

ARPA-E REMEDY VAM Projects

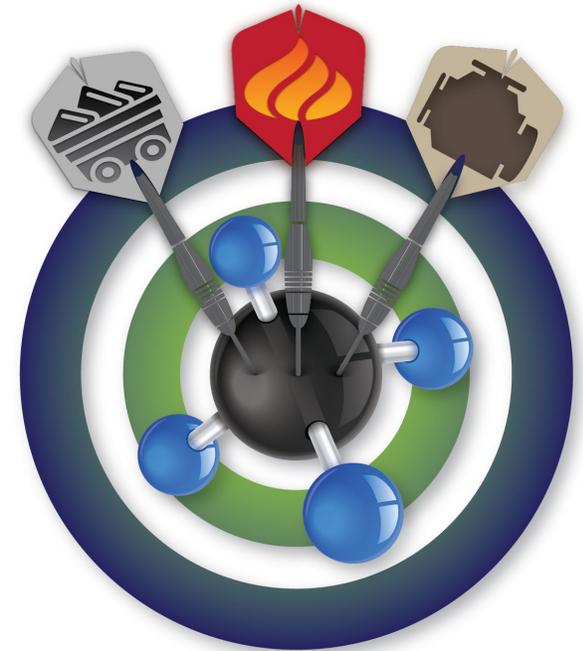
(Reducing Emissions of Methane Every Day of the Year)

2024 Global Methane Forum

Jack Lewnard, Program Director

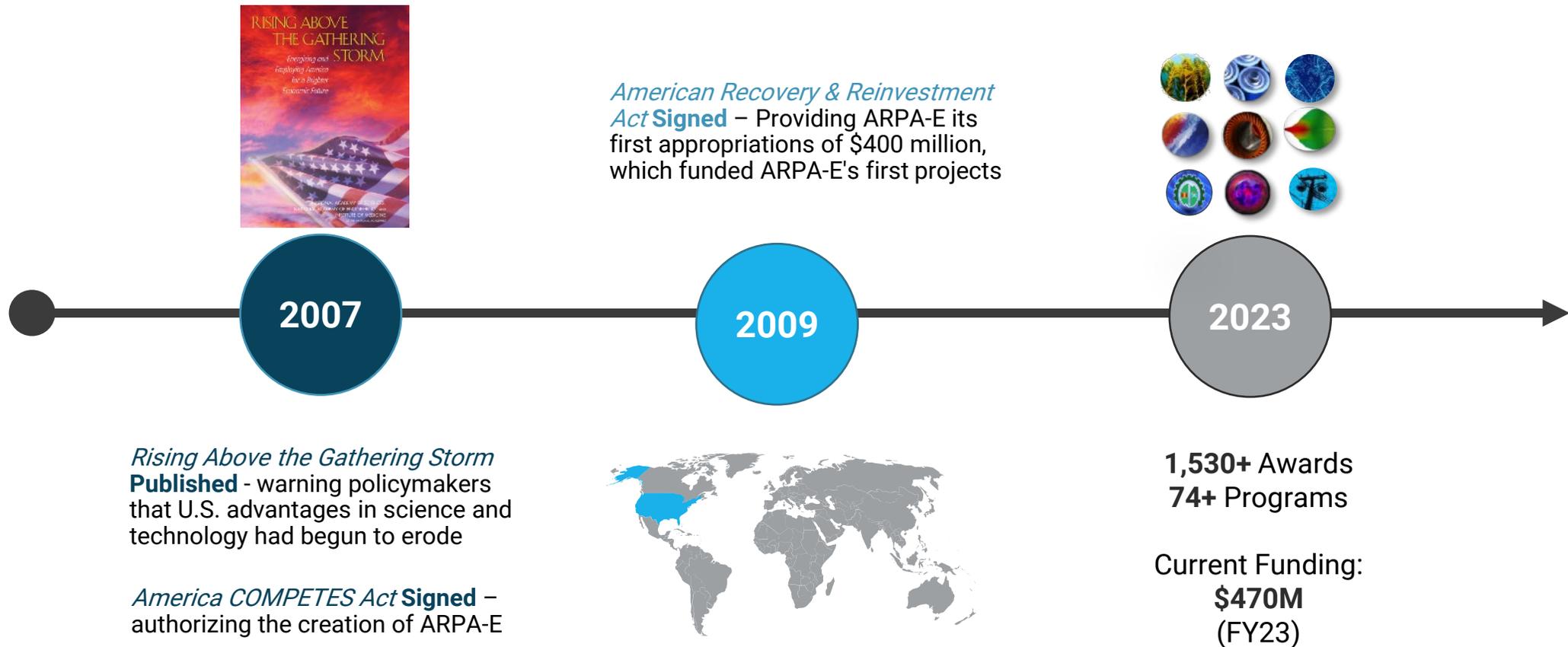
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202-507-0003



ARPA-E: Fund High-Impact, High Risk Disruptive Technologies

In 2007, The National Academies recommended Congress establish an Advanced Research Projects Agency within the U.S. Department of Energy to fund advanced energy R&D.



REMEDY Methane Abatement Program

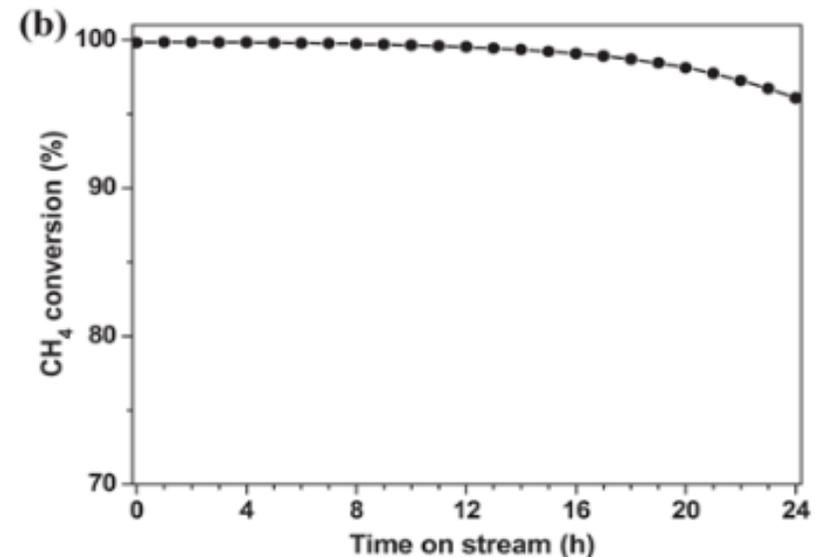
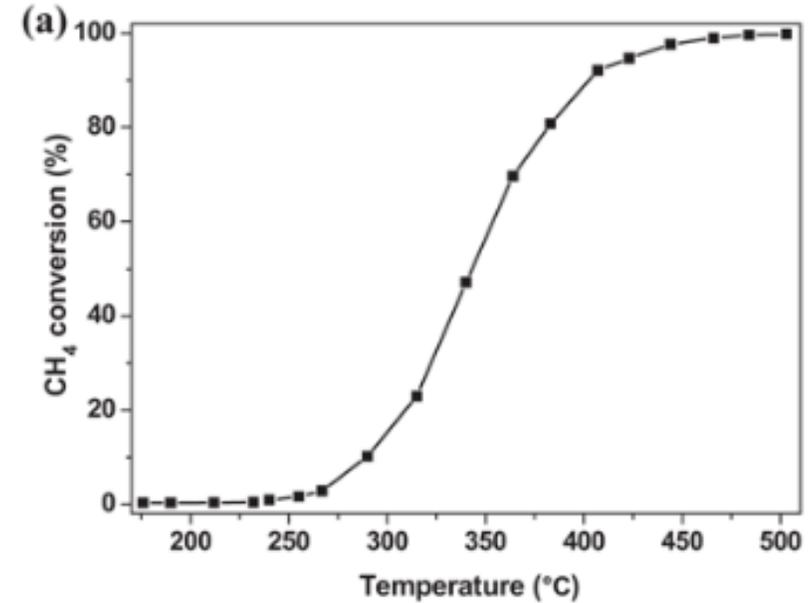
- ▶ 3 yr, \$40MM program funding diverse teams, multiple approaches
 - 40,000+ natural gas-fired engines
 - 300,000 oil and gas flares
 - 200 coal mine ventilation shafts

- ▶ Stage 1: Lab-scale proof of concept, preliminary economics

- ▶ Stage 2: Field test for **system** proving 99.5% methane conversion to CO₂ and <\$40/ton CO₂ equivalent (GWP 28)

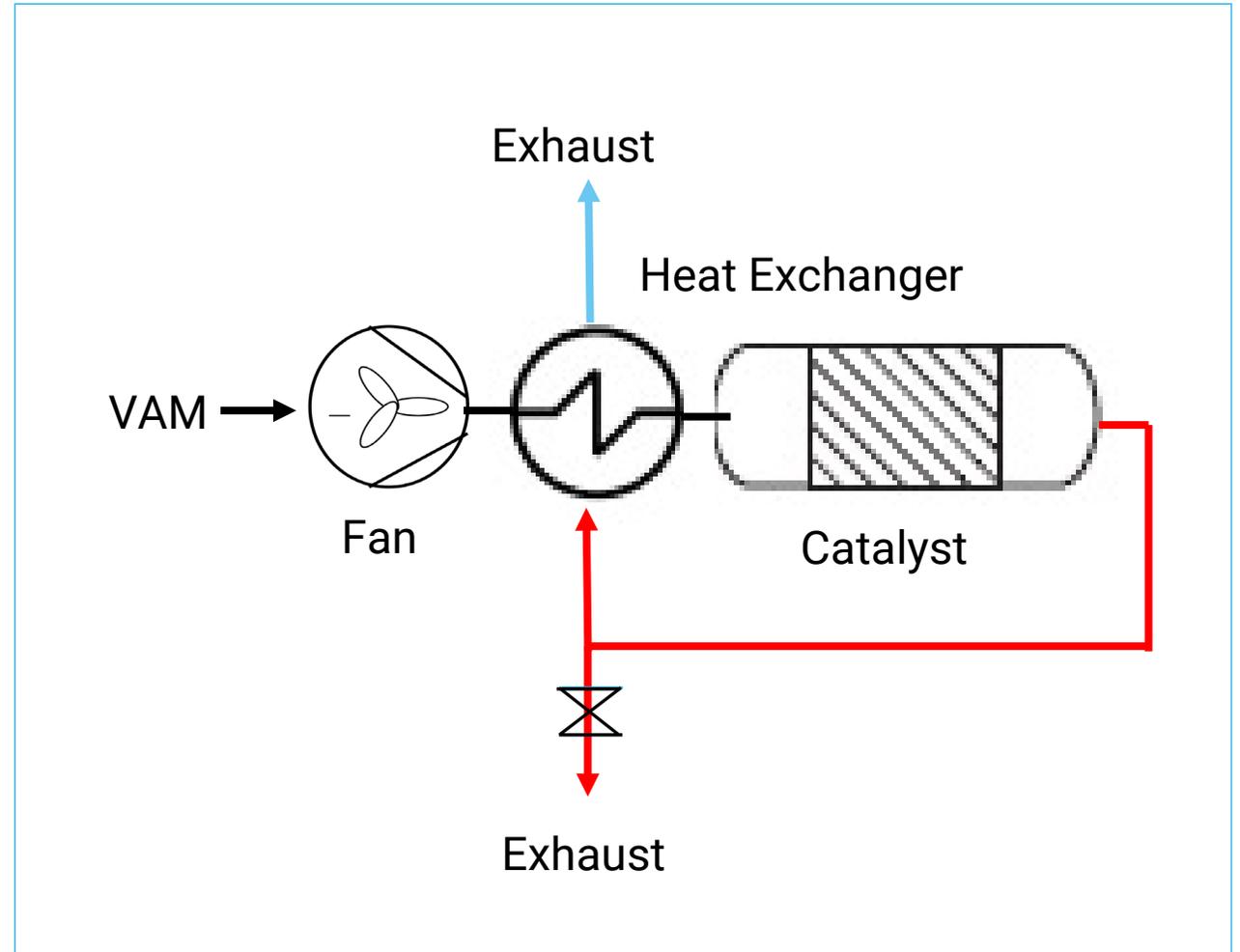
VAM Approach: Catalytic Oxidation with Recuperator

- ▶ VAM:
 - VAM too dilute to sustain combustion
 - Methane won't ignite below 600 C
- ▶ VAM Options
 - Enrich/Supplemental fuel
 - RTO –commercial today
 - **Catalytic combustion**
- ▶ What's new?
 - New catalyst materials/formats
 - Lower light-off temperature
 - Longer catalyst life
 - Lower overall costs



Potential Advantages

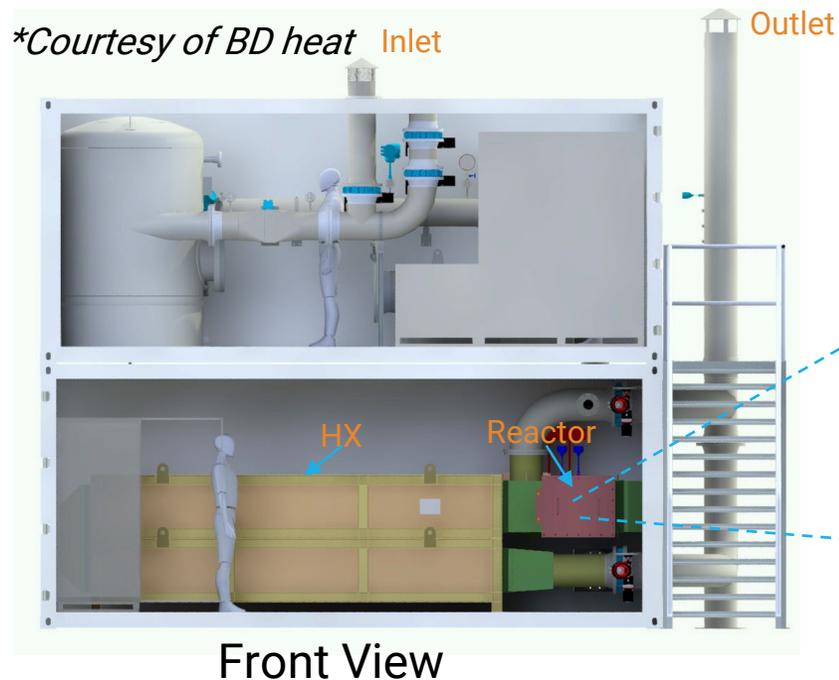
- ▶ Hardware
 - Lower operating temperature
 - Wider methane concentration range
 - Low VAM gas pressure drop
- ▶ Modular
 - Replicable design; minimize engineering cost
 - Minimize field cost
 - More easily “Move-able”



Johnson Matthey Project – Bituminous Coal Field Test

- Catalyst development and design complete
- All government permits approved
- Field test unit fabrication in progress
- Expected commissioning by Nov 2024
- Interested in international opportunities

Field Test Unit Design



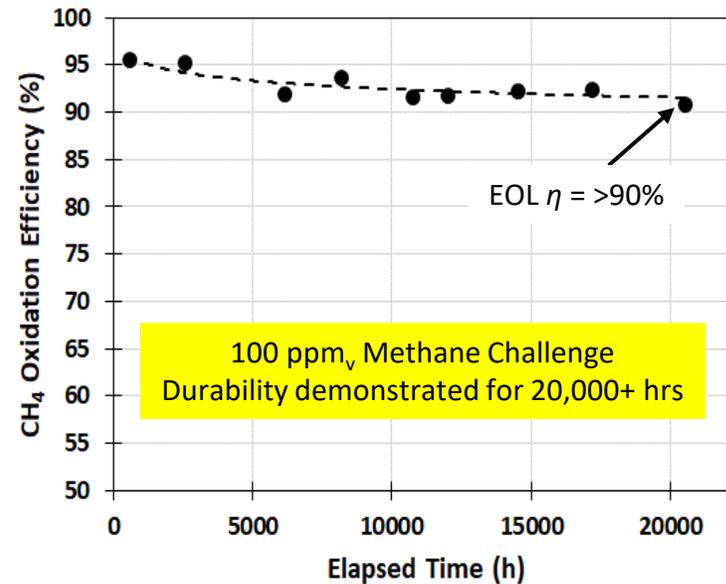
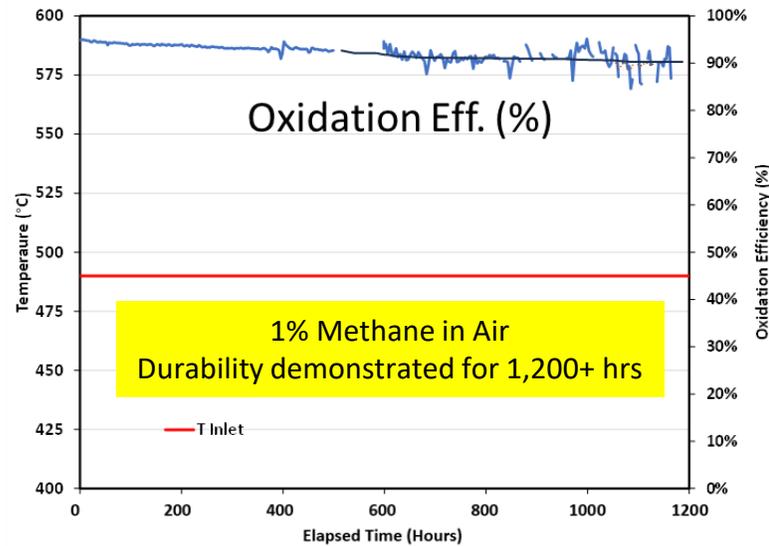
Catalyst design

- Monolith catalyst
- Lower temperature
- Operates 0.1mol% CH₄
- Continuous flow and scalable
- High conversion, no NO_x
- Potential for power generation

PCI Project – Metallurgical Coal Field Test



- Scale up of reactor and system ongoing, 2025 field test
- Options for stand-alone catalytic reactor or “polishing” RTO’s
- Seeking partnerships

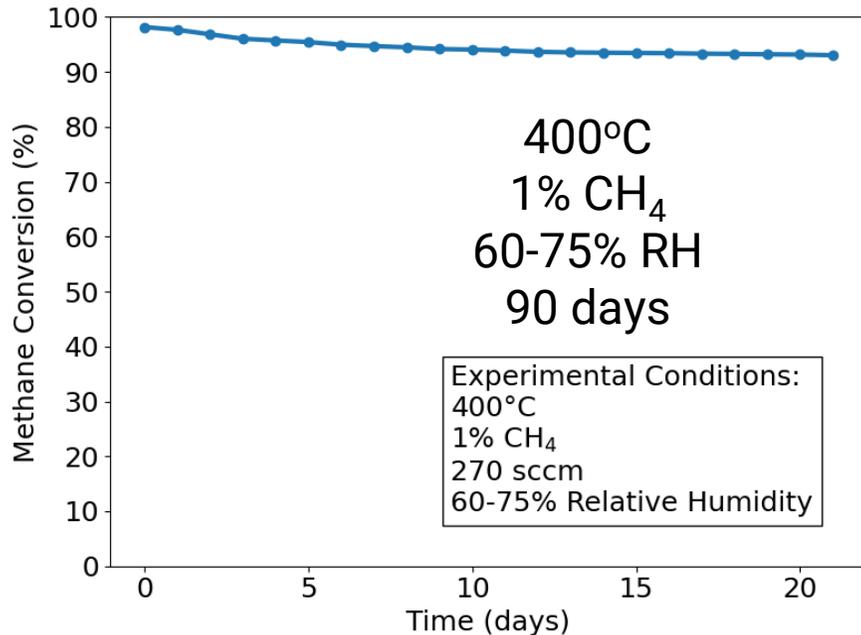


** S.A. Vilekar, et al.; Performance of Flight Compatible Microlith® Catalytic Oxidizer for Exploration Trace Contaminant Control; 52nd ICES-2023-1; 16-20 July 2023, Calgary, Canada

MIT Project – Bituminous Coal Field Test



- Low cost, non-PGM catalyst
- Low-temperature (400°C)
- Durable, Resistant to poisons
- 100% conversion of 2 ppm-2% CH₄ + variable input
- 2025 field test
- MOXAIR start-up seeking partners



REMEDY Needs Engagement with the Coal Mining Industry

- ▶ Goal is de-risking potential technical approaches from the perspective of
 - Coal mine operators
 - 3rd party owner/operators
 - Carbon credit trading agencies
 - Regulators (MSHA, EPA, states, international agencies)
- ▶ Specific Input Possibilities:
 - Mine site prioritization, access
 - Prior VAM data, future emission projections
 - Life Cycle Analysis, Levelized Cost of Carbon data/guidance for teams
 - Engineering, operations, safety
 - Recommendations for VAM stakeholders – engineering, environmental companies; researchers, equipment vendors
- ▶ Success requires communications and coordination among stakeholders

Teams and Contacts

- ▶ ARPA-E REMEDY Program Director jack.lewnard@hq.do.gov
- ▶ Catalytic Oxidation of Ventilation Air Methane
Prime: Johnson Matthey Inc.
Team Members: Oak Ridge National Laboratory, CONSOL Energy Inc.
Joseph Fedeyko Joseph.Fedeyko@jmusa.com
- ▶ Destruction of VAM Using a Modular Catalytic Element System
Prime: Precision Combustion Inc (PCI)
Team members: SRK Consulting, University of Kentucky
Subir Roychoudhury sroychoudhury@precision-combustion.com
- ▶ VAM Abatement via Catalytic Oxidation (VAMCO)
Prime: Massachusetts Institute of Technology
Team Members: Northeastern University; Fluor; Alliance Resource Partners
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