

**Solar<sup>®</sup> Turbines**  
*A Caterpillar Company*

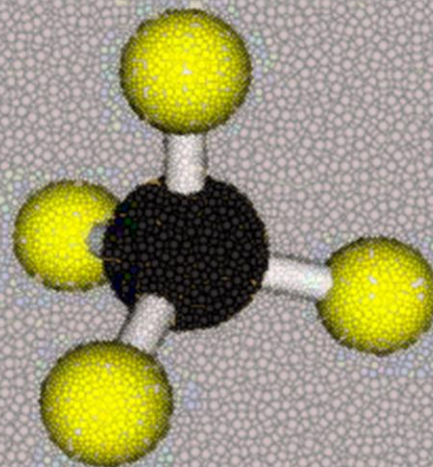
# Fugitive Methane Emissions Reduction Solutions

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# Environmental Impact



120x more powerful than  
CO<sub>2</sub> in trapping heat



Cut CH<sub>4</sub> Pollution by  
**45% by  
2025**

Ref: Environmental Defense Fund

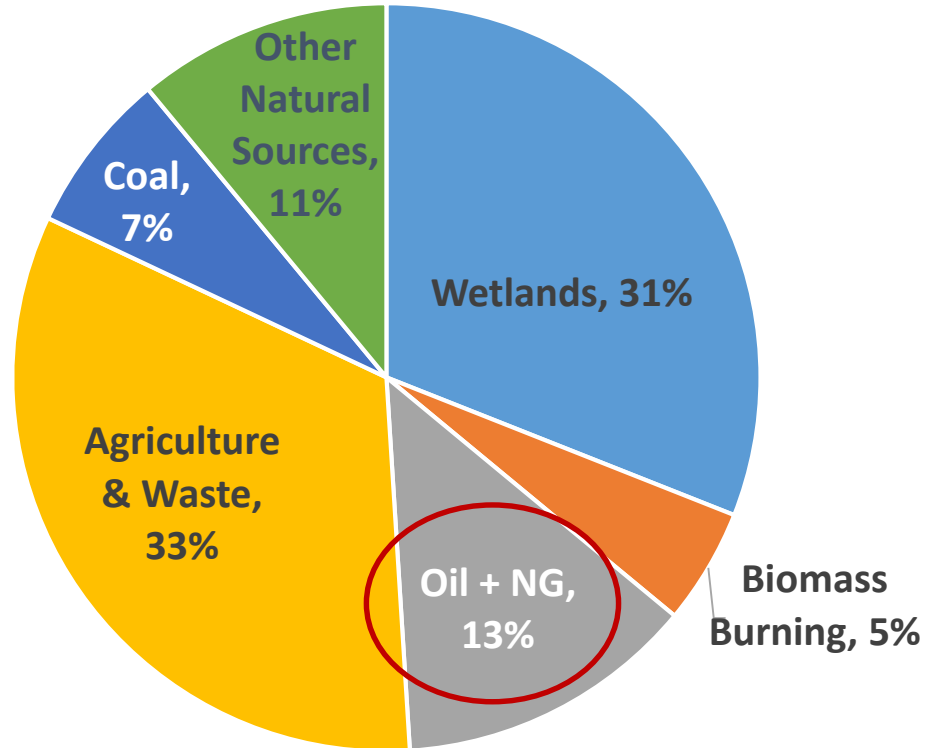
<https://www.youtube.com/watch?v=mcsCVQF6ODs>

<https://www.edf.org/approach/fourth-wave/satellite-ted-talk>



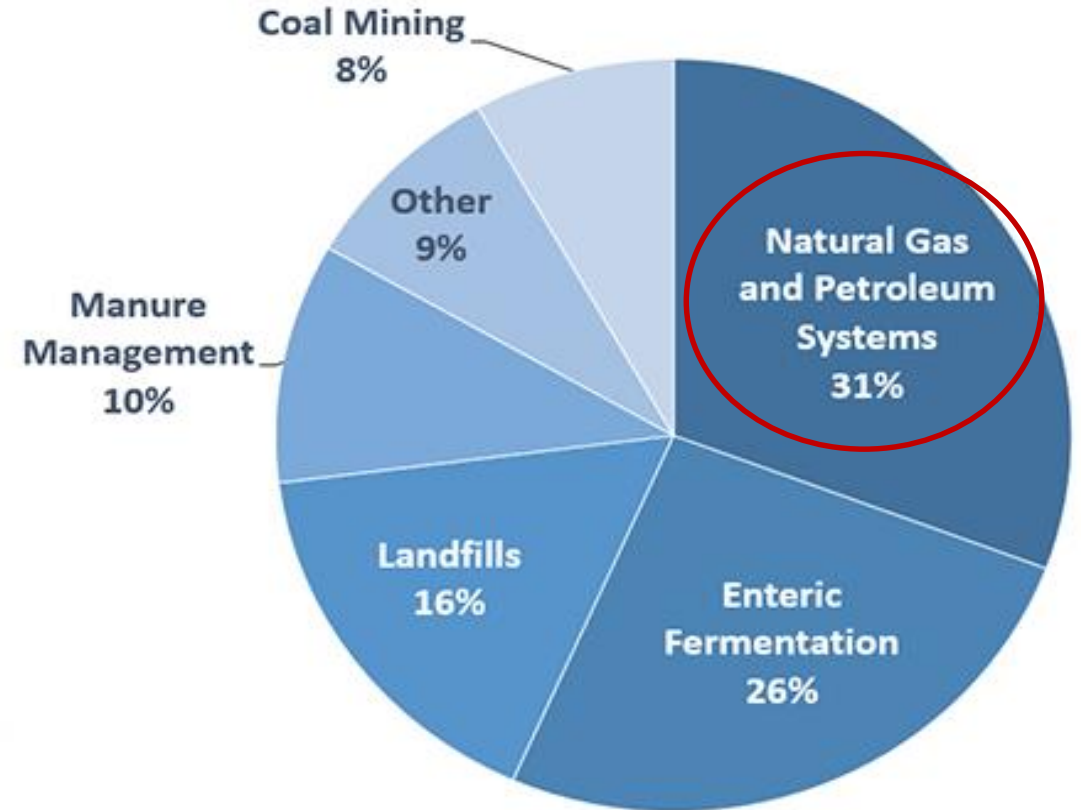
# Contribution from O&G Industry

**Global Methane Emissions, By Source 2003-2012**  
(bottom-up calculation)



Source: Global Carbon Project

**2016 U.S. Methane Emissions, By Source**



U.S. Environmental Protection Agency (2018). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016



# Why is Abatement Required?



**"Social License"**



# Solar Turbines' Solutions to Address Regulation Changes

Wet Seal



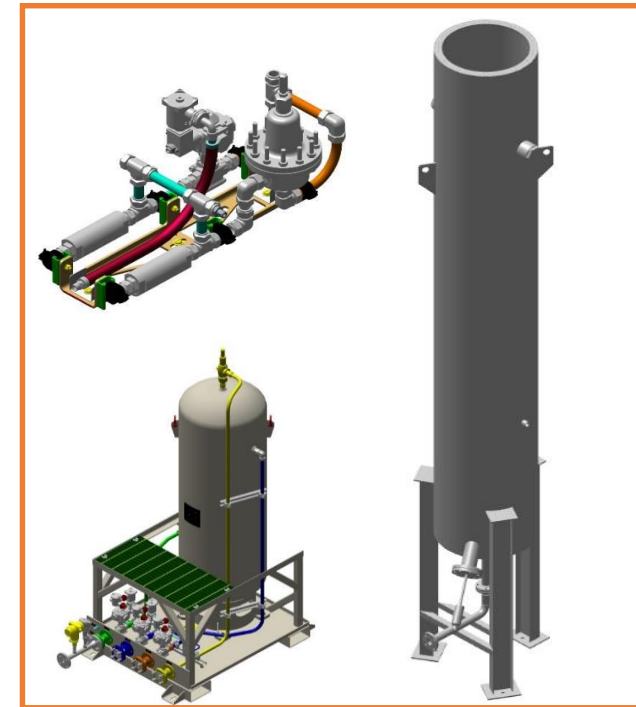
**Intelligent Dry Gas Seal Module**

Facility Venting Limit



**Electric Seal Gas Booster  
to Avoid Venting  
(Pressurized Hold)**

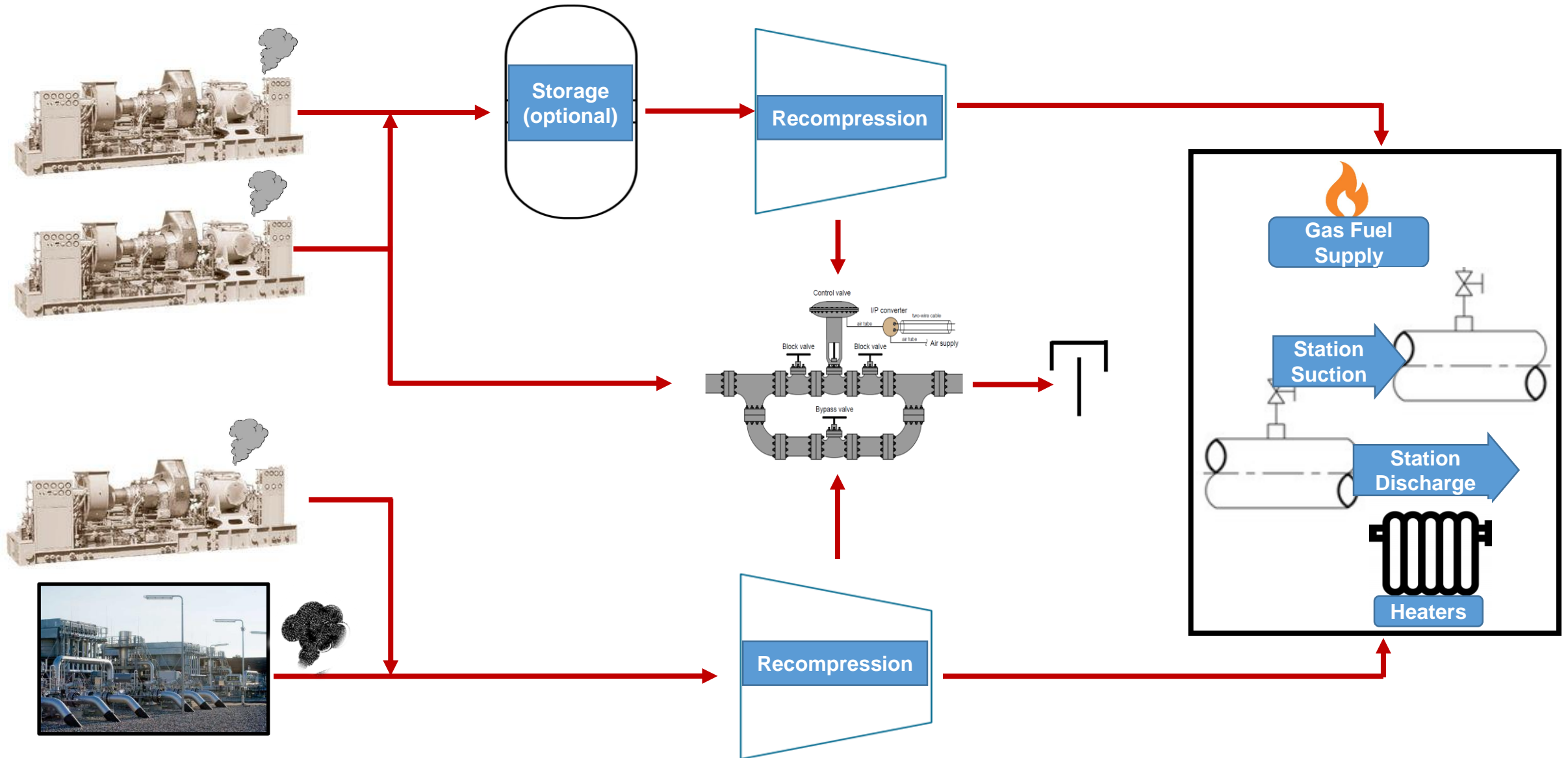
Dry Gas Seal Primary Vent



**Fugitive Methane Reduction Systems**

- Enclosed Burner - 98% Destruction
- **Recompression - Near Zero**  
(capture/recompress/reinject – in work)

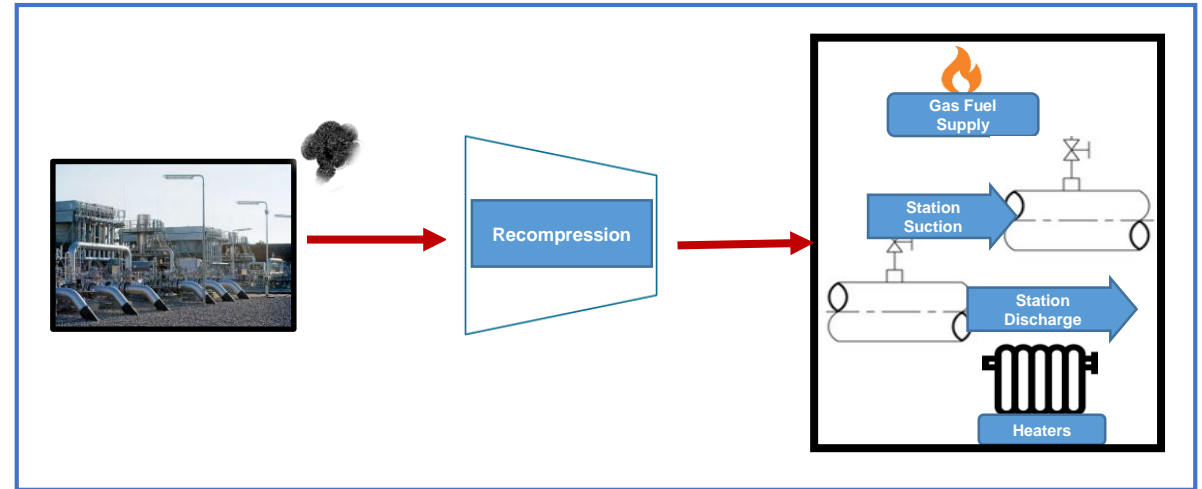
# RECOMPRESSION SYSTEM CONCEPT



# CONFIGURATIONS OFFERED BY SOLAR

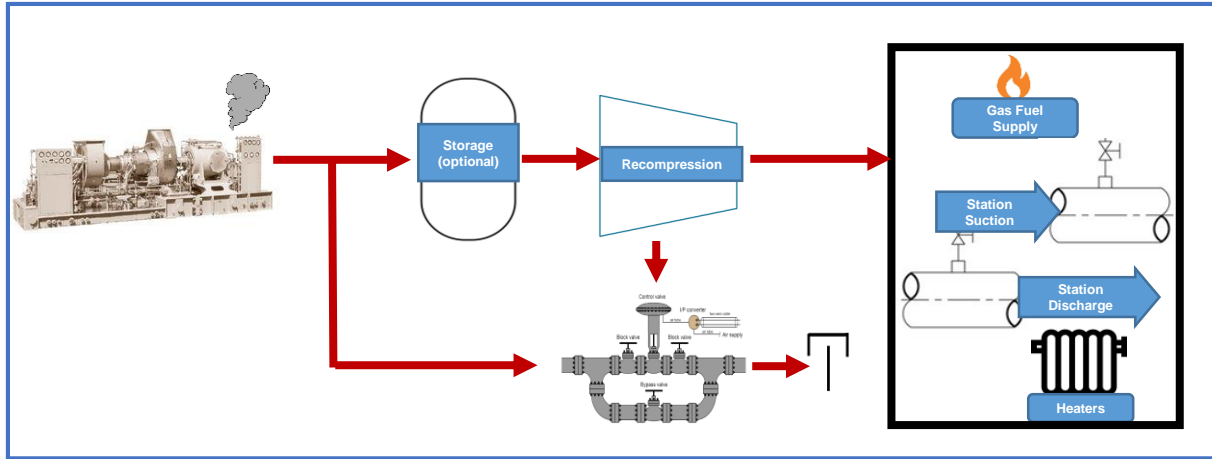
## Option 1: Process Gas Recompression

- $\text{CH}_4$  is captured between the compressor's suction and discharge valves
- Gas recompression occurs when compressor case is depressurized in a non-emergency shutdown condition
- The time to capture & recompress the process gas is determined during project execution



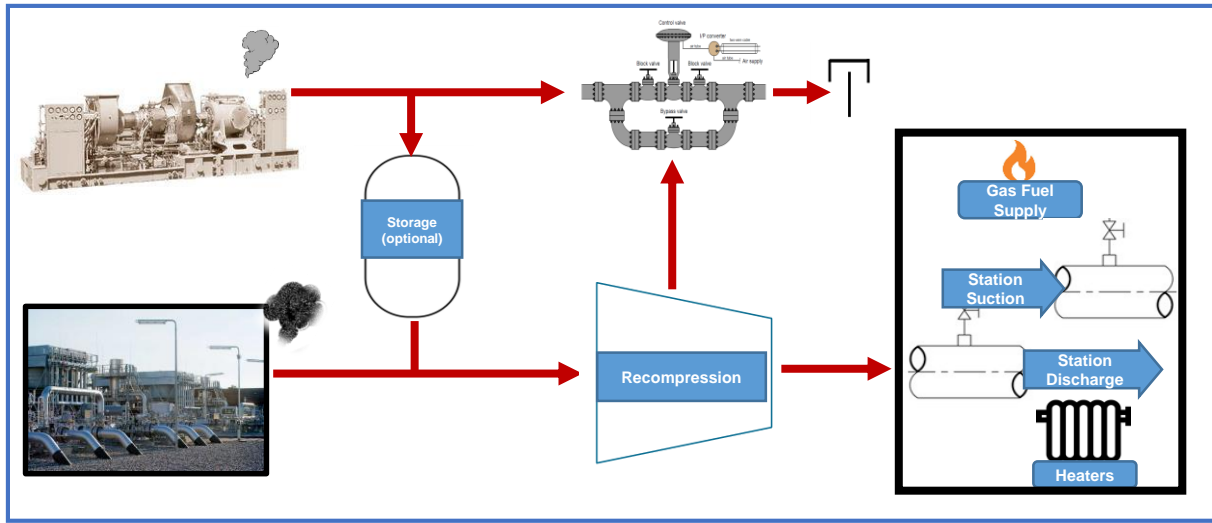
# CONFIGURATIONS OFFERED BY SOLAR

## Option 2: Dry Gas Seal Primary Vent Recompression



CH<sub>4</sub> will be captured from the compressor's primary seal vent while the compressor is in operation.

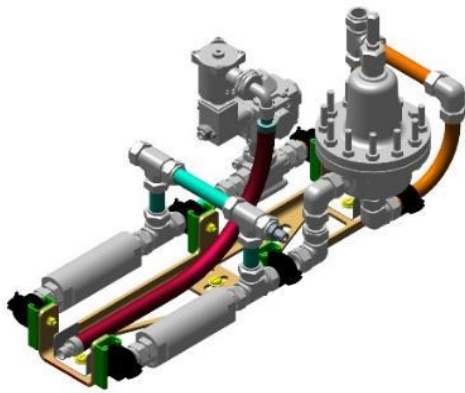
## Option 3: Process Gas & DGS Primary Vent Recompression



Combination of Options 1 and 2



# SOLAR'S METHANE REDUCTION SYSTEM COMPONENTS



Module 1:  
Primary Vent Back Pressure  
System (On or Off Skid)

+



Module 2:  
Accumulator System (Off Skid)

+



Module 3:  
Motor-Driven Reciprocating  
Compressor (Off Skid)  
Near Zero

OR



Module 3A:  
Enclosed Burner  
(Off Skid)  
98% Destruction

## SCHEDULE

### Enclosed Burner System

- ✓ Product Complete and First Unit Installed – Q3 2018

### Recompression System for CH<sub>4</sub> from Primary Seal Vent

- ❖ Standard Product Complete – Q3 2019
- ❖ First 2 units sold for installation in Q3 2020

### Recompression System for CH<sub>4</sub> from Process Gas Vent

- ❖ Standard Product Complete – Q4 2019

### Field Trial Period for Primary Seal and Process Gas Vent Products

- ❖ Q3 2019 to Q3 2020



## BENEFIT TO OUR CUSTOMERS

- Decrease GHG emissions to the atmosphere
- Achieve targets to cut CH<sub>4</sub> emissions
- Reduce compressor related CH<sub>4</sub> emissions to near-zero levels
- Minimize the number of station blow-downs
- Eliminate risk of accidents caused by gas leaks
- Avoid penalties resulting from high CH<sub>4</sub> numbers
- Cost savings



# Advancement Through Collaboration



Understanding your needs & applications

Partnering in field studies and development efforts

Anticipating regulatory changes and strategic solutions to meet targets

Participating in Market Survey



T H A N K   Y O U

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## Global Warming Potential of Methane

**FIGURE 4**

**Illustration of the changing GWP of methane over time.**

Sources: Alvarez et al. [38] and Allen et al. [37]. Note, these numbers do not include the effect of carbon-climate feedback resulting in slightly lower values than expressed within this section (e.g. a GWP100 of 28 rather than 34).

