. Minas o hornos subterráneos subproducciones</td>
<td>Son aquellas labores o extracciones subterráneas, para las cuales la concentración de metano en cualquier uno de los hornos superiores al 0,3%</td>
</tr>
</tbody>
</table>

Parágrafo. La clasificación de las labores mineras subterráneas de carbón será realizada por la autoridad minera, encargada de la administración de los recursos mineros.
FATALIDADES Y EMERGENCIAS MINERAS OCURRIDAS ENTRE LOS AÑOS 2005 - 2018*

*Datos a 28 de febrero de 2018

EMERGENCIAS MINERAS OCURRIDAS ENTRE LOS AÑOS 2005-2018*

Total = 1073

*Datos a 28 de febrero de 2018
FATALIDADES EN EMERGENCIAS MINERAS OCURRIDAS ENTRE LOS AÑOS 2005-2018*

Total = 1283

CAUSAS DE EMERGENCIA 2005-2018*

*Datos a 28 de febrero de 2018
CAUSAS DE FATALIDADES 2005-2018*

*Datos a 31 de enero de 2018.
Uniminas S.A.S., titular del contrato de concesión 2505 es una sociedad comercial e industrial creada en el año 1998 con el objeto de realizar la extracción de minerales en todas sus fases; especialmente el aprovechamiento de carbón coquizable.

« Dignificar la actividad del minero dándole estatus dentro de la sociedad »

C.I. MILPA S.A. – UNIMINAS S.A.S.
NUESTRA OPERACION

Uniminas realiza la operación minera de extracción del carbón mediante labores subterráneas cumpliendo con los parámetros de seguridad establecidos y comprometidos con la calidad de nuestro producto y con el medio ambiente.
El desarrollo de esta actividad se realiza directamente y a través de contratos de asociación.

C.I. MILPA S.A. – UNIMINAS S.A.S.

CONTRATO DE CONCESIÓN 2505

C.I. MILPA S.A. – UNIMINAS S.A.S.
### GEOLOGÍA CONTRATO DE CONCESIÓN

Rumbo predominante N45E
Buzeimiento 55 SE

---

### RESERVAS CONTRATO CONCESION

<table>
<thead>
<tr>
<th>Carbones Bloque Sur</th>
<th>R. Medidas (Ton.)</th>
<th>R. Indicadas (Ton.)</th>
<th>R. Inferidas (Ton.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajo Volátil</td>
<td>3'299'725</td>
<td>8'079'181</td>
<td>22'171'720</td>
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<tr>
<td>Medio Volátil</td>
<td>2'561'903</td>
<td>8'286'496</td>
<td>10'541'146</td>
</tr>
<tr>
<td>Subtotal</td>
<td>5'861'628</td>
<td>16'365'677</td>
<td>32'712'866</td>
</tr>
<tr>
<td>TOTAL RESERVAS</td>
<td></td>
<td></td>
<td>55'540'171 Toneladas</td>
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</table>

<table>
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<tr>
<th>Carbones Bloque Norte</th>
<th>R. Medidas (Ton.)</th>
<th>R. Indicadas (Ton.)</th>
<th>R. Inferidas (Ton.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajo Volátil</td>
<td>1'391'394</td>
<td>4'679'849</td>
<td>6'095'168</td>
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<tr>
<td>Medio Volátil</td>
<td>933'596</td>
<td>1'845'699</td>
<td>2'424'642</td>
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<tr>
<td>Subtotal</td>
<td>2'325'992</td>
<td>6'525'548</td>
<td>8'519'810</td>
</tr>
<tr>
<td>TOTAL RESERVAS</td>
<td></td>
<td></td>
<td>17'175'350 Toneladas</td>
</tr>
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</table>

**TOTAL RESERVAS CONCESIÓN 2505**  72,715,521 ton
MARCO PRODUCTIVO UNIMINAS

- PROYECTOS DIRECTOS
  Mina túnel Casablanca
  Producción: 8.000 ton/mes
  Empleos directos: 345

- PROYECTOS ASOCIADOS
  14 Empresas Mineras Asociadas
  Producción: 12.000 ton/mes
  Empleos directos: 378

C.I. MILPA S.A. – UNIMINAS S.A.S.

TECNIFICACIÓN EXPLOTACIÓN MINERA

C.I. MILPA S.A. – UNIMINAS S.A.S.
Se está realizando la construcción del Inclinado menos uno con el fin de habilitar 2.152.180 ton de carbón bajo y medio volátil, que permite garantizar la actividad económica de la compañía para los próximos 10 años.
INCLINADO MENOS UNO

Con este proyecto se busca optimizar el medio de transporte, pasando a un transporte continuo (bandas transportadoras) facilitando la operación minera, mejorando costos de producción y permitiendo producciones mayores a 15.000 Ton/mes.

C.I. MILPA S.A. – UNIMINAS S.A.S.
INCLINADO MENOS UNO

C.I. MILPA S.A. – UNIMINAS S.A.S.

PARAMETROS INCLINADO MENOS UNO

<table>
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<tr>
<th>VARIABLES</th>
<th>ESPECIFICACIÓN</th>
<th>UNIDAD</th>
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<tbody>
<tr>
<td>INCLINACIÓN</td>
<td>26</td>
<td>Grados</td>
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<tr>
<td>Constante Total</td>
<td>508</td>
<td>m</td>
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<tr>
<td>Reservas a Habitar</td>
<td>1,794,000</td>
<td>Ton</td>
</tr>
<tr>
<td>Producción Proyectada Año</td>
<td>180,000</td>
<td>Ton</td>
</tr>
</tbody>
</table>

C.I. MILPA S.A. – UNIMINAS S.A.S.
CONTRATO DE CONCESIÓN No. 2505
PROCESO DE FORMALIZACIÓN
MINERA

C.I. MILPA S.A. – UNIMINAS S.A.S.

OPCIONES

EJECUTAR AMPARO ADMINISTRATIVO Y CIERRE CON EL CONFLICTO SOCIAL QUE SE GENERA

LEGALIZAR UTILIZANDO LAS HERRAMIENTAS JURIDICAS ESTABLECIDAS EN EL CODIGO DE MINAS

C.I. MILPA S.A. – UNIMINAS S.A.S.
LOS MAYORES LOGROS

14 EMPRESAS (UNIDADES DE PRODUCCIÓN MINERA FORMALIZADAS, AJUSTADAS A LAS NORMAS Y EN MEJORAMIENTO CONTINUO)

C.I. MILPA S.A. – UNIMINAS S.A.S.

LOGROS: ASPECTOS SOCIALES Y CALIDAD DE VIDA

ASPECTOS SOCIALES
- Empleos directos: 768
- Empleos indirectos: 3.500
- Población área influencia: 11.200 habitantes Guachetá
- Sistema de vida: Agropecuaria y minera
- Educación: Primaria y Básica
- Municipios de influencia: Guachetá, Lenguazaque, Ubaté, Cucunubá

MEJORAMIENTO CALIDAD DE VIDA
- Sistema de potabilización de agua
- Área de ducha y vestidores con agua caliente
- Casino para el suministro de alimentación
- Sistema de monitoreo por Biométrico
- Capacitación a todo nivel y validación primaria y bachillerato personal operativo

C.I. MILPA S.A. – UNIMINAS S.A.S.
LOGROS OBTENIDOS

C.I. MILPA S.A. – UNIMINAS S.A.S.

LOGROS OBTENIDOS

C.I. MILPA S.A. – UNIMINAS S.A.S.
Annex VIII

Pictures

A. *Casablanca Mine (2\textsuperscript{nd} biggest in the country)*
B. Average Mine
C. Average mine 2
D. Cementos Argos abandoned mine
**Workshop Agenda**

**UNECE Group of Experts on Coal Mine Methane**

**Global Methane Initiative**

**Workshop on Best Practices in Coal Mine Methane Capture and Utilization**

**Bogota, Colombia**

Radisson AR Bogota Airport

Avenida Carrera 60 No 22 - 99, Teusaquillo, 110010 Bogotá, Colombia

24-25 July 2018

<table>
<thead>
<tr>
<th>Day 1: Tuesday 24 July 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>9:30 – 9:40</strong></td>
</tr>
<tr>
<td>9:30 – 9:40</td>
</tr>
<tr>
<td>Mr. Raymond C. Pilcher, Chair, UNECE Group of Experts on Coal Mine Methane</td>
</tr>
<tr>
<td>9:40 – 9:50</td>
</tr>
<tr>
<td>9:50 – 9:55</td>
</tr>
<tr>
<td>9:55 – 10:00</td>
</tr>
<tr>
<td><strong>10:00 – 10:20</strong></td>
</tr>
<tr>
<td><strong>10:20 – 11:45</strong></td>
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<tr>
<td><strong>10:20 – 10:40</strong></td>
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<tr>
<td>10:20 – 10:40</td>
</tr>
<tr>
<td>Speaker from Drummond</td>
</tr>
<tr>
<td>10:40 – 11:00</td>
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<tr>
<td>Mr. Ruben Dario Chanci, UPME</td>
</tr>
<tr>
<td>11:00 – 11:20</td>
</tr>
<tr>
<td>Mr. Jonathan Kelafant, Senior Vice President, Advanced Resources International (ARI)</td>
</tr>
<tr>
<td><strong>11:20 – 12:00</strong></td>
</tr>
<tr>
<td><strong>12:00 – 14:00</strong></td>
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</tbody>
</table>
### Session Two: Calculation of Methane Gas Reserves in Coal Beds

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00 – 14:20</td>
<td>Drilling Techniques, Sampling, Required Analysis, and Models for Estimating Reserves</td>
<td><em>Is there methane gas potential in Colombia? Mr. Jorge Eliecer Mariño Martínez</em></td>
</tr>
<tr>
<td>14:20 – 14:40</td>
<td>Estimating Reserves and Resources – Colombian experience (TBC)</td>
<td><em>Mr. Roger Tyler</em></td>
</tr>
<tr>
<td>14:40 – 15:00</td>
<td>Standard Techniques for Sampling and Data Analysis to Estimate CMM/CBM Reserves</td>
<td><em>Mr. Jonathan Kelafant, Senior Vice President, Advanced Resources International (ARI)</em></td>
</tr>
</tbody>
</table>

#### Q&A – Discussion with the Audience

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:00 – 15:30</td>
<td>Q&amp;A – Discussion with the Audience</td>
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</tbody>
</table>

### Session Three: Drainage and Co-Development of Coal and Gas Resources

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:30 – 15:50</td>
<td>Pre-Mine Drainage</td>
<td><em>CBM potential in carboniferous zones of Cundinamarca, Boyacá and Santander Mr. Marco Antonio Rincón Mesa, Servicio Geológico Colombiano</em></td>
</tr>
<tr>
<td>15:50 – 16:10</td>
<td>Pre-Mine Drainage in Poland/ICE-CMM Poland - Mr. Jacek Skiba, Chief Specialist, Experimental Mine &quot;Barbara&quot;, GIG - Central Mining Institute</td>
<td></td>
</tr>
<tr>
<td>16:10 – 16:30</td>
<td>Co-Development of Coal and Gas Resources – Coal Mining in an Established Gas Field</td>
<td><em>Mr. Raymond C. Pilcher, Chair, UNECE Group of Experts on Coal Mine Methane</em></td>
</tr>
<tr>
<td>16:30 – 17:30</td>
<td>Drilling Solutions for Methane Drainage – panel discussion with Q&amp;A from the audience</td>
<td><em>Mr. Roger Tyler, Mr. Jonathan Kelafant, Mr. Raymond C. Pilcher, Mr. Jacek Skiba, Mr. Marco Antonio Rincón Mesa</em></td>
</tr>
</tbody>
</table>

### Day 2: Wednesday 25 July 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Four: Mine Safety</th>
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<tbody>
<tr>
<td>9:30 – 10:40</td>
<td>Good Practices in Risk Assessment</td>
<td><em>Ms. Felicia Ruiz, United States Environmental Protection Agency</em></td>
</tr>
<tr>
<td>9:30 – 9:50</td>
<td>New Directions in R&amp;D aiming to decrease methane hazard and to increase CMM capture - based on GIG experience</td>
<td><em>Mr. Jacek Skiba, Chief Specialist, Experimental Mine &quot;Barbara&quot;, GIG - Central Mining Institute</em></td>
</tr>
<tr>
<td>9:50 – 10:10</td>
<td>Q&amp;A – Discussion with the Audience</td>
<td></td>
</tr>
<tr>
<td>10:10 – 10:40</td>
<td>Q&amp;A – Discussion with the Audience</td>
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<tr>
<td>10:40 – 11:00</td>
<td>Coffee Break</td>
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<tr>
<td>Time</td>
<td>Session</td>
<td>Topic</td>
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<tr>
<td>11:00 – 15:00</td>
<td><strong>Session Five: Ventilation</strong></td>
<td></td>
</tr>
<tr>
<td>11:00 – 11:20</td>
<td>Overview of Ventilation Characteristics, Practices, and Challenges in Colombia</td>
<td>Ms. Gloria Catalina Gheorghe, ANM</td>
</tr>
<tr>
<td></td>
<td>Good Practices in Effective Ventilation of Underground Coal Mines</td>
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</tr>
<tr>
<td>11:40 – 12:00</td>
<td>Polish Practices and Regulations</td>
<td>Mr. Henryk Kotkoń, Head of the Gas Hazard Department, GIG - Central Mining Institute</td>
</tr>
<tr>
<td>12:00 – 14:00</td>
<td>Lunch</td>
<td></td>
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<tr>
<td>14:00 – 14:20</td>
<td>VAM processing - international experiences from proven technology</td>
<td>Mr. Richard Mattus, Consultant, RM Business Consulting</td>
</tr>
<tr>
<td>14:20 – 15:20</td>
<td>Regulations for Coal Mine Ventilation and Their Impact on Methane Abatement - panel discussion with Q&amp;A from the audience</td>
<td>Moderator: Mr. Raymond C. Pilcher, Chair, UNECE Group of Experts on CMM Ms. Susan B. Patton, Senior Associate, Agapito Associates, Inc. Mr. Henryk Kotkoń, Head of the Gas Hazard Department, GIG - Central Mining Institute Mr. Richard Mattus, Consultant, RM Business Consulting Mr. Willian Guevara, Manager, Uniminas</td>
</tr>
<tr>
<td>15:20 – 16:45</td>
<td><strong>Session Six: Abandoned Mine Methane</strong></td>
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<tr>
<td>15:20 – 15:40</td>
<td>Abandoned Mine Methane – Significance and Utilization</td>
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<tr>
<td>15:40 – 16:00</td>
<td>Best Practices in Transition from Operating Mine to Abandoned Mine Methane</td>
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<tr>
<td>16:00 – 16:45</td>
<td>General Discussion among the Experts and Q&amp;A with the Audience</td>
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<tr>
<td>16:45 – 17:00</td>
<td>Closing Remarks</td>
<td>Mr. Raymond C. Pilcher, Chair, UNECE Group of Experts on Coal Mine Methane</td>
</tr>
</tbody>
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