# Current Status of Coal Mine Methane Research in CSIRO

## CSIRO煤矿瓦斯研究现状

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# Agenda
题纲

## Coal Mine Methane (CMM) - Overview
煤矿瓦斯 – 综述

## CMM Research in CSIRO
CSIRO的煤矿瓦斯研究工作

## Current Projects
**Sponsored by Australian Greenhouse Office (AGO)**
**under Australia-China Bilateral Climate Change Partnership**
由澳大利亚温室气体办公室在澳中双方气候变化伙伴关系下资助的三个项目

# Coal Mine Methane

煤矿瓦斯

## Current CMM Emissions 目前煤矿瓦斯排放

- Australia
  - 390 Mt black coal production and ~20 Mt $CO_2$-e in 2006（煤年产量3亿9千万，煤矿瓦斯年排放量1千8百万吨$CO_2$-e, 2006）
- China
  - 2,300 Mt coal production and ~200 Mt $CO_2$-e in 2004（煤年产量23亿，煤矿瓦斯年排放量2亿吨$CO_2$-e, 2004）

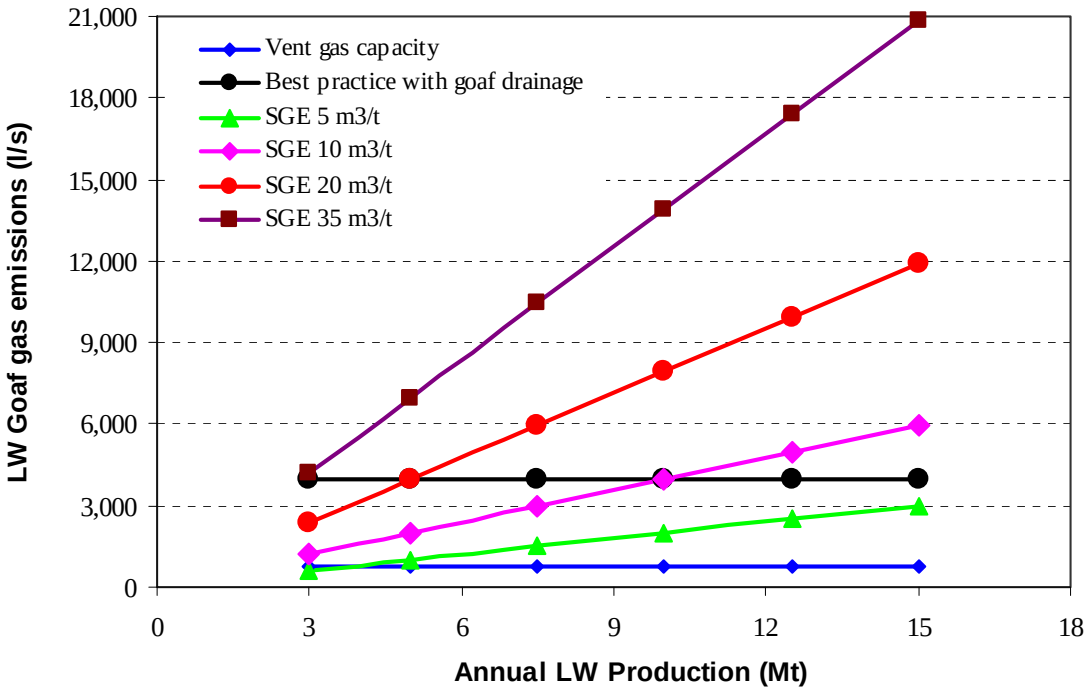
## CMM Expected to Increase 未来煤矿瓦斯排放会增加

- higher face production rates (from 2-3Mt to 5-7Mt per year) 产量增加
- increased depth (about 15-20m increase per year) 开采深度增加
- larger LW panel sizes (from 200m to 300-400m) 长壁面加宽

# Coal Mine Methane

## (Continued) 煤矿瓦斯

## CMM vs Coal Production 煤矿瓦斯与煤产量的关系




- Goaf gas emissions – up to 21,000 l/s 采空区涌出量达21000l/s
- LW ventilation can manage gas up to about 600- 800 l/s 长壁回采面通风可解决600—800 l/s瓦斯涌出量
- Australian best practice ~ 4,000 l/s with goaf drainage 在澳洲采空区抽采量可达4000 l/s

Most of the gassy mines SGE 10 to 20 $m^3/t$ in Australia, more in China
澳大利亚高瓦斯煤矿相对涌出量10-20m3/t, 中国的煤矿瓦斯相对涌出量更大

# Coal Mine Methane

## (Continued) 煤矿瓦斯

### Australia 澳大利亚煤矿瓦斯储量技术

- CMM reserve: ~ 6.5 trillion m3, greater than natural gas reserves 储量
- *Pre-drainage* 预抽
  - High $CH_4$ concentration ~ >70%
  - Typical low rates – 1,000 to 2,000 l/s
  - Relatively consistent flow
- *Post-drainage* 采空区抽放
  - Medium $CH_4$ concentration >50%
  - Flow rates - 500 to 4000 l/s
- *Ventilation air* 通风
  - VAM accounts for 65% mine $CH_4$ emission
  - Variable $CH_4$ concentration <1%

### China 中国煤矿瓦斯储量与技术

- CMM reserve: ~35 trillion $m^3$, equal to the natural gas reserve 储量

*Drainage* 抽放

- Over 70-80% of the drainage gas: <30% $CH_4$
- Typical flow rates – 200 to 400 l/s
- Opportunities for increasing flow rates and $CH_4$ concentration

*Ventilation air* 通风

- VAM accounts for 91% mine $CH_4$ emission (2004, CCII)
- Variable $CH_4$ concentration <1%,

# CMM Research at CSIRO

## CSIRO煤矿瓦斯研究工作

# CMM Research in CSIRO
## CSIRO煤矿瓦斯研究工作

## Integrated CMM Research in CSIRO CSIRO煤矿瓦斯综合研究

- Gas, geology and geotech characterisation 瓦斯，地质，岩石力学评估
- In-situ gas resource assessments 瓦斯资源评估
- Gas emissions predictions before and during mining 瓦斯排放预测
- Mine gas drainage designs and control strategies瓦斯抽放设计与控制方法
- Pre-mining gas capture 开采前瓦斯预抽
- Optimisation of mine gas capture in high production mines高产矿瓦斯采集优化
- Abandoned mine methane predictions 废弃煤矿瓦斯的预测
- CMM utilisation 瓦斯利用

## Collaborations国内外合作

- Working in collaboration with Australian Coal Industry
- Working with Overseas Companies – Gas capture & utilisation

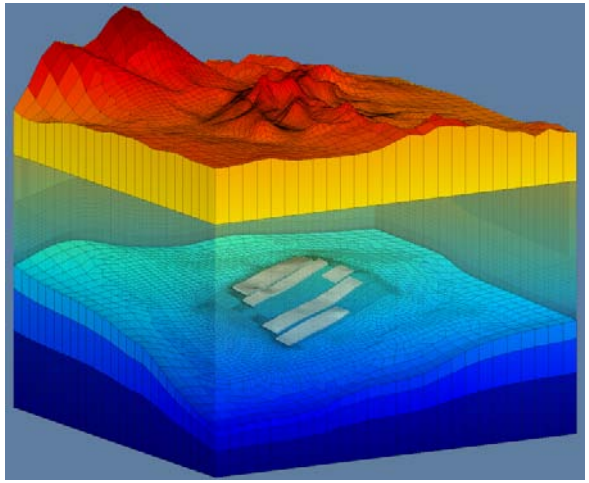
# CMM Research in CSIRO
## CSIRO的煤矿瓦斯研究工作

- **CSIRO Outcomes** CSIRO研究成果
  - Advanced scientific understanding on gas flow dynamics in LW goafs
    先进的采空区瓦斯流体动力学理论研究
  - Developed advanced tools for CMM emission prediction during mining
    先进的用于开采过程中瓦斯排放的预测方法
  - Applied to real mining situations to address major issues, and 用于实际采煤解决煤矿瓦斯重大问题
  - Produced significant benefits for the industry 已取得明显的工业效益

- **Industry Uptake** 现场应用
  - Australia: Dartbrook/Kayuga, Newlands, Moranbah North, Appin, Central, Southern, United, West Cliff and Grasstree Collieries
  - Overseas: Huainan (China), Spring Creek (New Zealand)

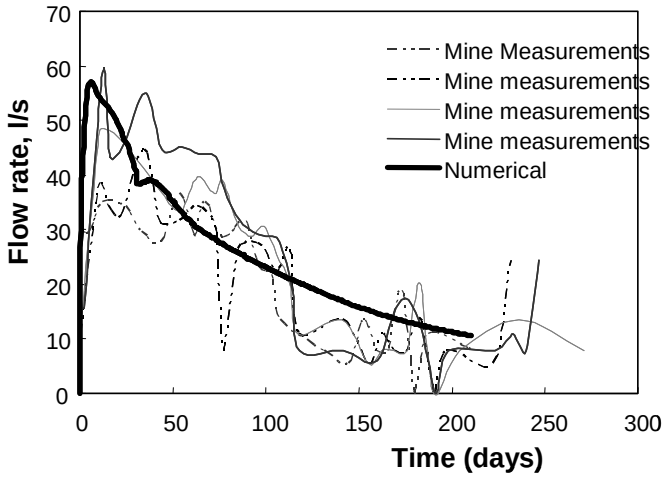
# CMM Research in CSIRO
## CSIRO的煤矿瓦斯研究工作

### CMM Emission Prediction 瓦斯排放预测



- Demonstrated an advanced integrated CMM modelling and forecast approach, using COSFLOW COSFLOW 示范了先进藕合的瓦斯运移模拟与预测方法

- Provide reliable and accurate CMM production forecast and planning for utilisation 提供准确可靠的瓦斯生产预测、为瓦斯利用提供科学数据

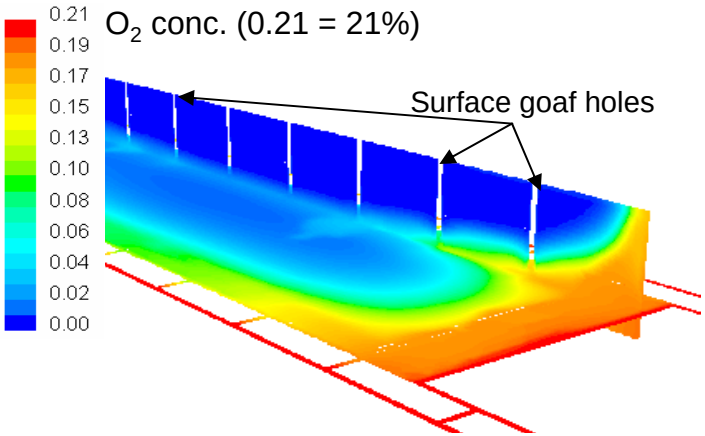


# CMM Research in CSIRO
## CSIRO的煤矿瓦斯研究工作

## CMM Capture Strategies 瓦斯抽采方法

Developed and implemented optimum gas control strategies based on goaf gas flow mechanics
根据采空区瓦斯运移动态规律开发了瓦斯抽采最佳方案

- Increased goaf gas drainage flow rates by more than 50% 把采空区的瓦斯抽放提高50%以上
- Achieved high goaf gas drainage rates of around 4,000 l/s 采空区的瓦斯抽放达4,000l/s
- Significantly reduced gas delays and enabled production increases (over 10,000 t/wk at a site) 大幅度地减少由于瓦斯造成的停产




Goaf gas control designs and strategies optimisation

Gas drainage plant

# CMM Research in CSIRO
## CSIRO的煤矿瓦斯研究工作

## Research in Emission Reduction 瓦斯减排与利用研究

- CMM & Ventilation Air Methane Mitigation and Utilisation
  抽放与通风瓦斯的减排与利用
  - Research and develop innovative enabling technologies研究开发新技术
  - Characterise mine methane emissions and pollutant characteristics评估煤矿瓦斯和污染物排放
  - Site assessment and identification of best option for the CMM/VAM mitigation & utilisation 确定煤矿抽放与通风瓦斯的减排与利用方案
  - Conceptual plant design and optimisation of the feasible technology 煤矿瓦斯减排与利用示范装置的概念设计与优化
  - Design and commission small scale demonstration units 设计与调试小型示范机组
- Greenhouse Gas Emissions Measurement for Coal Mining 煤矿瓦斯排放计量统计
  - Measure GHG from coal mines测量煤矿温室气体排放
  - Development of standardised database for reporting GHG emissions 开发温室气体排放的标准数据库

# Current Projects

## (Sponsored by Australian Greenhouse Office (AGO) under Australia-China Bilateral Climate Change Partnership)

由澳大利亚温室气体办公室在澳中双方气候变化伙伴关系下资助的三个项目

# AGO CMM Capture Maximisation Project
## AGO煤矿瓦斯抽采最大化项目

- **Project Manager: Dr Hua Guo** 项目负责人：郭华 博士
- **Project Objectives** 项目目标
  - Demonstrating advanced gas capture techniques and strategies 示范先进的瓦斯抽采技术与方法
  - To significantly improve coal mine methane drainage efficiency, methane concentration and flow rates 提高煤矿瓦斯抽采率，瓦斯浓度及流量
  - Identifying gaps and opportunities for improved drainage gas capture and its utilisation 在中国五个重点矿区找出提高瓦斯抽采与利用的差距和发展潜力

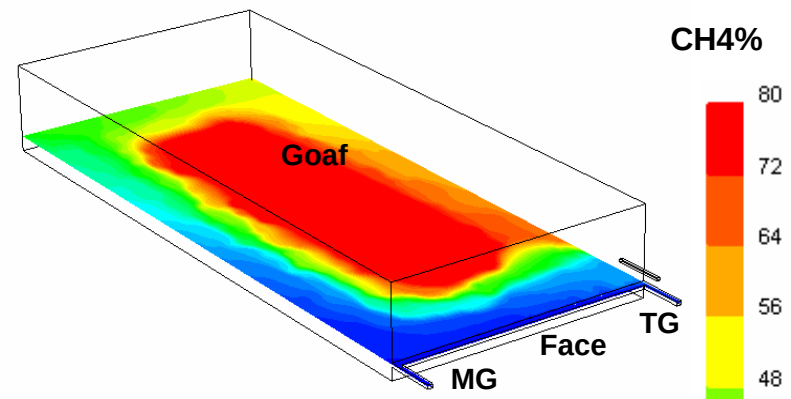
The 2 x 1360 kW gas engine units at the Panyi mine

潘一矿的内燃机组

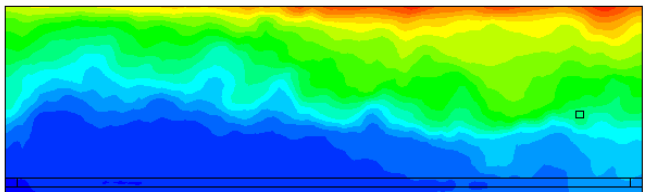
# AGO CMM Capture Maximisation Project

(Continued) **AGO煤矿瓦斯抽采最大化项目**

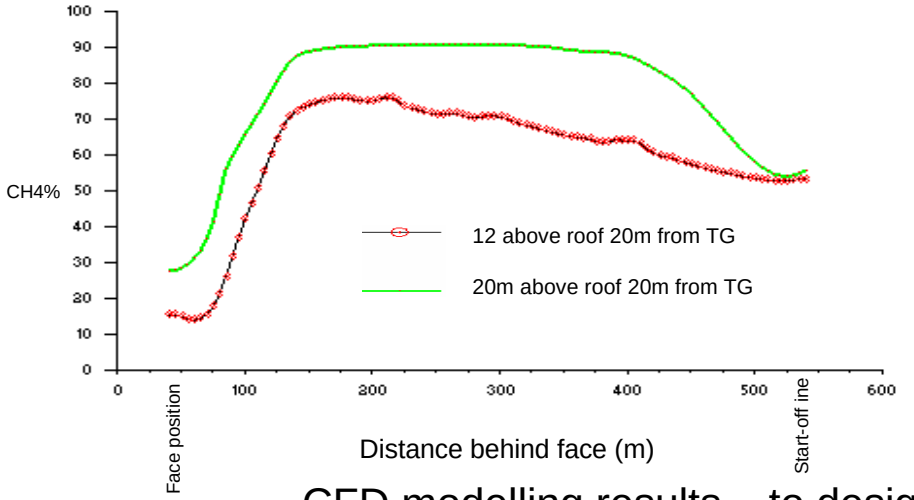
- **Current Project Progress** 项目进展
  - Demonstration mine site selected: Panyi at Huainan示范矿井为淮南潘一矿
  - Design and optimisation of advanced drainage gas systems in progress 瓦斯抽采系统的优化设计（进行中）
- **Project Partners** 项目合作伙伴
  - Huainan Coal Mining (Group) Co. Ltd.
  - China Coal Information Institute




Methane distribution pattern at the working level behind the longwall face




Methane distribution pattern at 10m behind face across the goaf




CFD modelling results – to design boreholes and roadways (to maximise methane capture)

# AGO CMM resources Project

## AGO煤矿瓦斯资源评估项目

- **Project Manager: Dr Shi Su** 项目负责人：苏适 博士
- **Project Objectives** 项目目标
  - Investigating coal mine methane resources and emission in key coal mine areas in China调查中国主要煤矿区瓦斯资源与排放现状
  - Studying the potential of CMM/VAM capture and utilisation研究煤矿瓦斯/风排瓦斯减排与利用潜力
  - Conducting a case study on predicting CMM emission and production 进行矿井瓦斯排放预测的案例分析
  - Studying policy framework for CMM development projects in China.研究中国煤矿瓦斯项目开发的政策框架

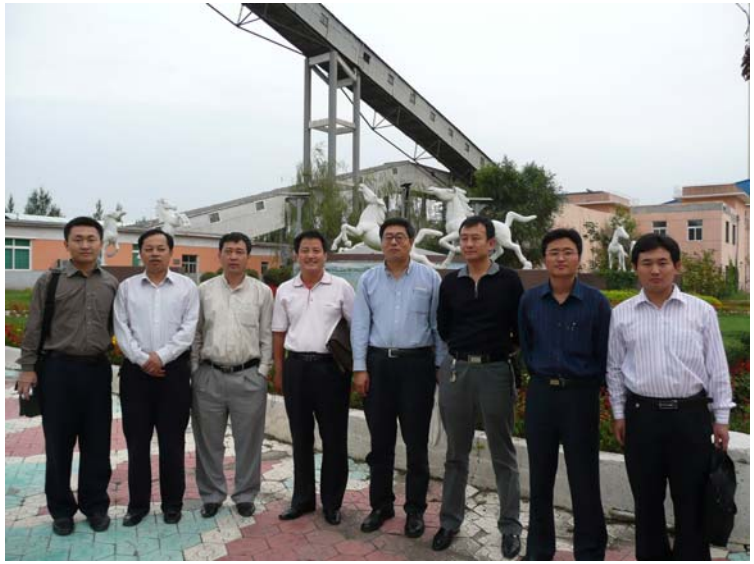
Project team at Songzao, Sept, 2007

项目组在松藻矿区调研

# AGO CMM resources Project

(Continued) **AGO煤矿瓦斯资源项目**

- **Current Project Progress** 目前项目进展
  - 5 coal mining areas selected 选定五个矿区
  - Completion of site survey at 3 mining groups 已完成在三个矿区的现场调研
- **Project Partner** 项目伙伴
  - China Coal Information Institute
- **Site Support from** 现场支持
  - Yangquan coal mining group 阳泉
  - Tiefa coal mining group 铁法
  - Songzao coal mining group 松藻
  - Huainan coal mining group 淮南
  - Zhengmei coal mining group 郑煤



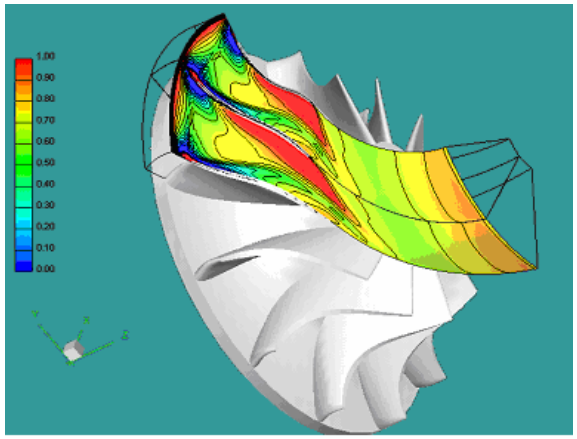
Project team at Tiefa, Sept 2007

项目组在铁法矿区调研

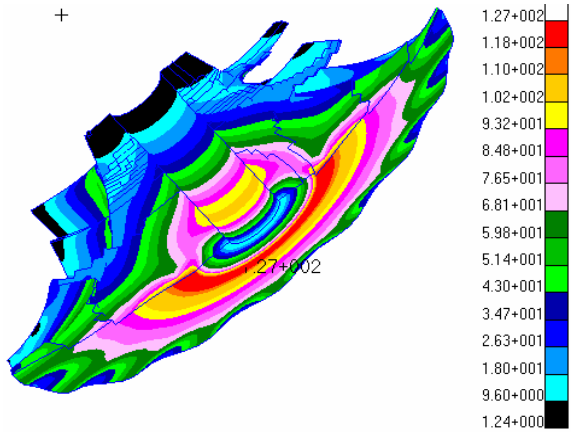
# AGO VAMCAT project

## AGO通风瓦斯燃气轮机发电示范项目

- **Project Manager: Dr Shi Su** 项目负责人：苏适 博士
- **Overall Goal** 总的目的
  - to mitigate and utilise mine ventilation air methane and poor quality drainage gas (GHG reduction, use as a clean energy source) 利用通风和低质抽放瓦斯以达到减排和作为洁净能源的目的
  - to recover heat release from methane oxidation to generate power 回收瓦斯氧化热量发电
  - can be powered with about 1% methane in air 能在大约1%瓦斯浓度下运行




- **Current AGO Project Objectives** 目前AGO项目目标
  - to develop and commission a ~30kW$_e$ prototype demonstration unit 设计与调试第一台30kW示范机组
  - to demonstrate the prototype unit at a mine site of Huainan Coal Mining Group in China 在淮南煤矿进行现场示范

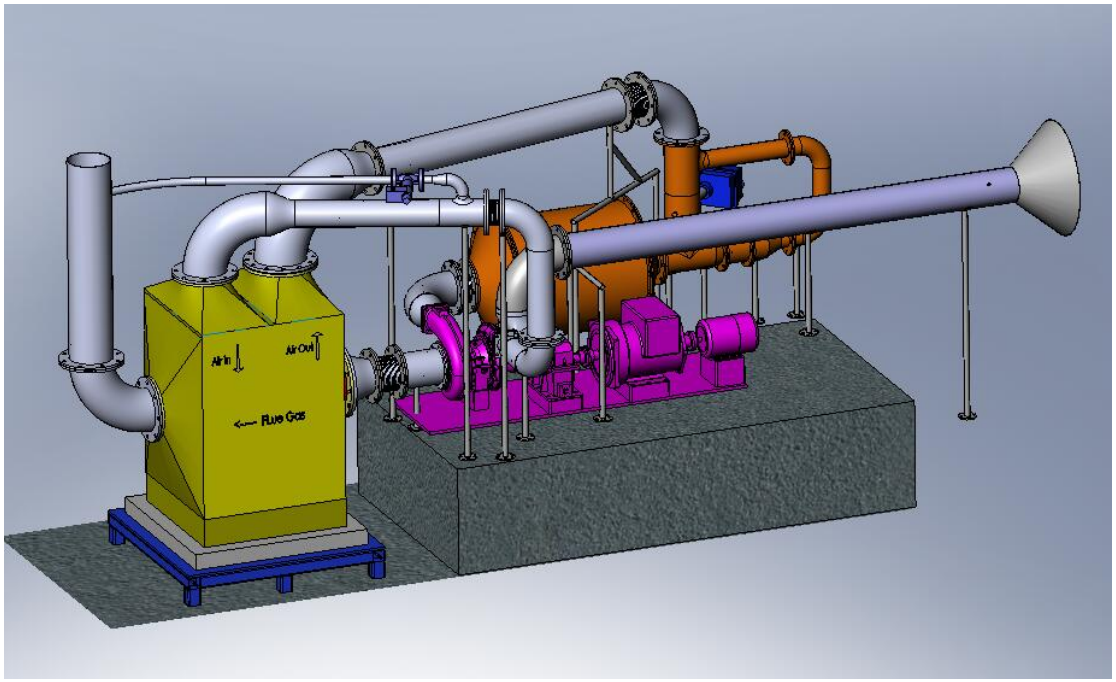



- **VAMCAT Technology** 通风瓦斯燃气轮机发电技术
  - an innovative lean burn catalytic combustion gas turbine technology 一种创新的超贫燃催化燃气轮机技术

# AGO VAMCAT project

(Continued) **AGO**通风瓦斯燃气轮机发电示范项目

- **Current Project Progress** 目前项目进展
  - Completion of designing of 30kW demo unit 完成了30kW示范机组设计
  - Constructing the demo unit is underway示范机组正在加工中
- **Project Partners** 项目伙伴
  - Shanghai Jiaotong University
  - Huainan Coal Mining (Group) Co. Ltd



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  - China Coal Information Institute: Ms Xin Sun, Mr Wenge Liu, Mr Jiaye Han, Mr Jingyan Wu, Dr Hongjun Li.
  - Shanghai Jiaotong University: Prof. Yiwu Weng, Prof. Hanping Chen, Ms Juan Yin; Mr Yaqian Liu & engineers from manufacturers
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# Thank You!
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