Incentives for CMM/AMM Projects in China

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GMI Coal Mines Subcommittee Meeting
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Global Methane Initiative

Incentives for CMM and AMM Project Opportunities in China

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GMI Coal Subcommittee
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汇报提纲 Outline

1.中国煤层气资源

2. 煤层气（煤矿瓦斯）开发技术

3. 煤层气（煤矿瓦斯）利用

4. 废弃煤矿瓦斯开发利用

5. 结论

1. CBM Resources in China

2. CBM/CMM Development Technology

3. CBM/CMM Utilization

4. Development and Utilization of AMM

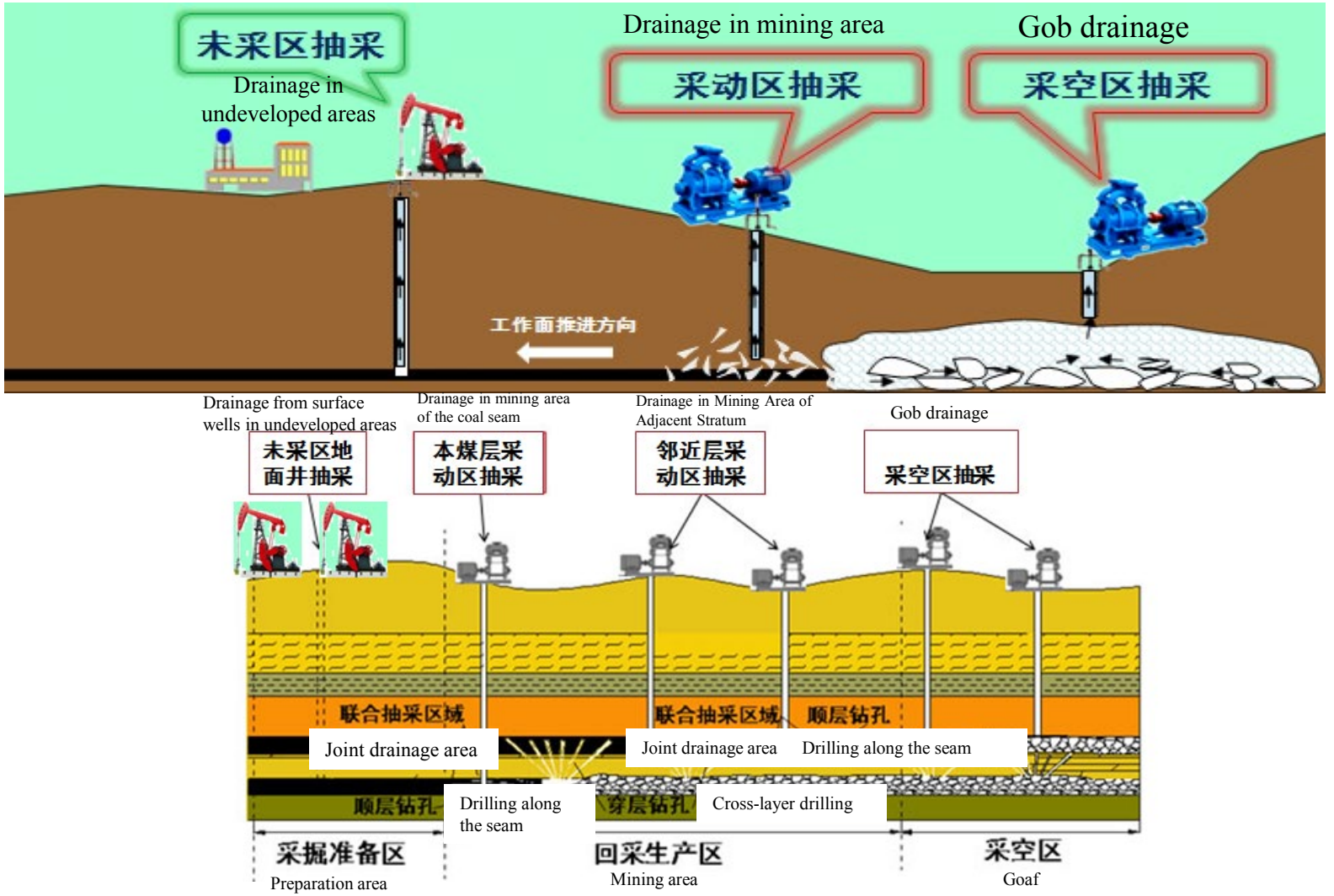
5. Conclusion

1.中国煤层气资源
1. CBM Resources in China

- 煤层气可采资源量和探明储量
  - 可采资源量 12.5 万亿方，高、中、低煤阶各占 1/3 ；
  - 全国累计探明储量 7111.2亿方，2018 年新增探明储量147.1亿方，比上年增长 40.3% 。

- CBM recoverable resources and proven reserves
  - The recoverable resources amount to 12.5 trillion m^3, with high, medium and low coal rank accounting for 1/3 respectively;
  - The total proven reserves in China were 711.1 billion m^3, and 14.7 billion m^3 were newly discovered in 2018, up by 40.3% over the previous year.

- 采煤采气一体化—晋城模式
- **Integration of Coal Mining and Gas Drainage-Jincheng Mode**

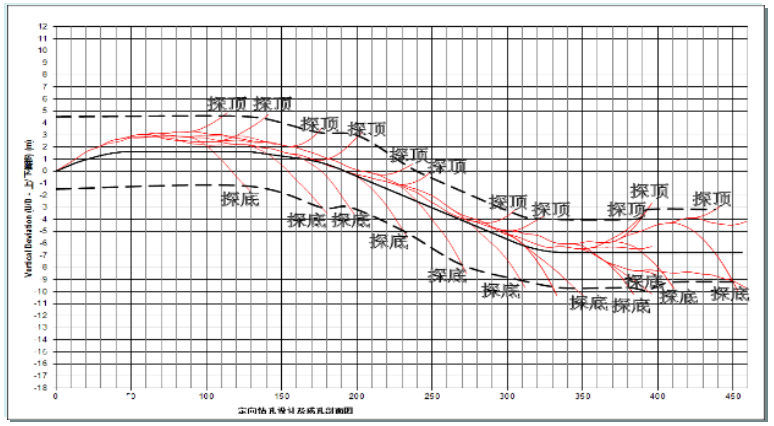


地面井“三区联动”抽采模式

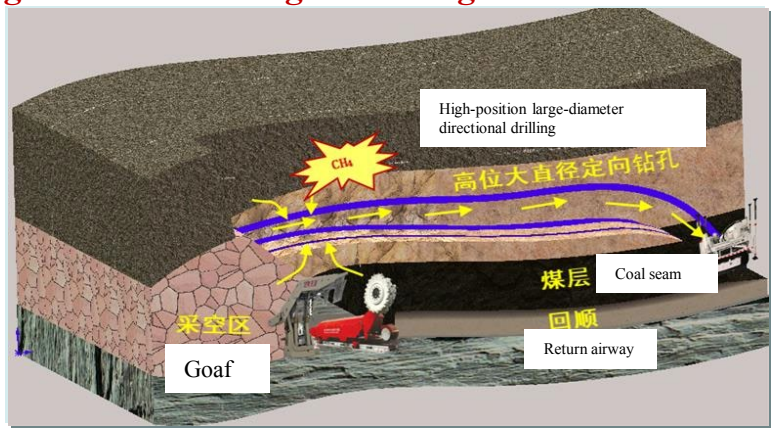
Three-reginal Linkage Drainage Mode for CBM Well

2.煤层气（煤矿瓦斯）开发技术
2. CBM/CMM Development Technology

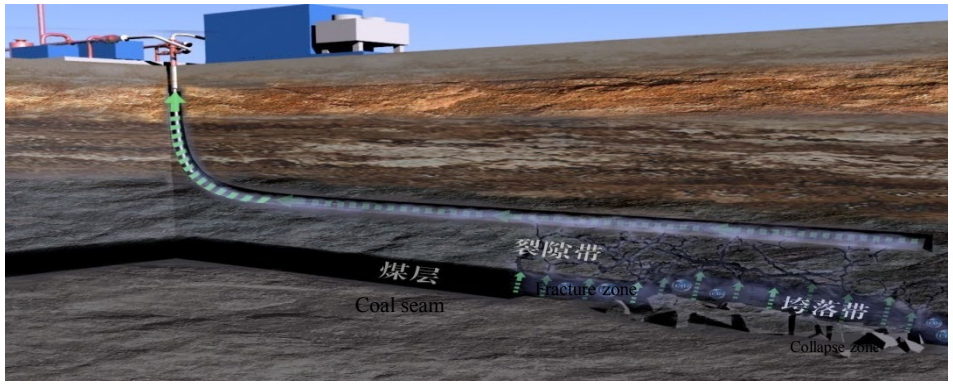
- 先采气后采煤、采气采煤一体化—晋城模式
- Coal Mining after Gas Drainage and Integration of Coal Mining and Gas Drainage-Jincheng Mode



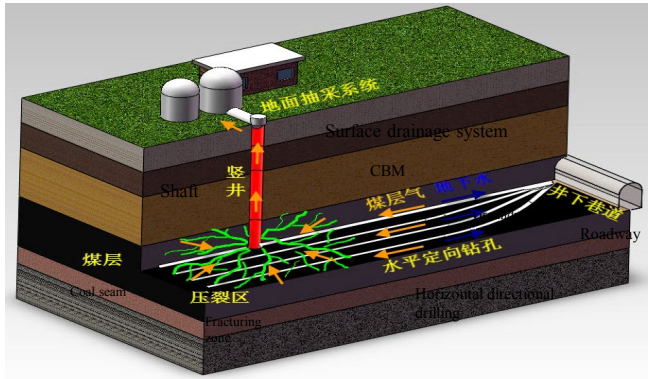
寺河矿定向钻孔抽采技术
Directional Drilling Technology in Sihe Coal Mine



高位钻孔抽采技术
High level borehole drainage technology



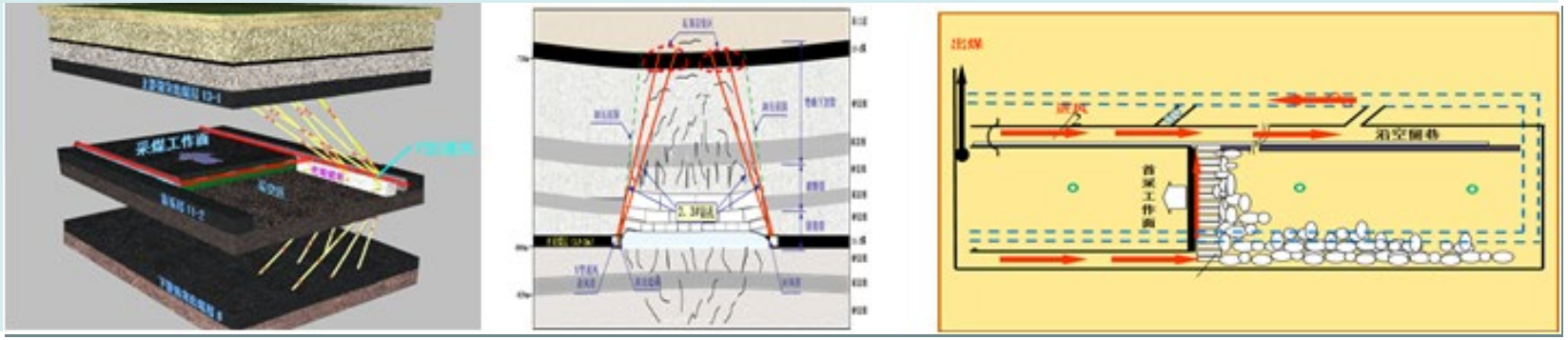
采动区L型井抽采技术
Extraction Technology of L-shaped Well in Mining Area



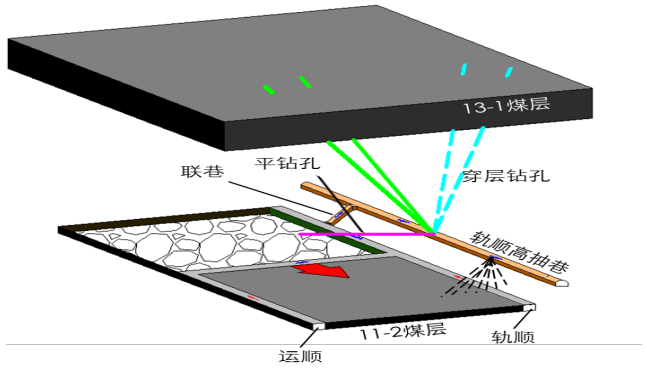
地面和井下联合抽采技术
Combined surface and underground drainage technology

2.煤层气（煤矿瓦斯）开发技术
2. CBM/CMM Development Technology

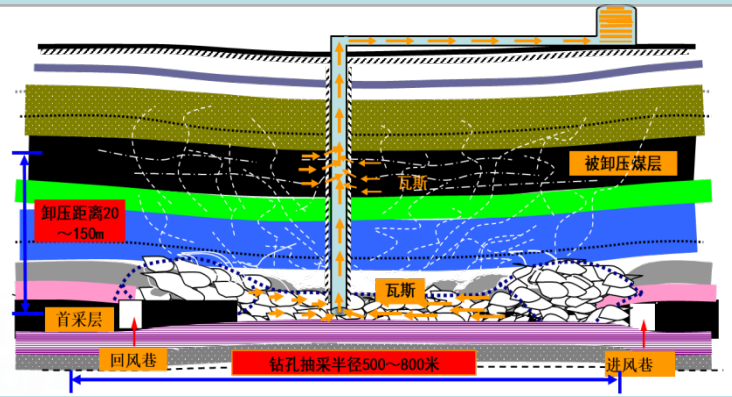
- 煤与瓦斯共采—淮南模式
- Coal and Gas Co-mining-Huainan Mode



无煤柱Y型通风沿空留巷煤与瓦斯共采技术
Co-mining Technology of Coal and Gas in Gob-side Entry Retaining with Y-type Ventilation without Coal Pillar



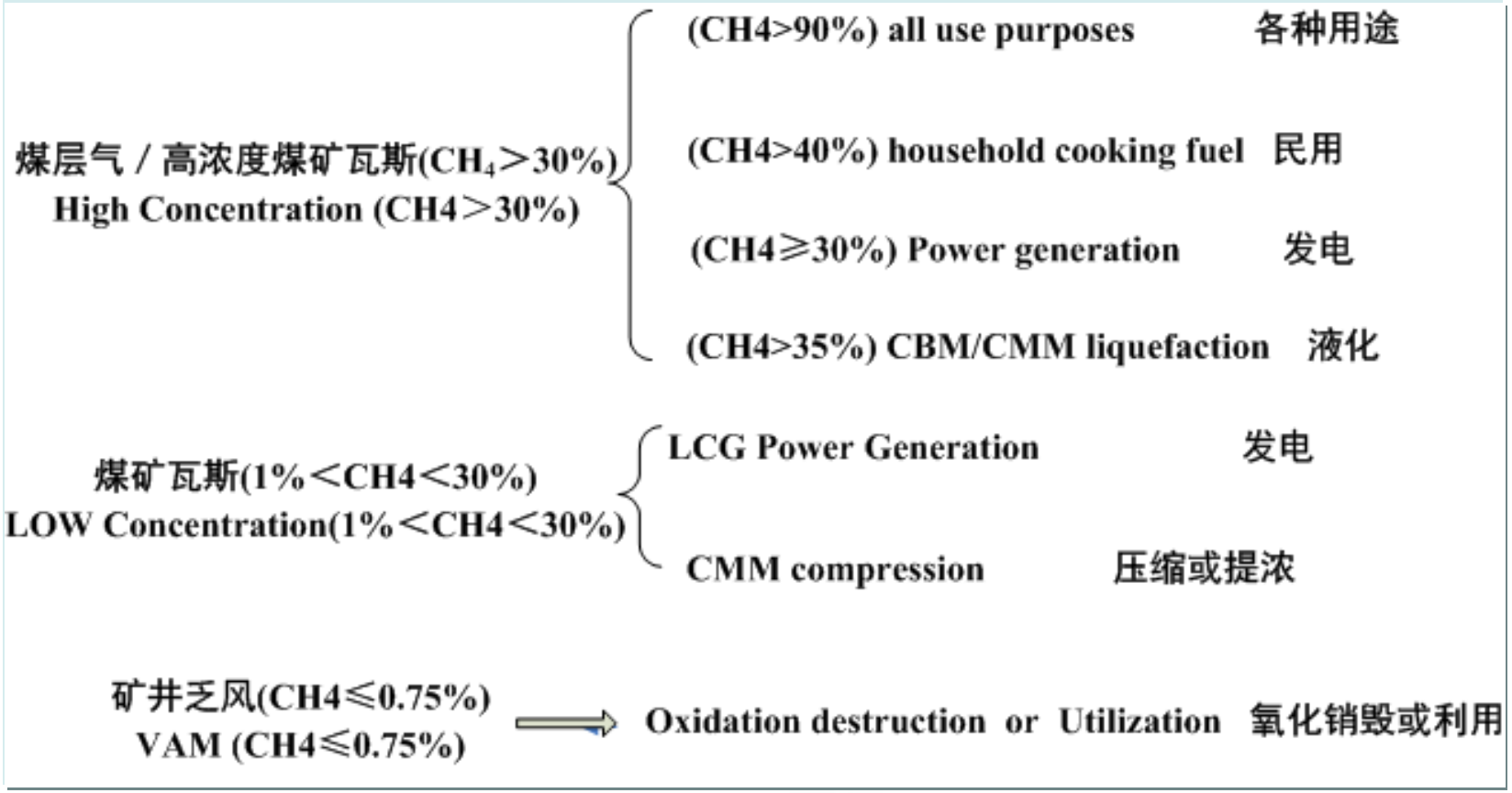
保护层开采+底板巷穿层卸压技术
Protective layer mining + floor roadway cross-layer pressure relief technology



保护层开采与地面钻井联合抽采瓦斯治理技术
Gas control technology by combined drainage of protective layer mining and surface drilling.

3.煤层气（煤矿瓦斯）利用
3. CBM/CMM Utilization

- 煤层气／煤矿瓦斯利用方案
- CBM/CMM Utilization Scheme



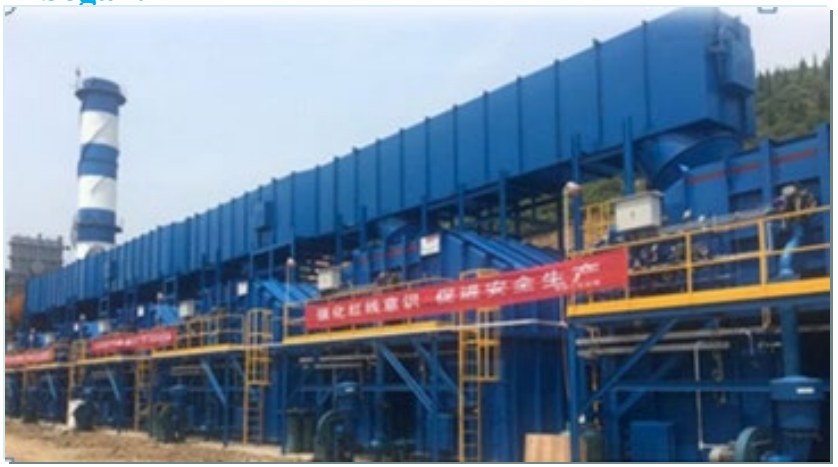
3.煤层气（煤矿瓦斯）利用
3. CBM/CMM Utilization

■ 通风瓦斯利用技术
- ➢ 热氧化
- ➢ 催化氧化
- ➢ 锅炉或瓦斯发动机辅助燃料

■ Utilization Technology for VAM
- ➢ Thermal oxidation
- ➢ Catalytic oxidation
- ➢ Auxiliary fuel for boiler or gas engine

3.煤层气（煤矿瓦斯）利用
3. CBM/CMM Utilization

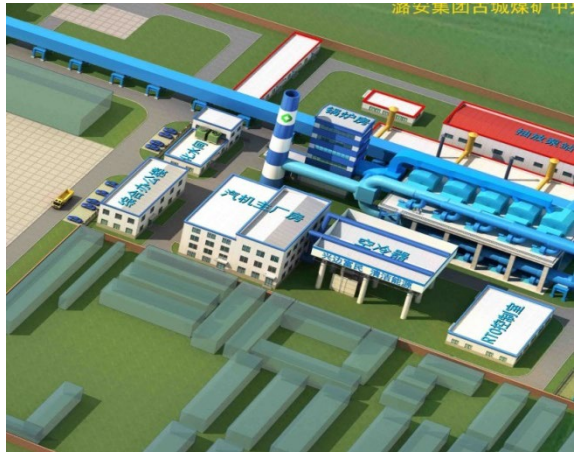
- **山西阳煤集团二矿桑掌通风瓦斯发电项目**
  - 投资规模：1.8 亿元
  - 氧化装置：6 台，汽轮发电装机容量：15 MW
  - 年销毁甲烷相当于二氧化碳温室气体：83 万吨
  - 2018 年 11 月 1 日开始为煤矿风井供暖
  - 2018 年 12 月完成电网接入工程后开始并网发电
- **Sangzhang VAM Power Generation Project in No.2 Coal Mine of Shanxi Yangquan Coal Industry (Group) Co., Ltd.**
  - Investment scale: 180 million RMB
  - Oxidation devices: 6 units, installed capacity of steam turbine: 15 MW
  - Annual destruction volume of methane: 830,000 tons CO_2 equivalent
  - Since November 1, 2018, heating has be started for the air shaft of the Coal Mine.
  - After completing the grid connection project in December 2018, grid-connected power generation was began.



3.煤层气（煤矿瓦斯）利用
3. CBM/CMM Utilization

■ 古城煤矿中央区和桃园区通风瓦斯发电项目（规划）

- 古城煤矿中央区项目和桃园区项目的设计规模相同
- 投资规模：2 × 1.85 亿元
- 氧化装置：2 × 10 台
- 年销毁甲烷相当于二氧化碳温室气体：2 × 138 万吨
- 汽轮发电装机容量：2 × 25 MW
- 冬季热电联供，分别替代 20 蒸吨/小时 燃煤锅炉



■ VAM Power Generation Projects in Central and Taoyuan Districts of Gucheng Coal Mine (Planning)

- The design scales of Gucheng Coal Mine Central District Project and Taoyuan District Project is the same
- Investment scale: 2× 185 million RMB
- Oxidation devices: 2×10 units
- Annual destruction volume of methane: 2× 1.38 million tons CO_2 equivalent
- Installed capacity of steam turbine: 2×25 MW
- Combined heat and power supply in winter replaces 20-ton/hour coal-fired boilers respectively.

3.煤层气（煤矿瓦斯）利用
3. CBM/CMM Utilization

■ 矿井通风瓦斯

- 2013年，信息院承担《煤矿乏风甲烷氧化Pd基整体催化剂合成动力学模型》面上项目。
- 2017年，信息院承担自然科学基金《负载型铜锰多孔通风瓦斯利用催化剂调控及催化性能研究》青年基金项目

■ Ventilation Air Methane (VAM)

- In 2013, CCII undertook the general project *Synthesis and its reaction kinetic model research of novel Pd-based monolithic catalysts for ventilation air methane.*
- In 2017, the IIEM undertook the Youth Fund Project of Natural Science Fund *Controllable preparation and catalytic performance of binary Cu-Mn mixed oxide catalysts supported on hierarchical porous monolith for ventilation air methane combustion*

国家自然科学基金委员会
项 目 批 准 通 知

国科金计项〔2013〕57号

关于批准资助2013年度第二批项目的通知

国家安全生产监督管理总局信息研究院（单号：2013-57-0292）：

根据《国家自然科学基金条例》有关规定和专家评审意见，国家自然科学基金委员会（以下简称自然科学基金委）决定批准资助你单位2013年度（第2批）国家自然科学基金项目 1 项，金额 75.0 万元。其中，面上项目 1 项，上述资助项目清单详见附件。

自评审结果通告发布之日起25日内，项目负责人须按要求填写与提交《国家自然科学基金资助项目研究计划书》（以下简称计划书）电子版。2013年9月11日16点前，依托单位将审核后的计划书电子版通过科学基金网络信息系统（https://isis.nsfc.gov.cn）提交至自然科学基金委。自然科学基金委同期对计划书电子版进行审核。审核通过的，项目负责人可打印计划书纸质版（建议双面打印）；审核未通过的，退回至项目负责人修改，依托单位须在2013年9月18日16点前，将修改后的计划书电子版及时审核并再次提交至自然科学基金委。2013年9月27日16点前，依托单位须将自然科学基金委审核通过后的计划书纸质版（一式两份，应保证与电子版一致）加盖单位公章，报送至自然科学基

国家自然科学基金委员会
项 目 批 准 通 知

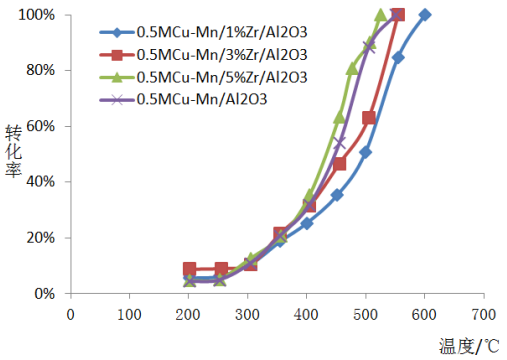
国科金计项〔2017〕38号

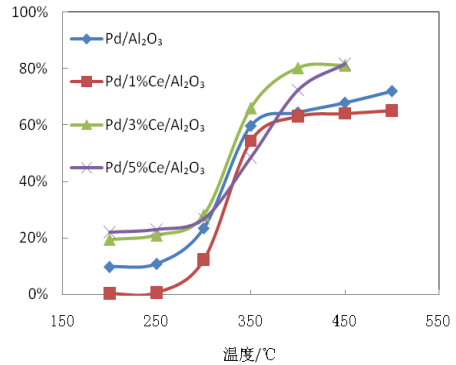
关于批准资助2017年度第二批项目的通知

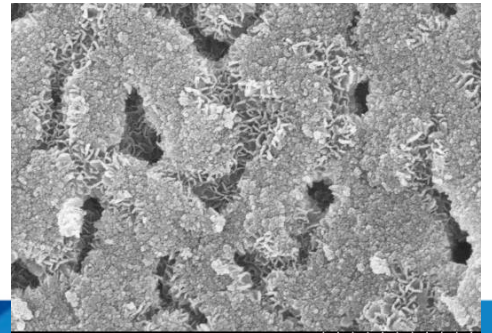
国家安全生产监督管理总局信息研究院（单号：2017-38-0303）：

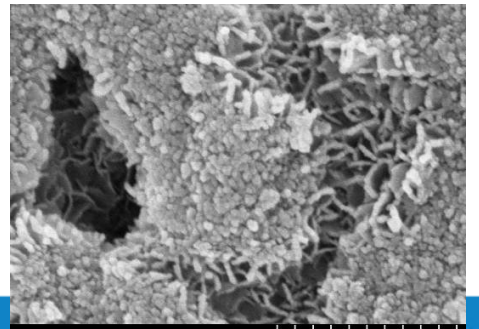
根据《国家自然科学基金条例》有关规定和专家评审意见，国家自然科学基金委员会（以下简称自然科学基金委）决定批准资助你单位2017年度（第2批）国家自然科学基金项目 1 项，直接费用 25 万元。其中，青年科学基金项目 1 项，上述资助项目清单详见附件。

自评审结果通告发布之日起25日内，项目负责人须按要求填写与提交《国家自然科学基金资助项目计划书》（以下简称计划书）电子版。2017年9月11日16点前，依托单位将审核后的计划书电子版通过科学基金网络信息系统（https://isisn.nsfc.gov.cn）提交至自然科学基金委。自然科学基金委同期对计划书电子版进行审核。审核通过的，项目负责人可打印计划书纸质版（建议双面打印）；审核未通过的，退回至项目负责人修改，依托单位须在2017年9月18日16点前，将修改后的计划书电子版及时审核并再次提交至自然科学基金委。2017年9月26日16点前，依托单位须将自然科学基金委审核通过后的



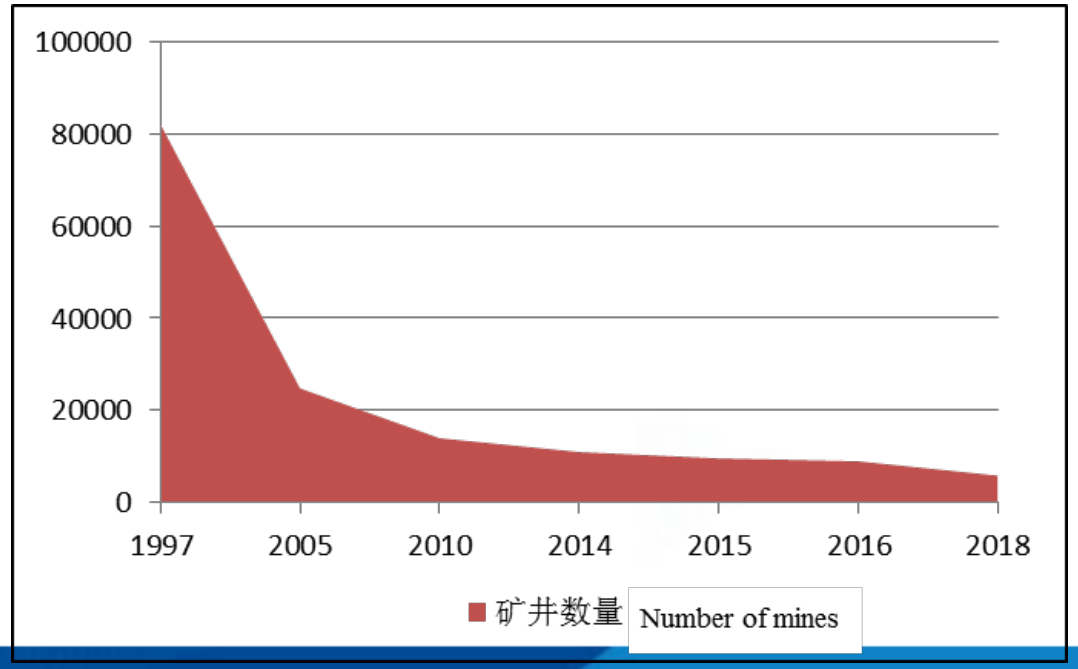






4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

- **大量煤矿关闭**
  - 1997年高达8.2万处
  - 2018年5900处
  - 2011-2018年期间，累计关闭煤矿约11200处
- **Large number of coal mines were closed**
  - Up to 82,000 in 1997
  - 5900 in 2018
  - From 2011 to 2018, a total of 11,200 coal mines were closed.



4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

■ 关闭矿井危害

- 安全隐患：瓦斯逸散、地表塌陷
  - 2018年10月1日，冀中能源张矿集团宣东煤矿关闭封填风井期间发生瓦斯爆炸事故，导致4人受伤，并造成百米以外的京张高速公路部分车辆受损；
  - 2018年10月15日，重庆市綦江区石壕镇梨园坝煤矿，在竖井井口进行封闭作业时发生瓦斯爆炸，爆炸导致5人死亡。

■ Risks of abandoned mines

- Potential safety hazards: gas escape and surface subsidence
  - On October 1, 2018, a gas explosion occurred in Xuandong Coal Mine of Jizhong Energy Zhangkuang Group during the sealing of the air shaft, resulting in 4 injuries and damage to some vehicles on the Beijing-Zhangjiakou Expressway over one hundred meters away.
  - On October 15, 2018, a gas explosion occurred in Liyuanba Coal Mine, Shihao Town, Qijiang District, Chongqing City, during the sealing operation of the shaft wellhead, causing 5 deaths.

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

■ **信息研究院长期致力于废弃煤矿瓦斯的资源及基础理论研究**

➢ 英国繁荣基金2014-2016年，资助信息研究院开展了三个废弃煤矿瓦斯开发利用项目。

- 2014-中国报废煤矿瓦斯抽采利用政策框架体系研究
- 2015-中国报废煤矿瓦斯开发利用示范项目可行性研究及政策建议
- 2016年度--借鉴英国经验促进中国报废煤矿瓦斯商业化开发

➢ 信息院研究人员赴英国、德国、美国、加拿大交流废弃煤矿瓦斯开发利用技术和现场考察。

■ **CCII has long been committed to the research on the resources and basic theories of AMM.**

➢ From 2014 to 2016, CCII undertook three projects funded by the British Prosperity Fund for three consecutive years.

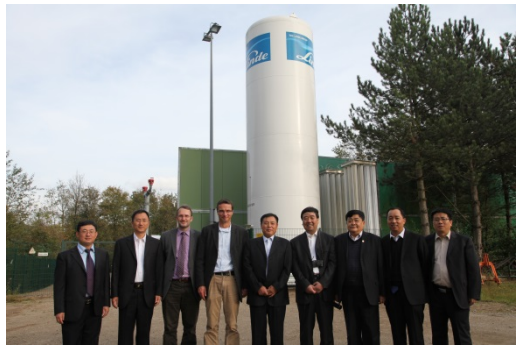
- 2014 - *Policy Recommendations to Improve China's AMM Extraction and Utilization*
- 2015 - *Feasibility Study of Pilot Project on AMM Development and Policy Recommendation for AMM Development and Utilization in China*
- *2016-Utilising UK Expertise to Promote the Commercialisation of AMM Recovery in China*

➢ Researchers from CCII went to Britain, Germany, the United States and Canada to exchange waste Coal Mine Methane development and utilization technologies and on-site inspections.

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

- **信息研究院长期致力于推动中国废弃煤矿瓦斯开发利用工作**
  - 带领晋城蓝焰煤层气公司、陕西省煤层气公司赴英国和德国参观学习先进技术、成功经验并进行现场考察。
- **CCII has long been committed to promoting AMM development and utilization in China.**
  - Organizing Shanxi Lanyan CBM Group and Shaanxi Coalbed Methane Development Company to visit the Britain and Germany to learn advanced technology, successful experience and conduct on-site inspection.

德国DMT公司面对面技术交流会
Face-to-Face Technical Exchange Meeting with DMT



参观德国报废煤矿瓦斯发电厂
Visit Germany's AMM Power Plant

与英国专家进行技术交流
Technical exchange with British experts

参观英国报废煤矿瓦斯发电厂
Visit Britain's AMM Power Plant

访问英国煤矿工业管理局
Visit Coal Authority of the UK

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

- **信息研究院长期致力于废弃煤矿瓦斯的资源及基础理论研究**
  - 陪同国家能源局煤炭司领导赴英国、德国参观学习废弃煤矿瓦斯开发利用先进技术，交流成功经验。
- **CCII has long been committed to the research on the resources and basic theories of AMM.**
  - Accompanying the leaders of the Coal Department of the National Energy Administration to visit the Britain and Germany to learn advanced technologies for AMM development and utilization and exchange successful experiences.

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

- 信息院承担了国家能源局委托的“关闭矿井残存煤层气资源开发利用政策研究”课题
  - 现场调研
  - ✓ 陕西：陕西煤层气公司
  - ✓ 辽宁：沈阳煤业集团
  - ✓ 重庆：重庆能源集团
  - ✓ 湖南：湖南能源局、湘煤集团
  - ✓ 内蒙古：内蒙古能源局、包头石拐工业园区
  - 起草了“关于促进关闭矿井瓦斯治理与利用的指导意见”（征求意见稿）

潜力区域现场调研
Field investigation of potential regions

- **CCII has undertaken the project *Policy Research on Exploitation and Utilization of AMM Resources in Closed Mines*, entrusted by the National Energy Administration**
  - Field Investigation
  - ✓ Shaanxi: Shaanxi Coalbed Methane Development Co., Ltd.
  - ✓ Liaoning: Shenyang Coal Trade Group
  - ✓ Chongqing: Chongqing Energy Group
  - ✓ Hunan: Energy Administration of Hunan Province, Hunan Coal Group
  - ✓ Inner Mongolia: Energy Administration of Inner Mongolia , Baotou Shiguai Industrial Park
  - Drafted "Guiding Opinions on Promoting Gas Control and Utilization in Closed Mines" (Draft for Comments)

召开讨论会
Hold a seminar

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

■ **举办报废煤矿瓦斯开发利用研讨会**

- 报废煤矿瓦斯开发利用研讨会列为国际煤层气暨页岩气研讨会的重要专题
- 推动了报废煤矿瓦斯开发利用方面的技术交流，为国外企业提供了技术服务展示平台

■ **Organizing a workshop on AMM development and utilization.**

- The workshop on AMM development and utilization was listed as an important topic in the International Symposium on CBM/CMM and Shale Gas in China.
- It has promoted technical exchanges in the AMM development and utilization and provided a platform for foreign enterprises to display technical services.

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

- **黑龙江龙煤集团废弃煤矿瓦斯项目**
  - 2017年3月，信息院院技术人员陪同英国何尔东方能源公司托马斯•布雷赫尼总裁赴黑龙江龙煤集团鹤岗南山煤矿和鸡西梨树煤矿现场调研废弃煤矿瓦斯开发利用潜力。
- **Heilongjiang Longmay Mining Holding Group Co., Ltd. Abandoned Coal Mine Methane Project**
  - In March 2017, technical experts from CCII accompanied Mr. Thomas Breheny, President of HEL-EAST Company, to visit Nanshan Coal Mine of Hegang Company and Lishu Coal Mine of Jixi Company, Heilongjiang Longmay Mining Holding Group Co., Ltd., and investigate the potential of AMM development and utilization.

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

■ 宁夏回族自治区

- 中节能宁夏新能源股份有限公司——乌兰煤矿（2016年5月关闭，）
  - ✓ 残存煤层气资源量为6.91亿m^3
  - ✓ 截止2018年6月，累计开发利用废弃煤矿瓦斯3582.69万立方米（纯量）；
  - ✓ 截止2018年6月，提供清洁能源电量9315万KWh；
  - ✓ 截止2018年6月，实现销售收入3648.68 万元，减少温室气（CO_2）排放51.75万吨

■ Ningxia Hui Autonomous Region

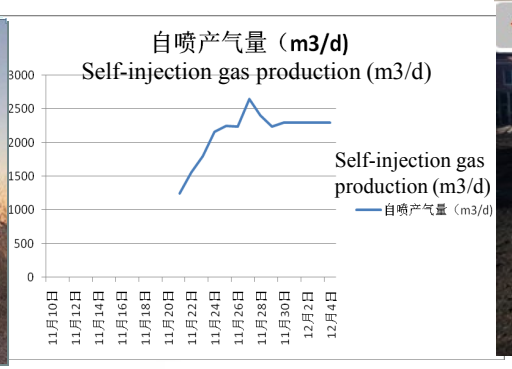
- CECEP Ningxia New Energy Resources Joint Stock Co., Ltd.-Wulan Coal Mine (Closed in May 2016)
  - ✓ Remaining CBM resources amount to 691 million m^3
  - ✓ Accumulative development and utilization volume of AMM: 35.8269 million m^3 (pure) by June 2018;
  - ✓ Providing 93.15 million KW•h of clean energy by June 2018;;
  - ✓ Achieved sales revenue of 36.486 million RMB and reduced greenhouse gas (CO2) emissions by 517,500 tons by June 2018;.

乌兰煤矿残存煤层气开发厂区、抽采管道和发电站
AMM development plant area, drainage pipeline and power station in Wulan Coal Mine

4. 废弃煤矿瓦斯开发利用
Development and Utilization of AMM

- 辽宁省
  - 辽宁红阳煤层气清洁能源开发有限公司——清水二井（2016年10月31日关闭）
    - ✓ 清水二井关闭施工先导性试验井5口
    - ✓ 1号井平均自喷产气量2300m³/d
    - ✓ 1号井最大自喷产气量：2700m³/d。

- **Liaoning Province**
  - Liaoning Hongyang CMM Clean Energy Development Co., Ltd-Qingshui No.2 Well (closed on October 31, 2016)
    - ✓ Qingshui No.2 Well constructed 5 pilot test wells when closed.
    - ✓ Average flowing gas production of No. 1 Well 1 is 2300m³/d.
    - ✓ Maximum flowing gas production of No. 1 Well : 2700m³/d.



面临问题

- 矿权问题
  - 矿权归属不明确
  - 煤层气矿权申请周期存在周期长，环节多。
- 关闭法规和标准
  - 煤矿关闭主要采取拆除设备、填实井筒等措施，未对次生灾害防范等做出要求。

Problems

- Mining rights
  - The ownership of mining rights is not clear
  - The application period of CBM mining rights is long and has many links.
- Regulations and standards for coal mine closure
  - Coal mine closure mainly takes measures such as dismantling equipment and filling the shaft, and does not require prevention of secondary disasters.

■ 面临的问题

➢ 开发技术问题

- 关闭煤矿地质条件复杂，地区差异大，目前废弃矿井瓦斯赋存、储量评估、运移、有利区选择等关键技术尚未突破；

➢ 缺乏示范引领

- 对技术可行性、经济性信心不足。

■ Problems

➢ Technical issues in development

- The geological conditions for abandoned coal mines are complex, with large regional differences. At present, key technologies for gas storage, reserves assessment, migration and favorable area selection in abandoned mines have not been broken through.

➢ Lack of demonstration and guidance

- Lack of confidence in technical feasibility and economy.

5.结论
Conclusion

- 中国煤层气资源丰富，开发潜力巨大；
- 地面煤层气开发、井下煤矿瓦斯抽采和井上下联合煤层气（煤矿瓦斯）抽采技术逐渐成熟；
- 中高浓度瓦斯民用、发电或用于工业燃料、低浓度瓦斯发电、低浓度瓦斯提纯和通风瓦斯热氧化利用技术逐渐成熟；
- 废弃矿井瓦斯回收利用工作取得积极进展。

- China has abundant CBM resources, with great development potential.
- The technologies of CBM development, CMM drainage and combined CBM/CMM extraction are gradually mature.
- The technologies for civil use of medium and high concentration CMM, power generation or industrial fuel, power generation of low concentration CMM, purification of low concentration CMM and thermal oxidation of VAM are gradually maturing.
- Positive progress has been made in AMM recovery and utilization.

Thank You

Thank You