CHANGING WHAT'S POSSIBLE

ARPA-E MONITOR Program Kickoff

Denver, Colorado · May 12-13, 2015

CHANGING WHAT'S POSSIBLE

Introduction to MONITOR

Developing Low-Cost, Highly Sensitive Technologies for Improved Methane Detection

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Program Director

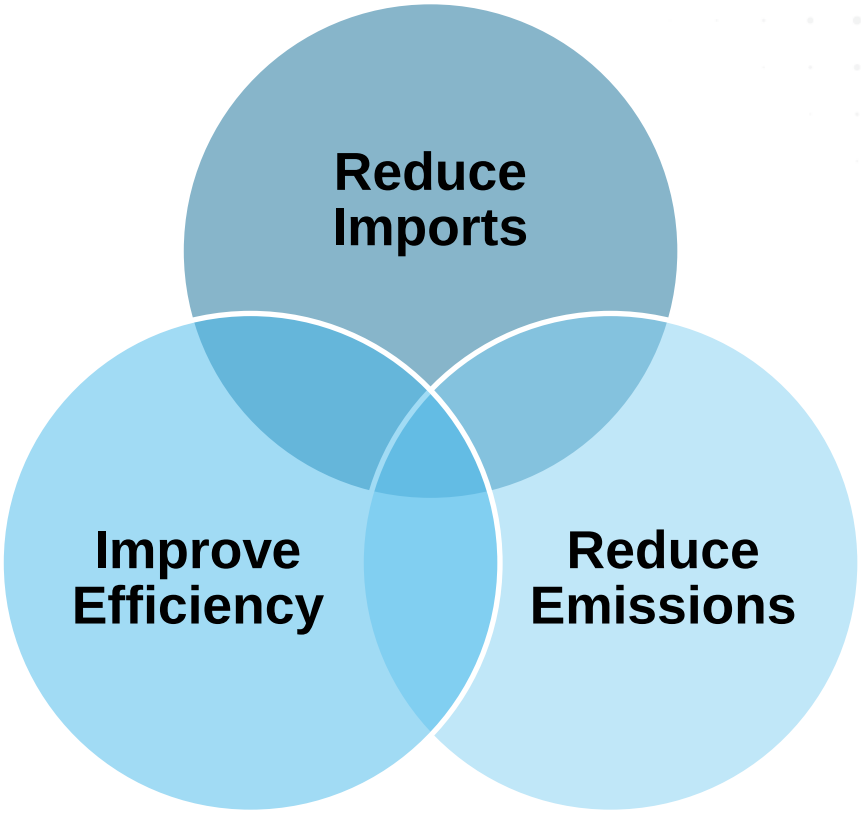
May 12, 2015

The ARPA-E Mission

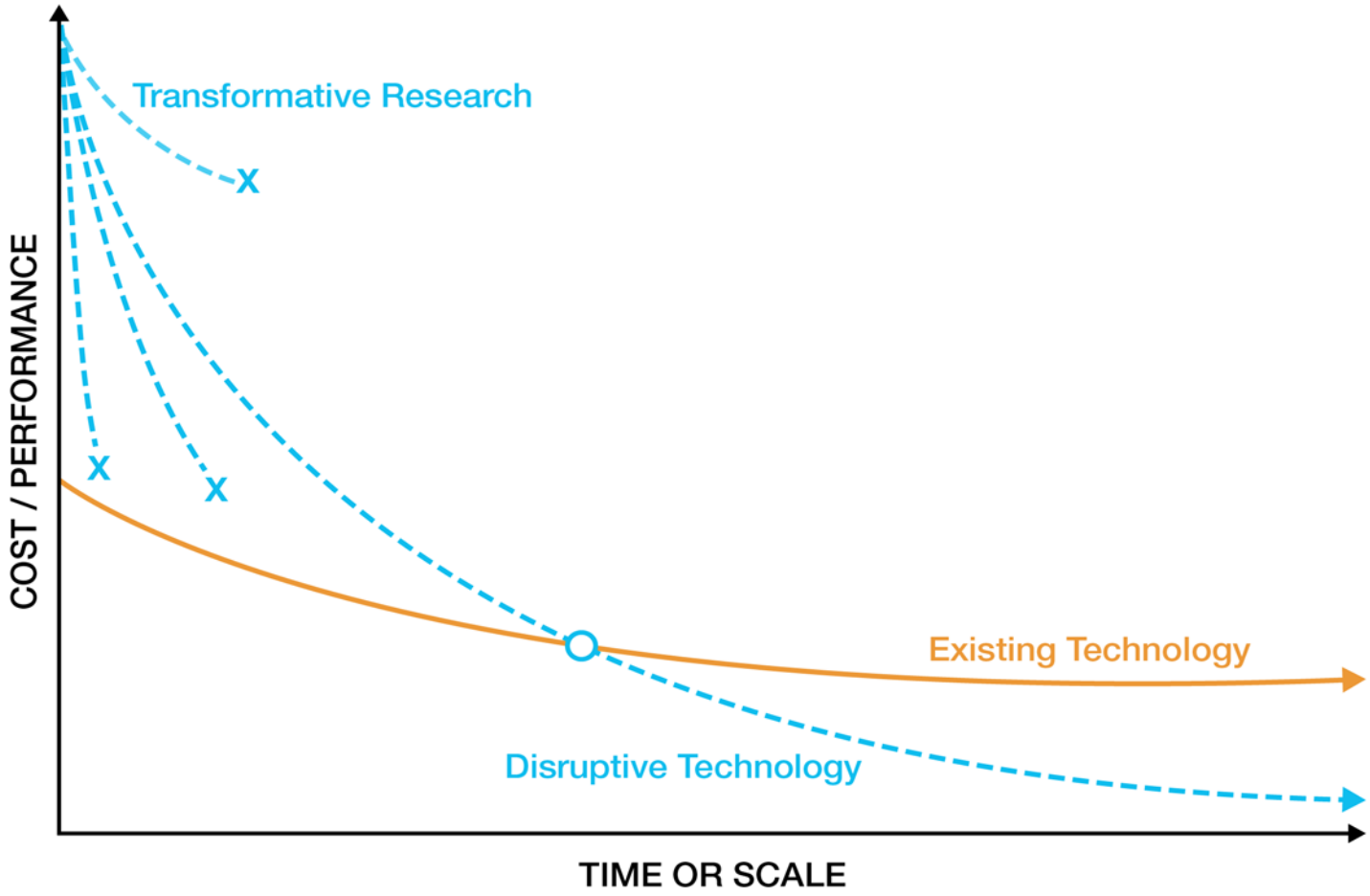
Catalyze and support the development of transformational, high-impact energy technologies

Ensure America's

- Economic Security
- Energy Security
- Technological Lead



Creating New Learning Curves



What Makes an ARPA-E Project?

IMPACT

- High impact on ARPA-E mission areas
- Credible path to market
- Large commercial application

TRANSFORM

- Challenges what is possible
- Disrupts existing learning curves
- Leaps beyond today's technologies

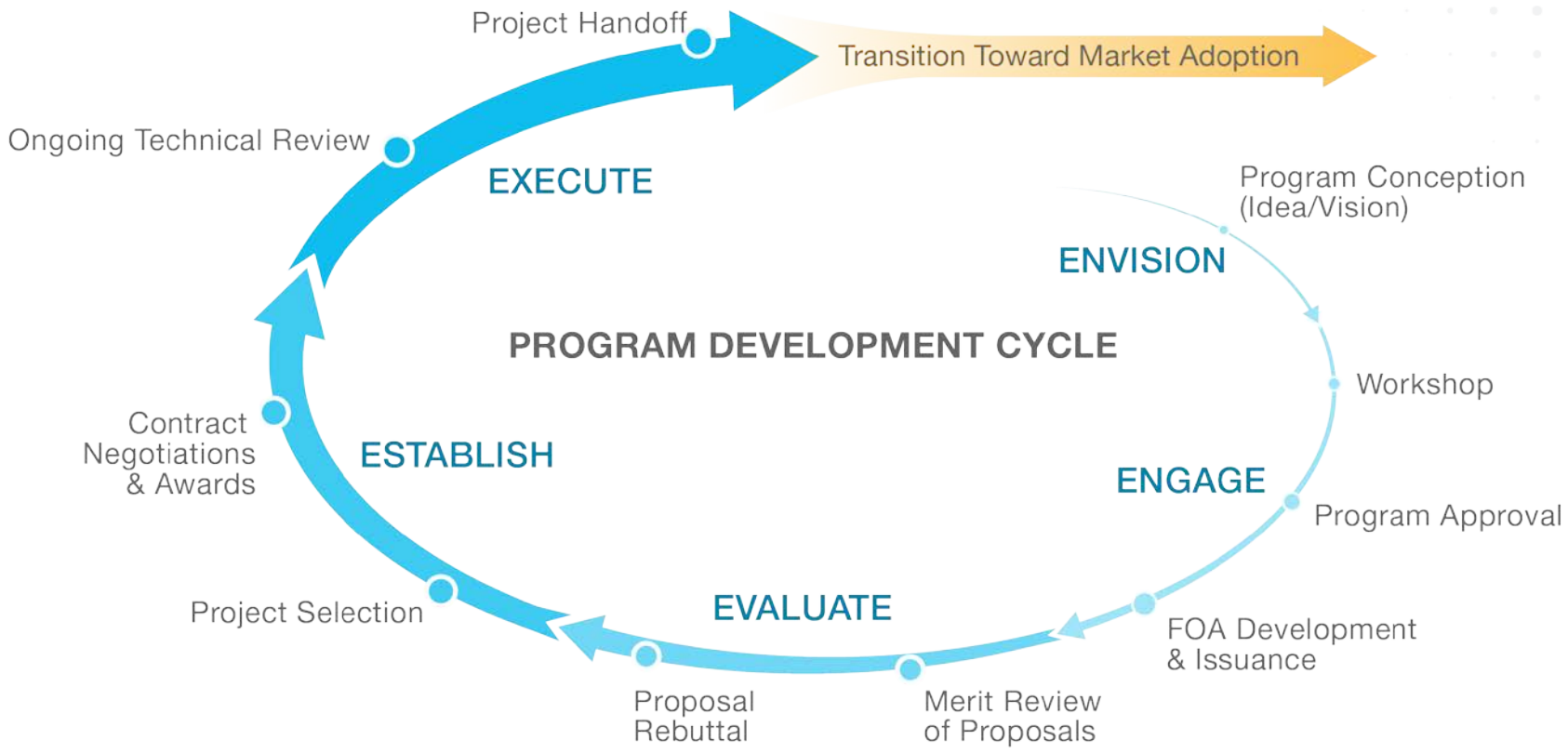
BRIDGE

- Translates science into breakthrough technology
- Not researched or funded elsewhere
- Catalyzes new interest and investment

TEAM

- Comprised of best-in-class people
- Cross-disciplinary skill sets
- Translation oriented

Technology Acceleration Model



Focused and Open Programs at ARPA-E

Open Solicitations

OPEN 2009	OPEN 2012 IDEAS	OPEN 2015

Stationary Energy

ADEPT Solar ADEPT GRIDS GENSETS	IMPACCT BEETIT GENI ARID	FOCUS REBELS MONITOR

Transportation Energy

BEEST PETRO	Electrofuels MOVE TERRA	RANGE REMOTE

Stationary & Transportation Energy

HEATS AMPED	REACT SBIR/STTR	METALS SWITCHES

Focused and Open Programs at ARPA-E

Open Solicitations

Why **MONITOR?**
Why **now?**

Focused Programs

Open Solicitations

OPEN 2009	OPEN 2012 IDEAS	OPEN 2015

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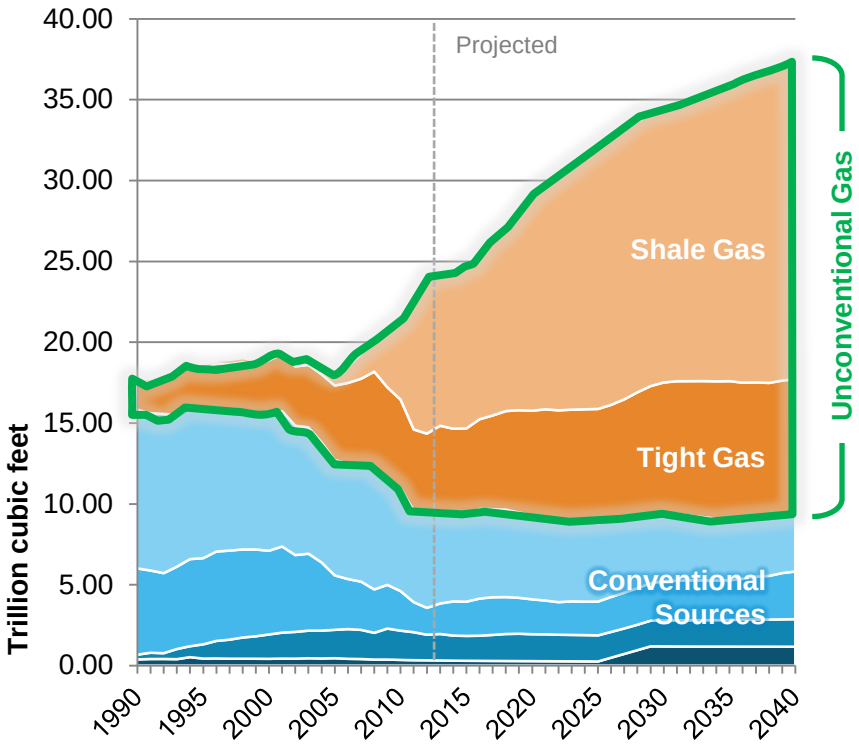
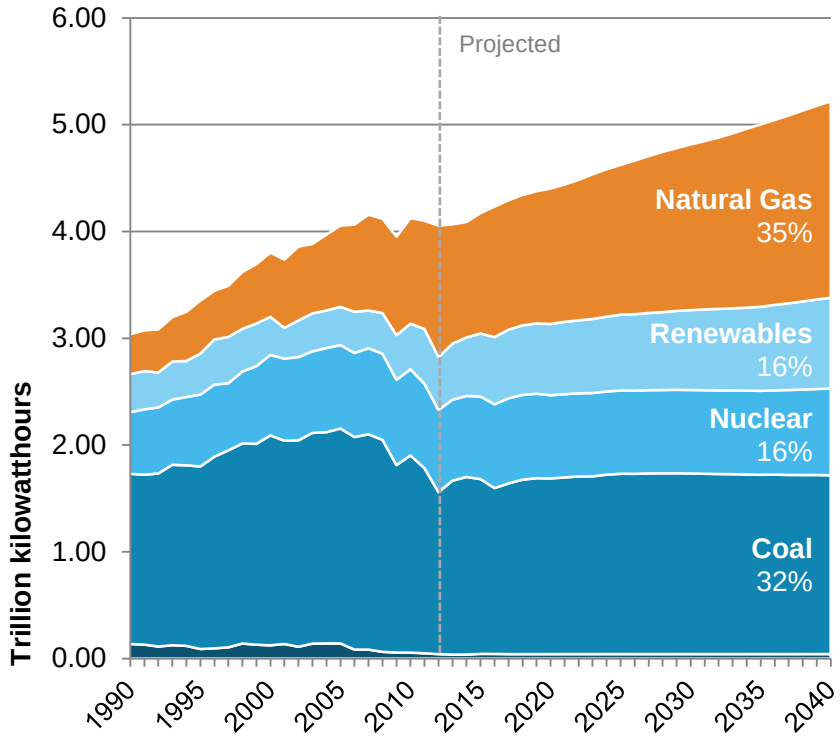
Responding to the Natural Gas Boom

Rapid growth in domestic oil and gas production has been driven by advances in horizontal drilling and hydraulic fracturing, allowing the U.S. to tap vast unconventional gas reserves; by 2035, natural gas is expected to surpass coal as the largest fuel burned to generate electricity

U.S. Dry Natural Gas Production, 1990-2040



Electricity Generation by Fuel, 1990-2040



Source: U.S. Energy Information Administration Annual Energy Outlook

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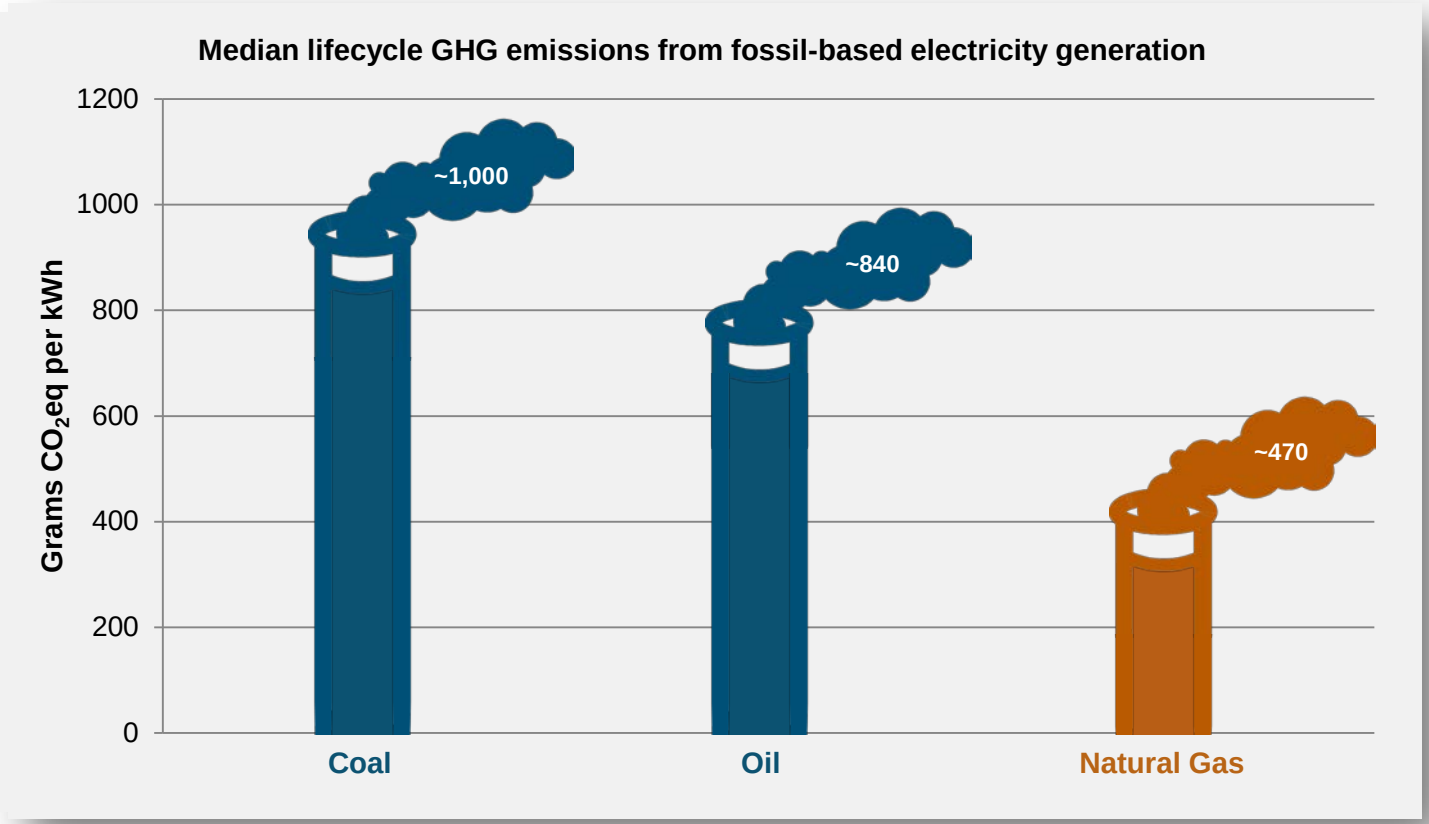
The Environmental Case for Natural Gas

On a lifecycle basis, natural gas emits nearly half the level of greenhouse gases as coal when burned; the challenge is ensuring that environmental risks throughout the supply chain are effectively mitigated



Source: IPCC AR4 Annex II (2007)

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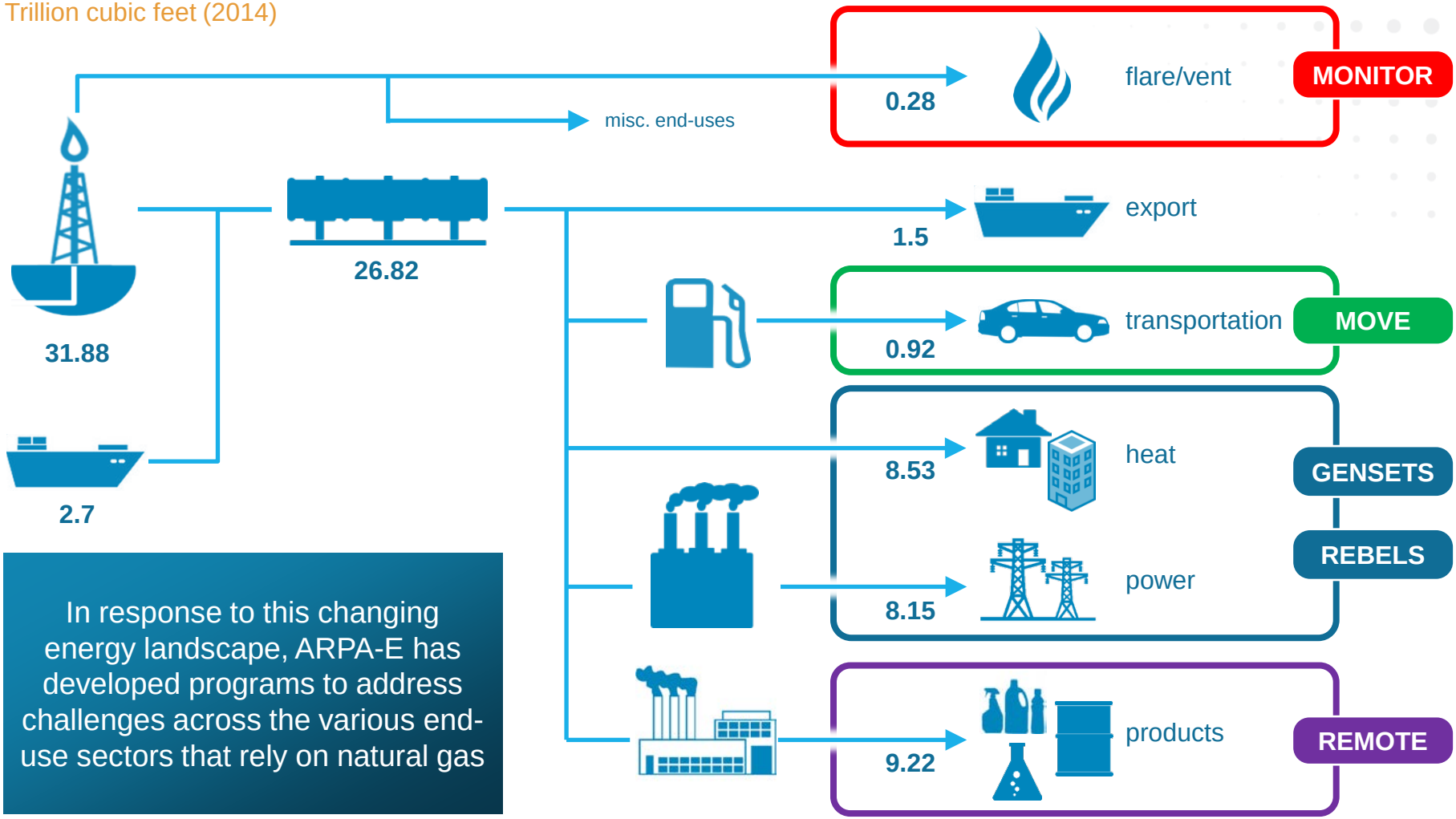
ARPA-E and the Natural Gas Boom

Trillion cubic feet (2014)

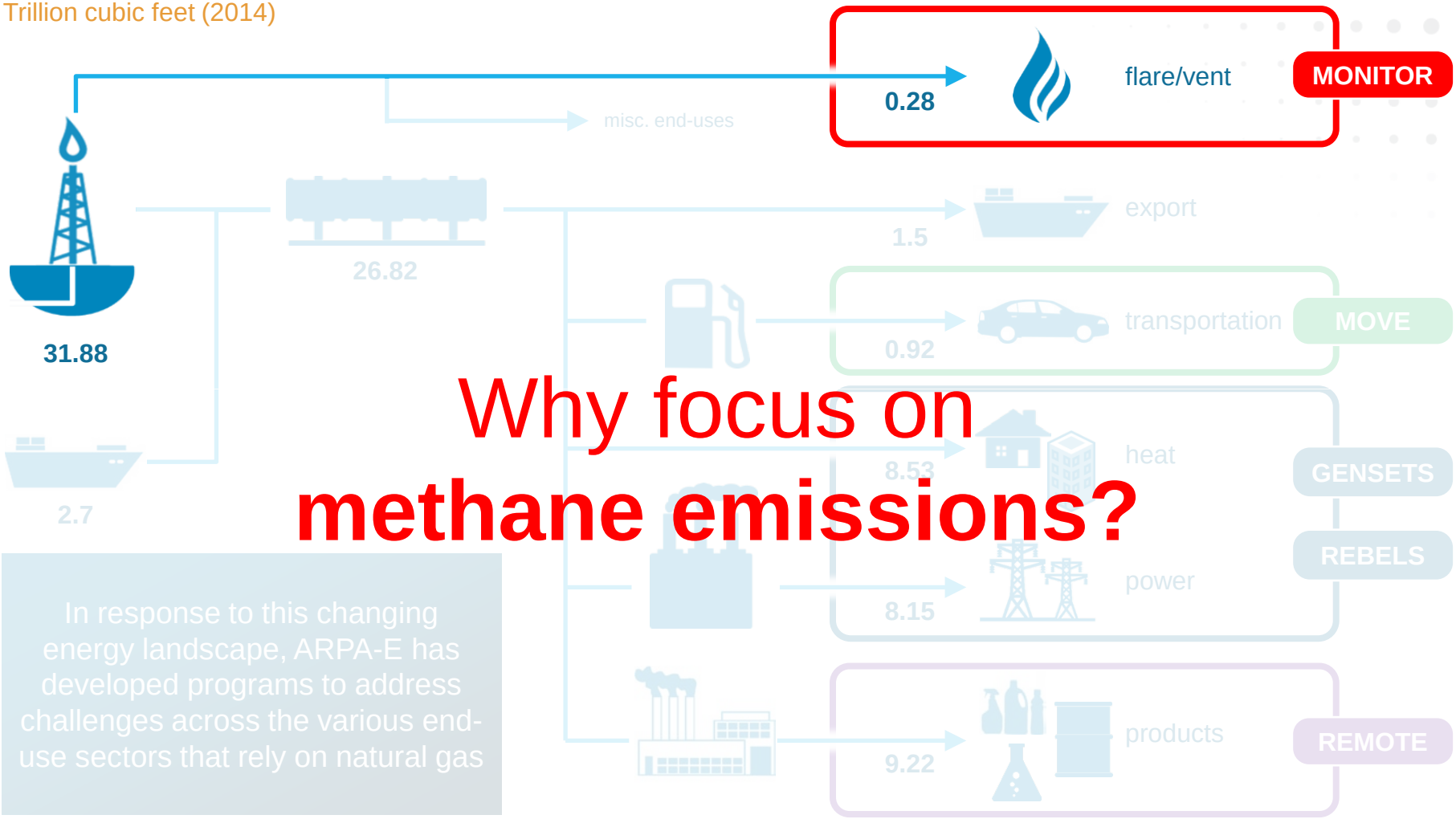


In response to this changing energy landscape, ARPA-E has developed programs to address challenges across the various end-use sectors that rely on natural gas

Source: U.S. Energy Information Administration Annual Energy Review Natural Gas Flow (2015)

ARPA-E and the Natural Gas Boom

Trillion cubic feet (2014)



Why focus on **methane emissions?**

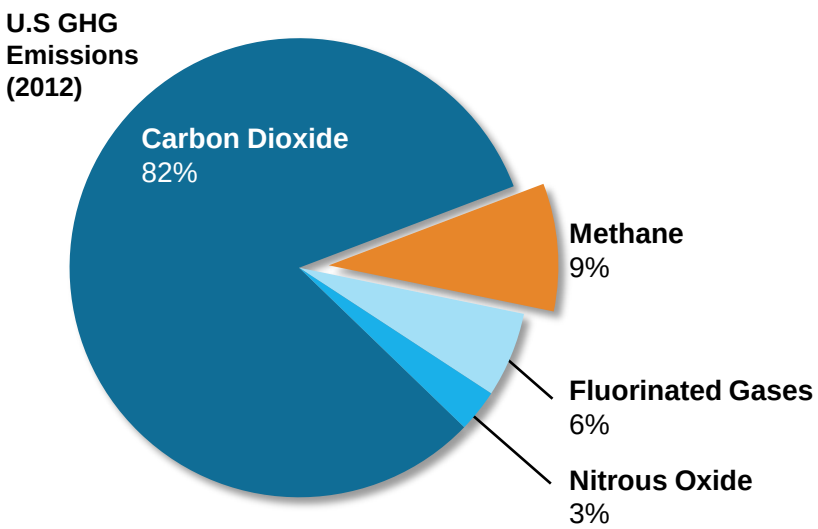
In response to this changing energy landscape, ARPA-E has developed programs to address challenges across the various end-use sectors that rely on natural gas

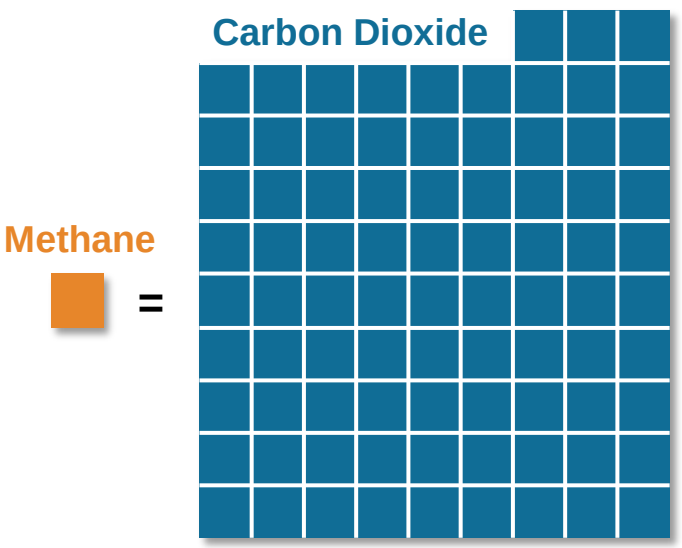
Source: U.S. Energy Information Administration Annual Energy Review Natural Gas Flow (2015)

The Importance of Focusing on Methane

Methane – the main component of natural gas – accounts for about one-tenth of U.S. greenhouse gas emissions

However, over a 20-year period, one gram of methane has 84 times the global warming potential as the same amount of carbon dioxide





Source: EPA Greenhouse Gas Inventory, IPCC AR5 (2013)

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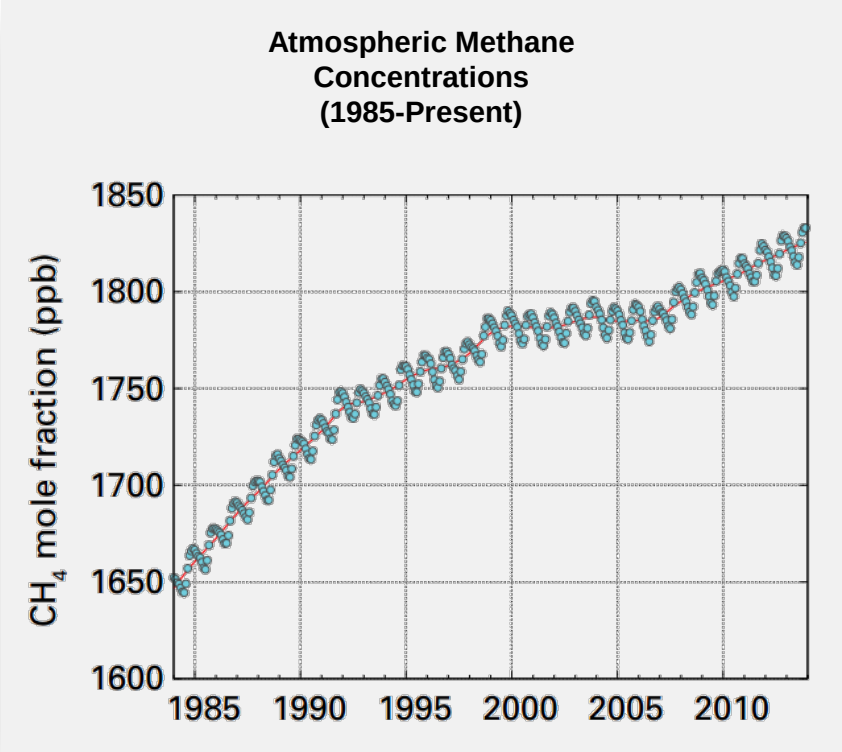
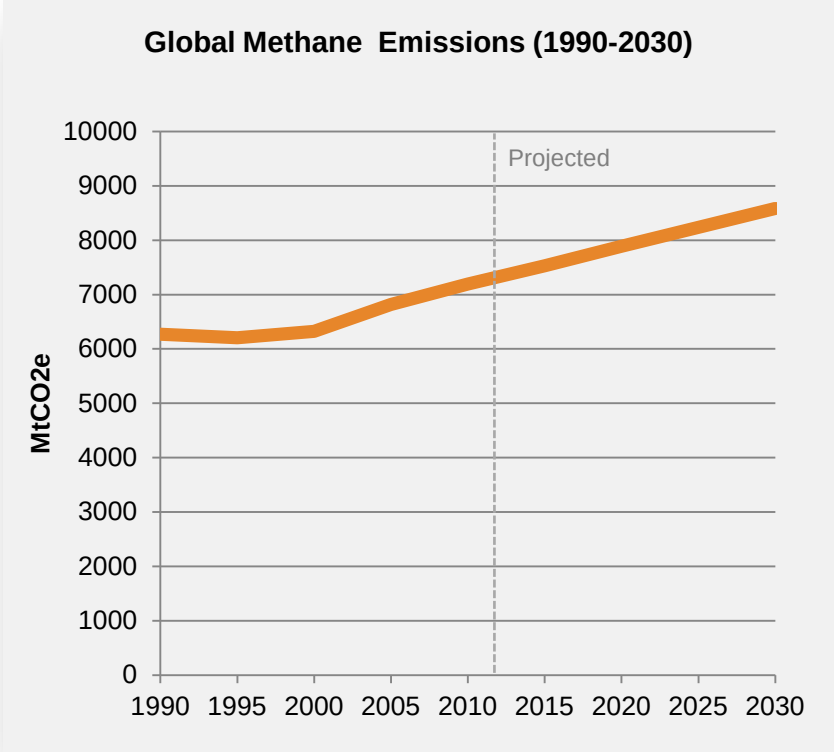
Methane Emissions as a Growing Problem

Atmospheric methane concentrations have increased about 10% since the mid-1980s and global emissions are expected to grow an additional 20% by 2030





Source: WMO Greenhouse Gas Bulletin (Sept. 2014), EPA Non-CO2 GHG Emissions 1990-2030 (Dec. 2012)

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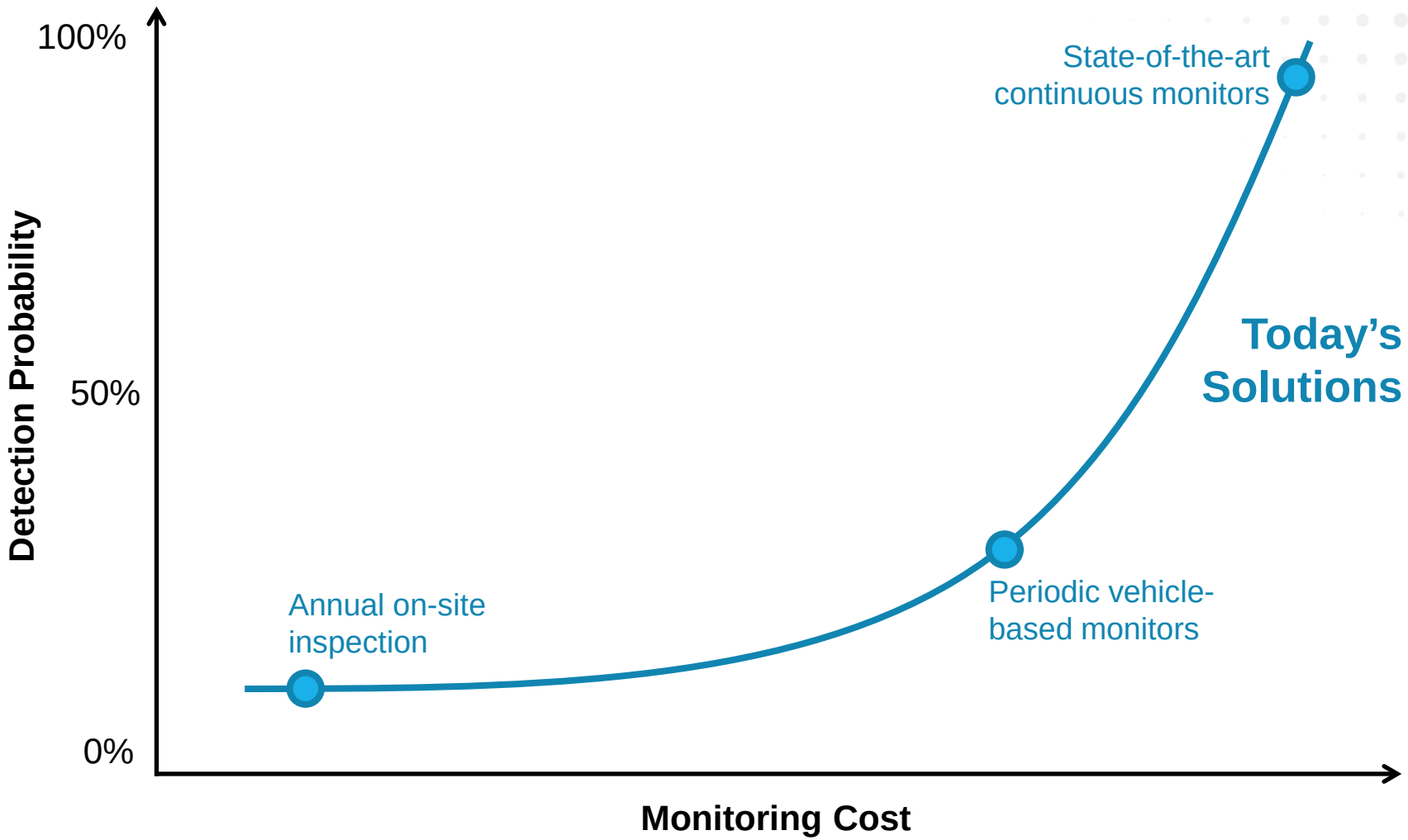
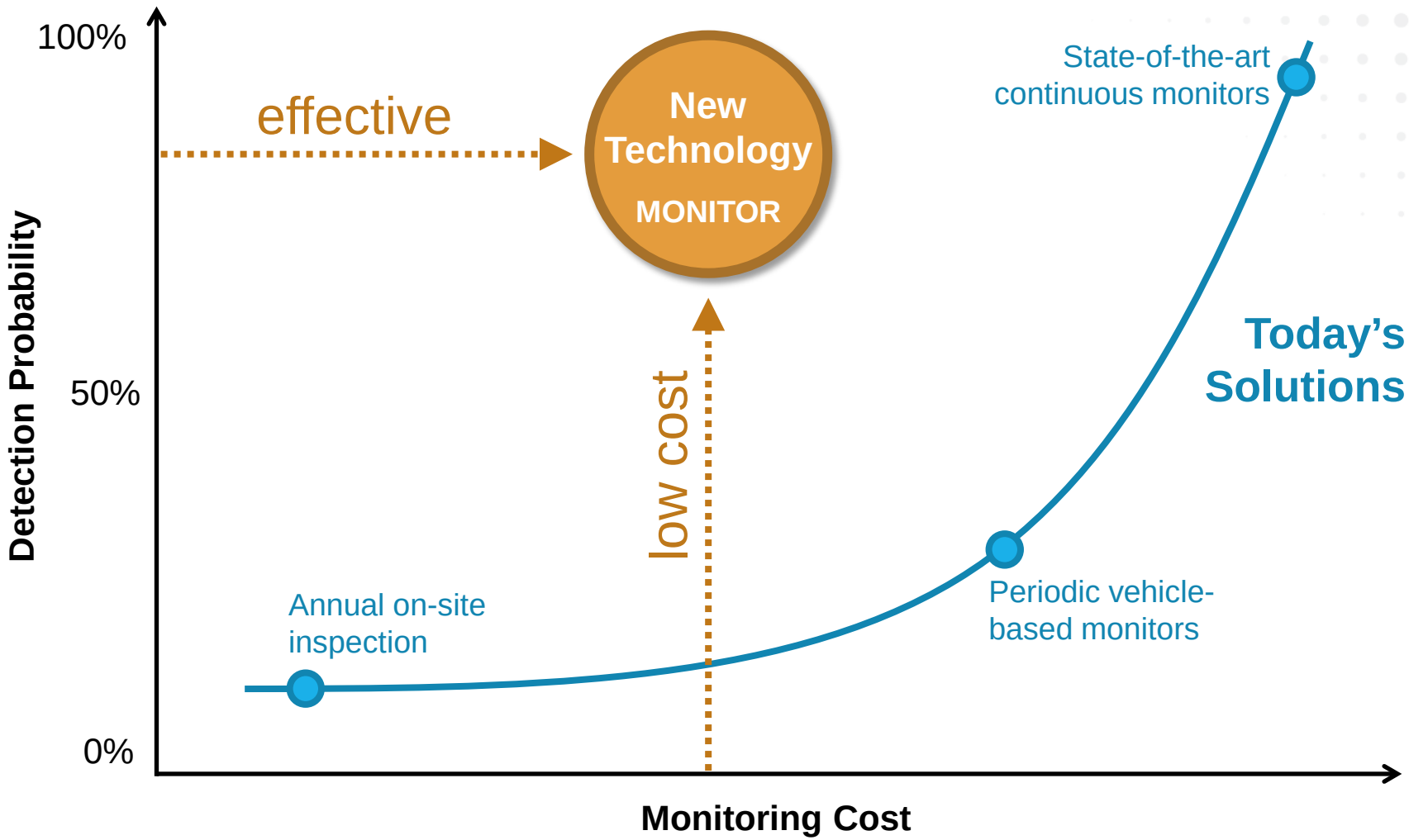
Today's Methane Sensing Solutions



Tomorrow's Methane Sensing Solutions



MONITOR Metrics & Targets

Detection Threshold	1 ton per year (6 standard cubic feet per hour)
Cost	$3,000 per site per year (for basic functionality)
Resulting Leak Reduction	90% methane leakage reduction with a 90% confidence level
False Positives	No more than 1 per year
Mass Flow Rate	Able to estimate mass flow rate within 20% margin of error
Leak Location	Able to estimate location within 1 meter
Communications	Transmits results wirelessly to remote receiver
Enhanced Functionality	Methane selectivity, speciation capability, thermogenic/biogenic differentiation, continuous measurement, enhanced stability

Two Technology Categories

Complete measurement systems: *6 projects*

- Systems that include: (1) methane emission sensing; (2) methane leakage characterization and data analytics in order to estimate the leakage rates and approximate location of leaks; (3) provisions for data quality control; (4) digital communication; and (5) enhanced functionality

Partial measurement systems: *5 projects*

- Nascent technologies that may be too early in the development process for incorporation into a complete sensing systems, but that could significantly contribute to progress towards the system level objectives in this FOA. Partial solutions are primarily envisioned as advances in detector technology or data analytics

The Portfolio: 11 Projects in 9 States

SYSTEM SOLUTIONS

BRIDGER PHOTONICS

Mobile LiDAR Sensors for Methane Leak Detection

Bozeman, MT

parc A Xerox Company

Printed Carbon Nanotube Sensors for Methane Leak Detection

Palo Alto, CA

IBM

On-Chip Optical Sensors and Network for Methane Leak Detection

Yorktown Heights, NY

PSI Physical Sciences Inc.

UAV-based Laser Spectroscopy for Methane Leak Detection

Andover, MA

REBELLION PHOTONICS

Portable Imaging Spectrometer for Methane Leak Detection

Houston, TX

AERIS TECHNOLOGIES

Miniaturized Tunable Laser Spectrometer for Methane Leak Detection

Redwood City, CA

PARTIAL SOLUTIONS

MAXION

Tunable Mid-infrared Laser for Methane Sensing

Jessup, MD

GE

Microstructured Optical Fiber for Methane Sensing

Niskayuna, NY

Duke UNIVERSITY

Miniaturized Coded Aperture Mass Spectrometer for Methane Sensing

Durham, NC

LI-COR

Laser Spectroscopic Point Sensor for Methane Leak Detection

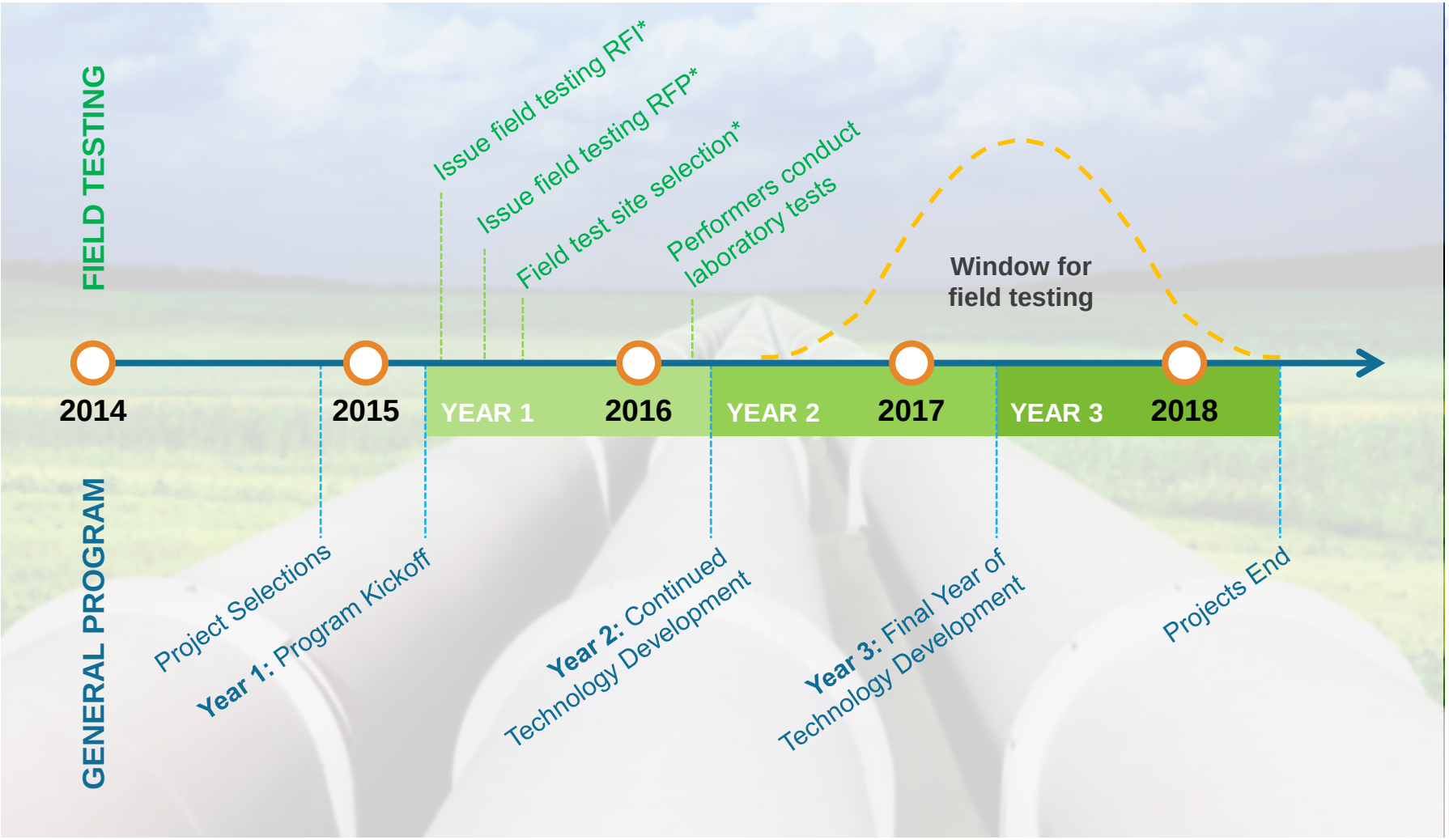
Lincoln, NE

University of Colorado Boulder

Frequency Comb-based Methane Sensing

Boulder, CO

The MONITOR Timeline: ARPA-E & Beyond



*Subject to change

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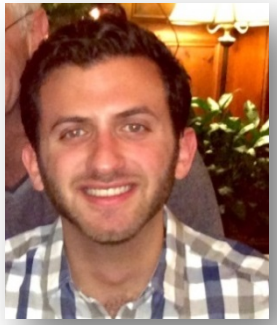

Adam Fischer
General Program Support

U.S. DEPARTMENT OF ENERGY