

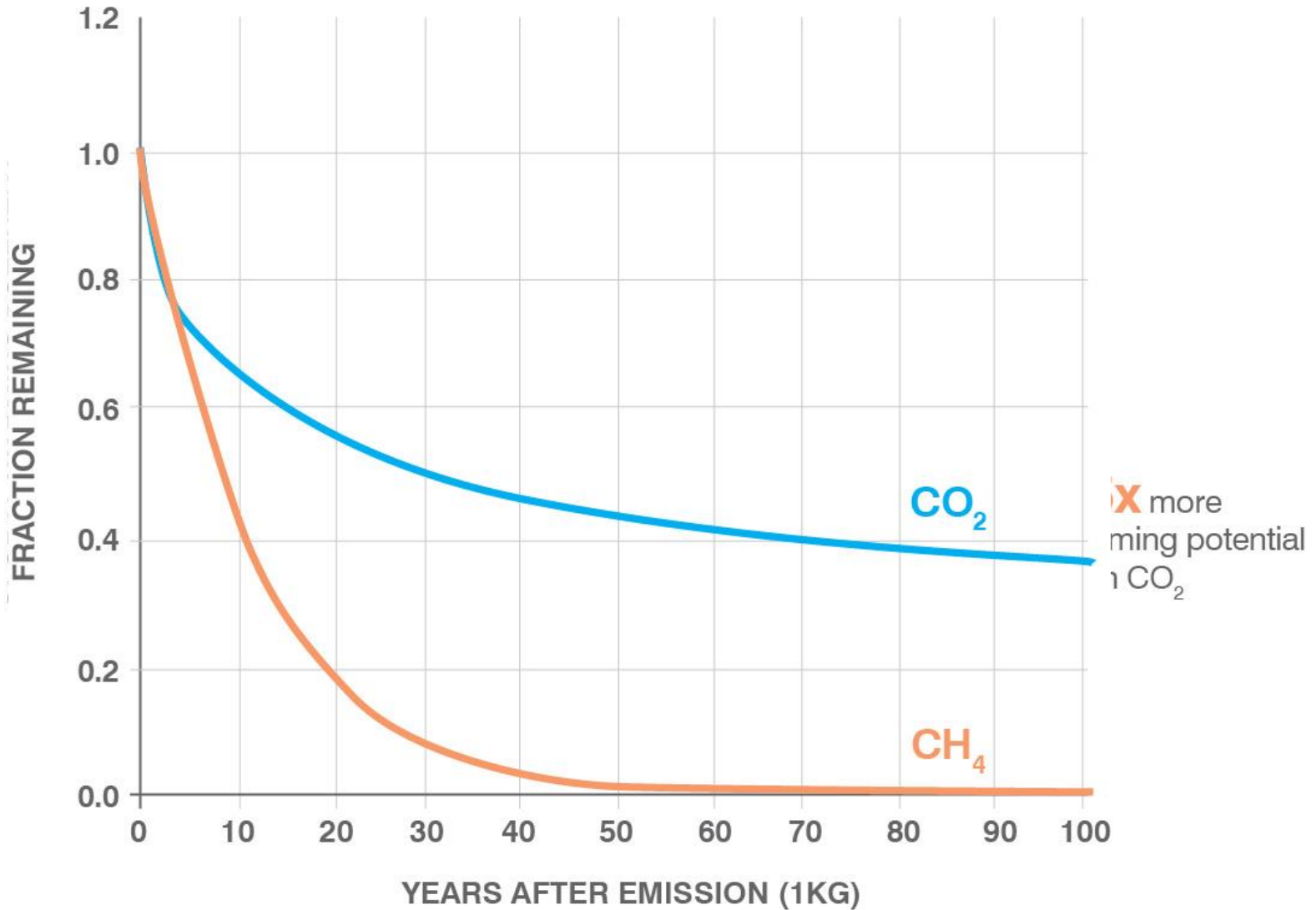
# Methane, Greenhouse Gases, Science and a Unique Partnership

Steven Hamburg  
Chief Scientist



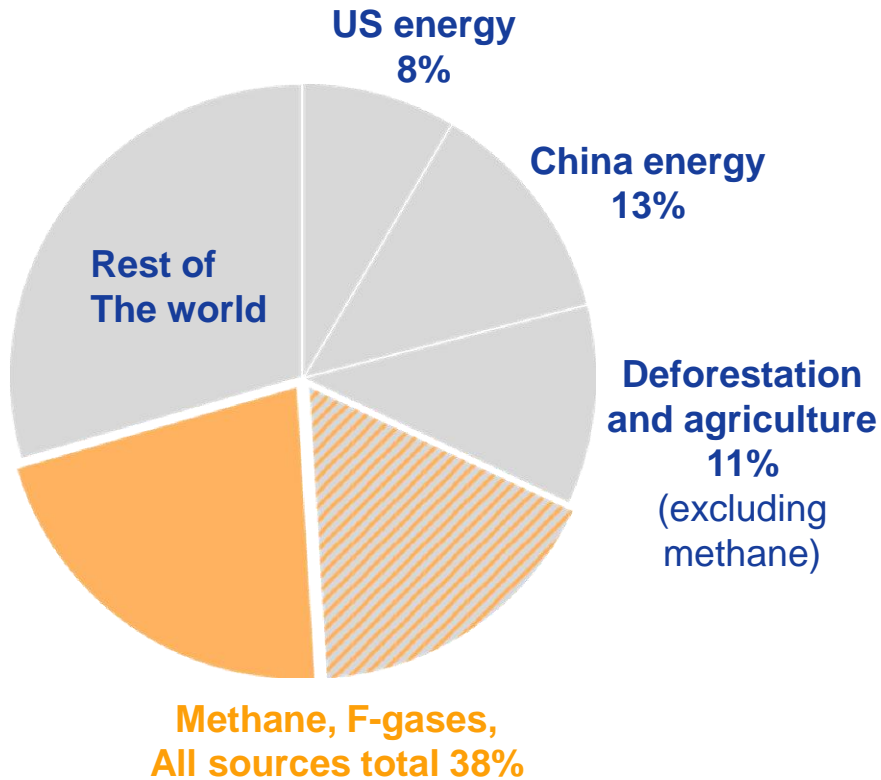
# Climate implications of methane

## METHANE AND CARBON DIOXIDE DEGRADATION

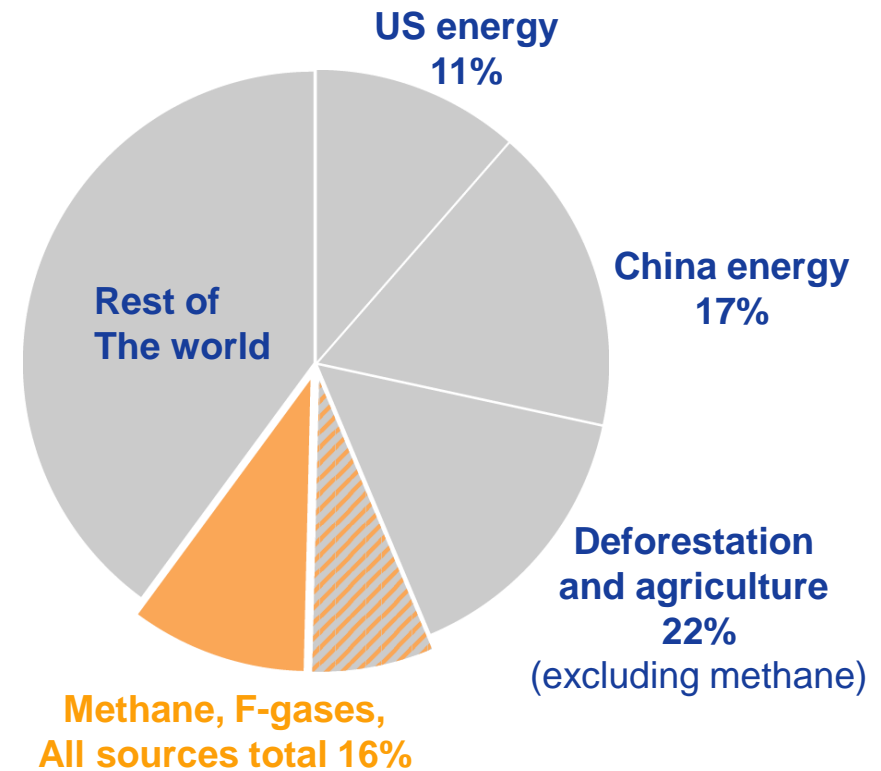


# Total GHG emissions

## 20-year impact



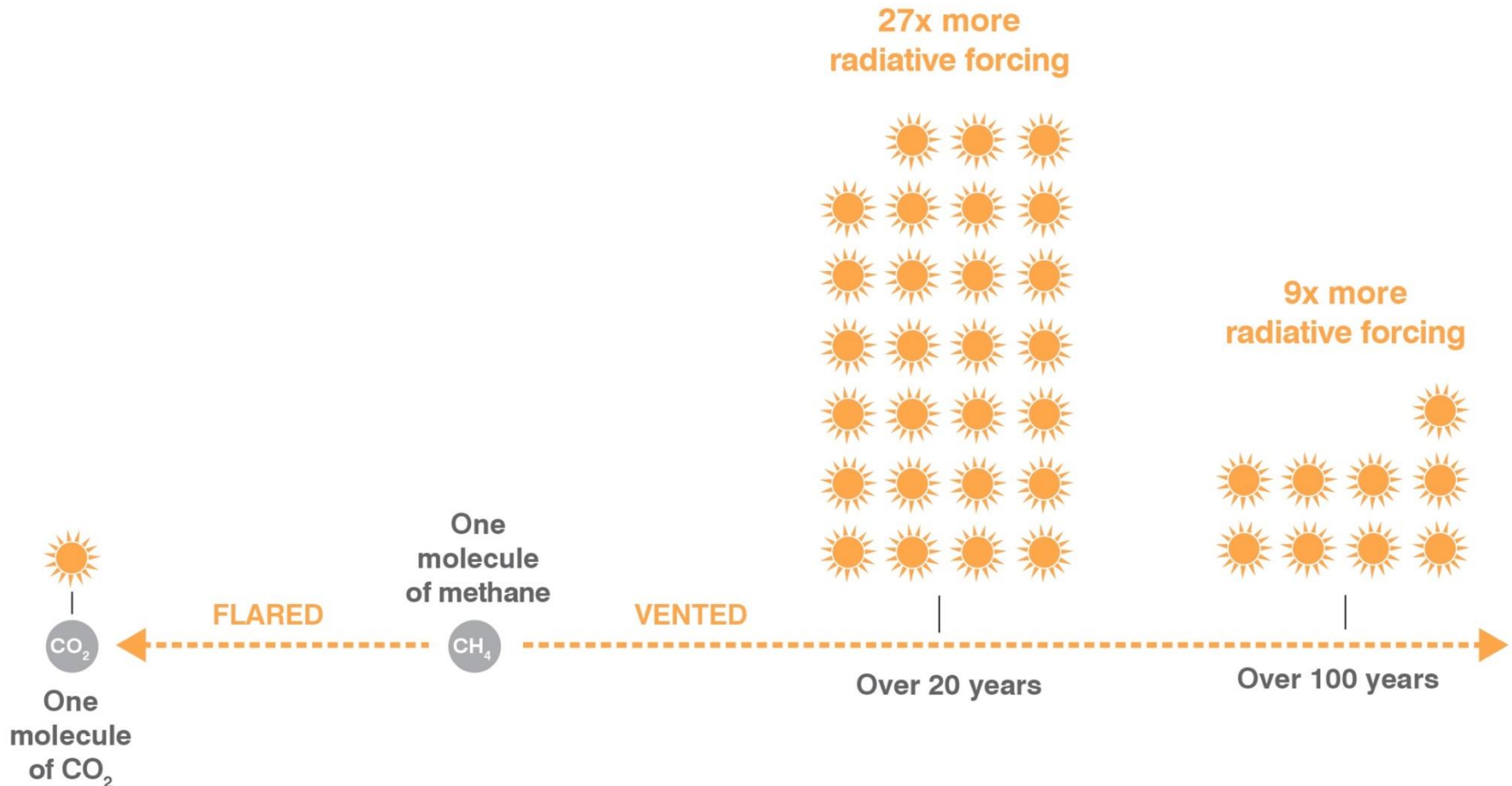
## 100-year impact



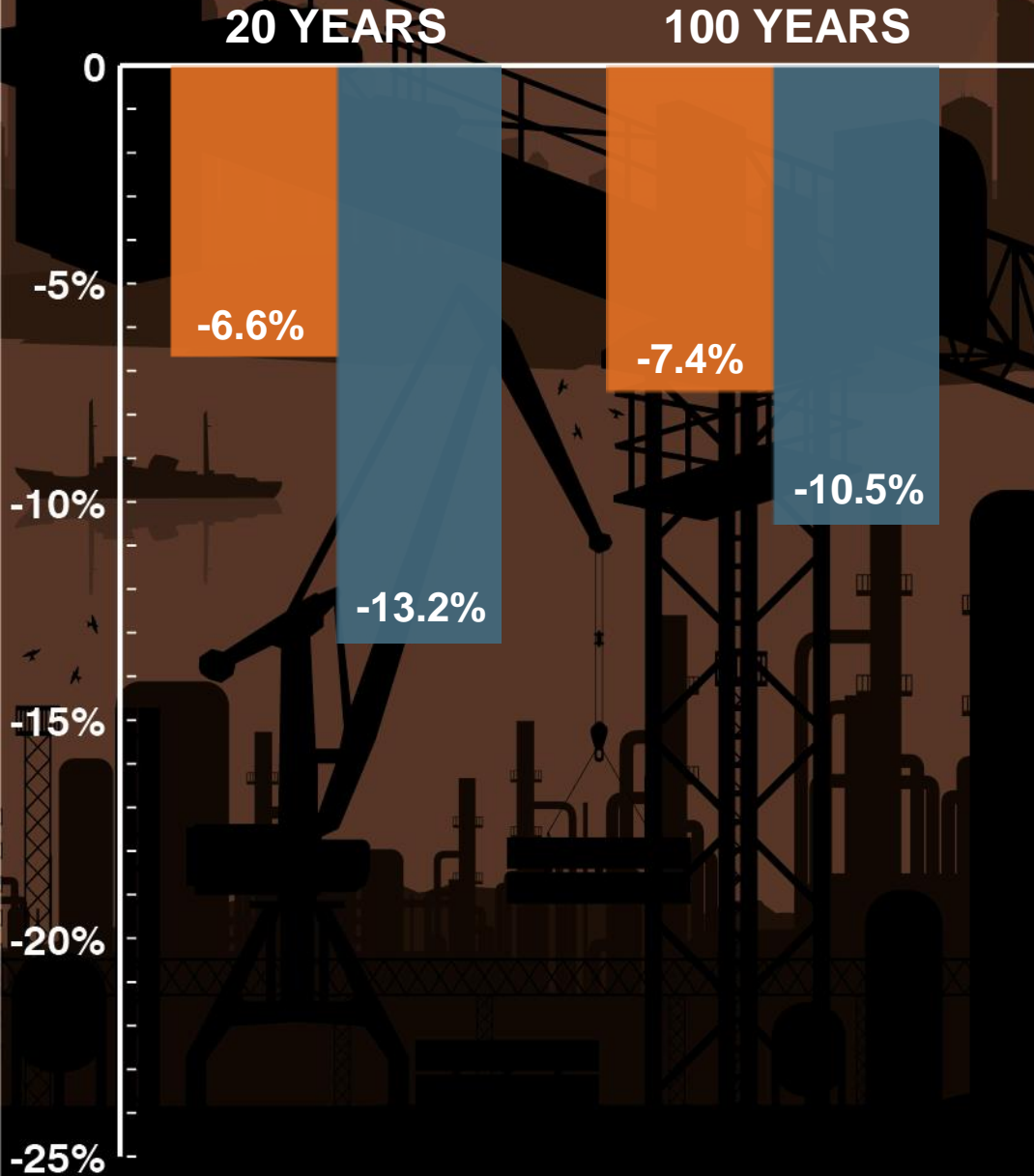
 Manmade methane and F-gases, non-agricultural sources

 Methane, agricultural sources

# Radiative forcing from venting methane rather than flaring it



# U.S. contribution to net radiative forcing



## FUEL MIX

40% reduction in coal  
half to natural gas and  
half to zero emitting fuels

## BASELINE

No leak rate reduction  
(2.8%)

## POLICY

leak rate reduction from  
2.8% to 1%

# **EDF's Approach:**

**Acquire the Data, develop the regulations necessary to minimizing leakage based on that data**



# EDF methane leakage study modules

Steering Committee report approval dates

Phase 1 – Done  
Phase 2 – Mar '14

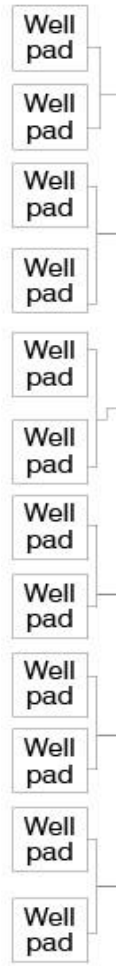
June '14

March '14

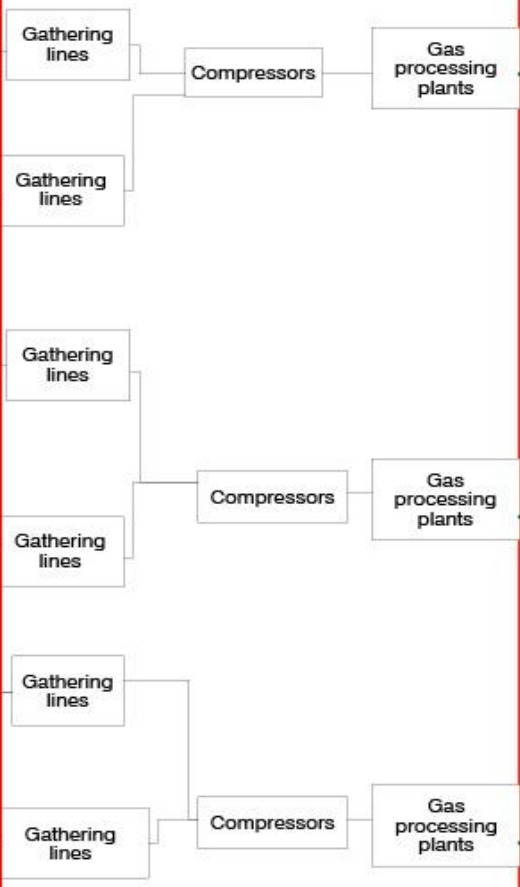
October '13

November '13

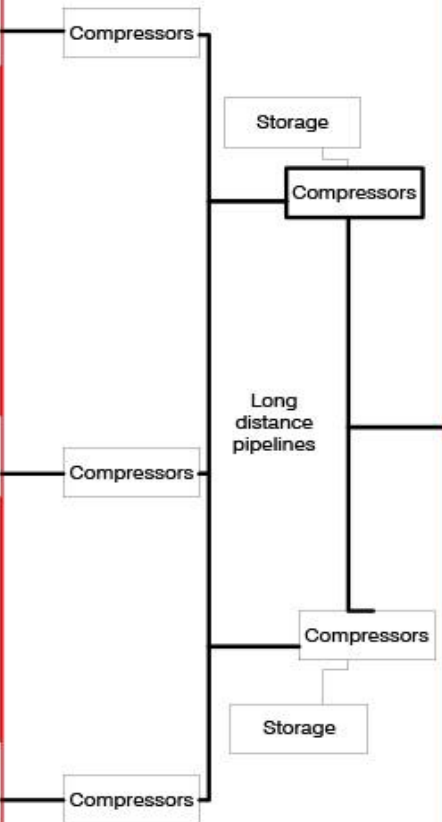
## Production module



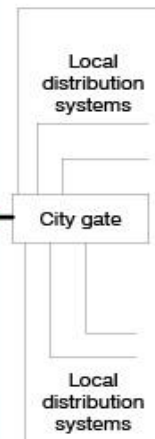
## Gathering and processing module



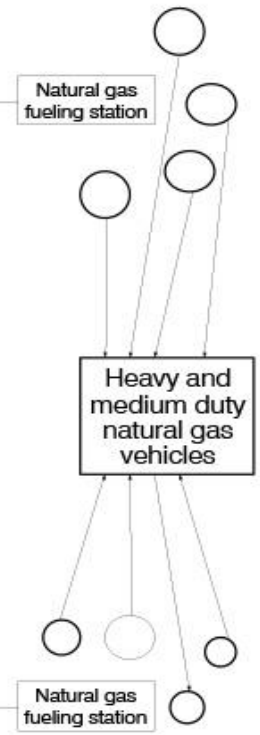
## Transmission and storage module



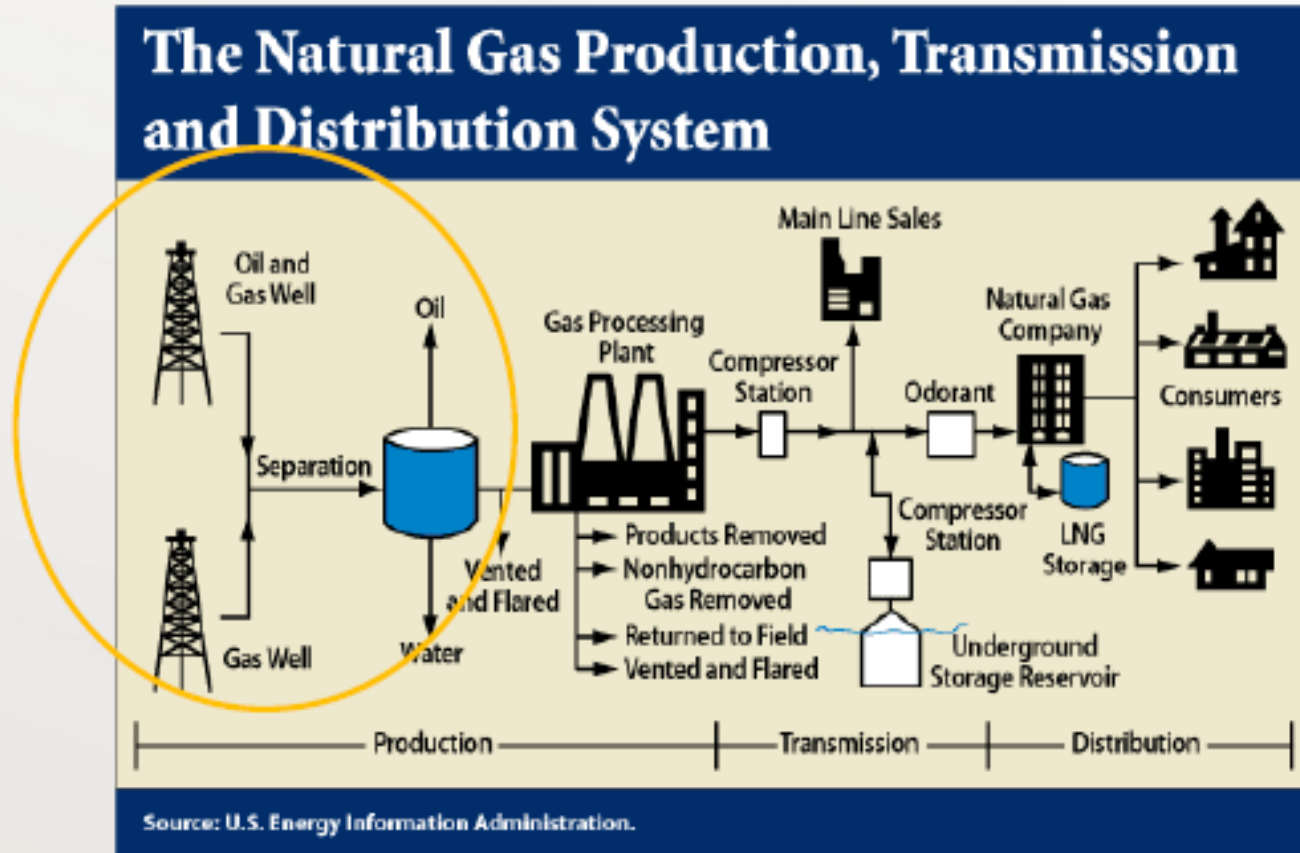
## Local distribution module



## Natural gas vehicles and fuel stations module




# Scope of Study



Environmental Defense Fund, with different groups of companies and study teams, are engaged in projects addressing the rest of the supply chain for natural gas



# Key elements of each study

- Led by academic researchers
  - Deploy multiple methods of measurement
  - External peer review
  - Released through publication in peer-reviewed journal
  - All data made public
- 

# A New Approach

- A Unique Partnership
  - Direct Access
  - First measurements
- 

# Direct source measurements

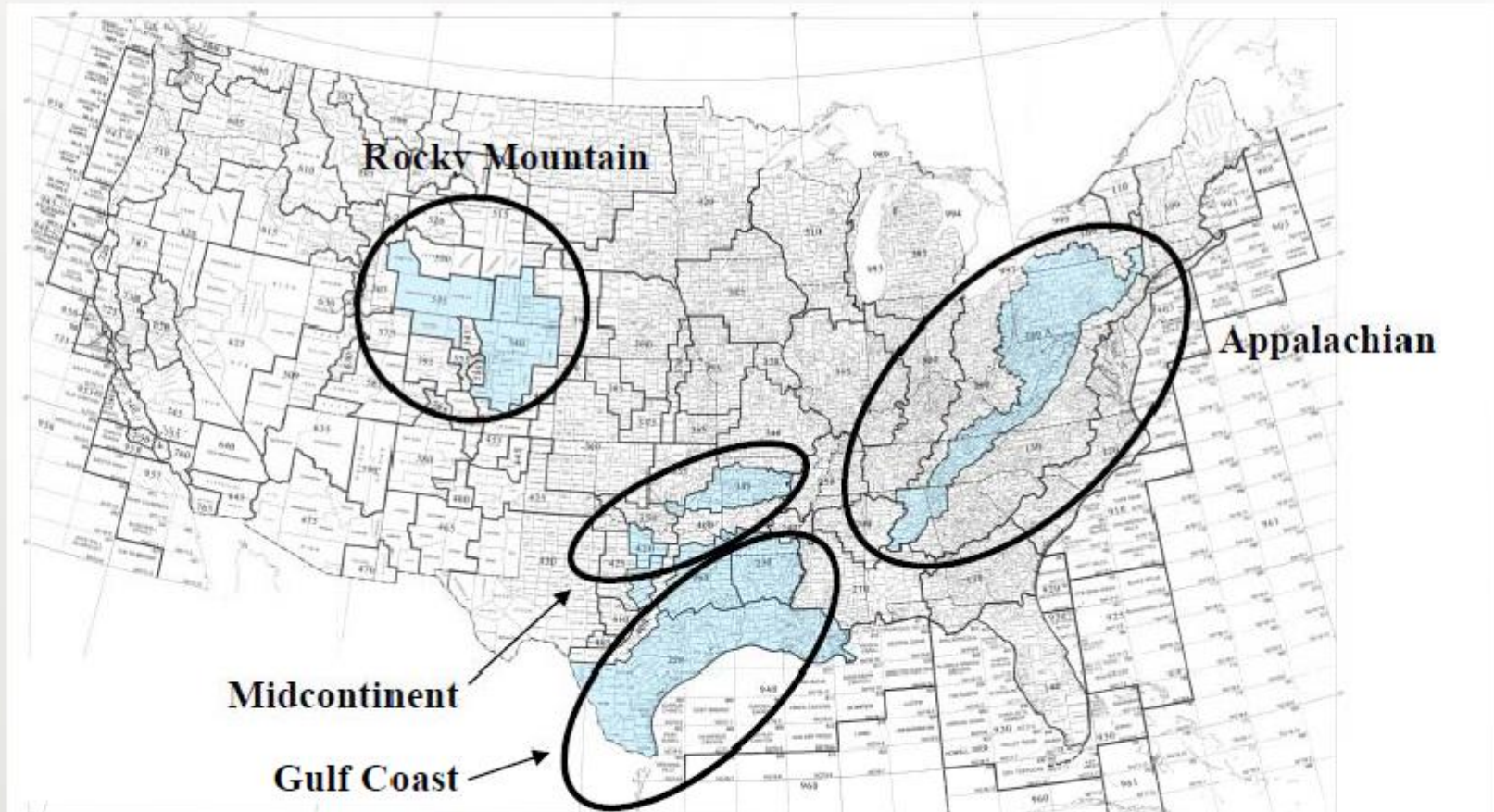
(methane emission measurements were made directly at the emission point, capturing the entire flow)



Many of the measurement systems were controlled 10-20 m from the sampling point

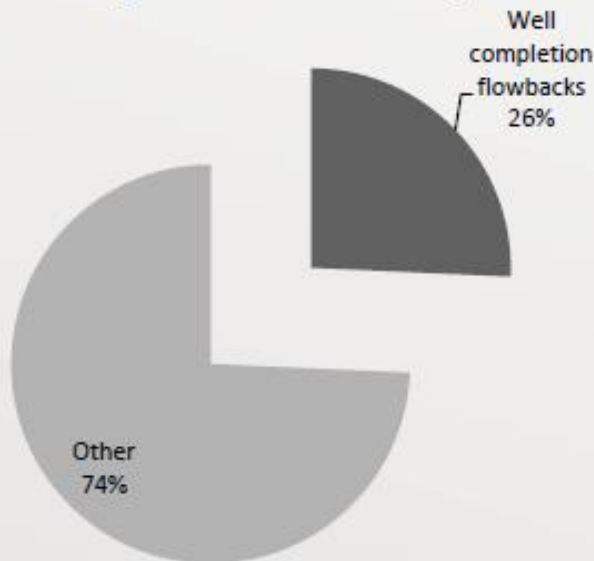


# Multiple production regions were sampled

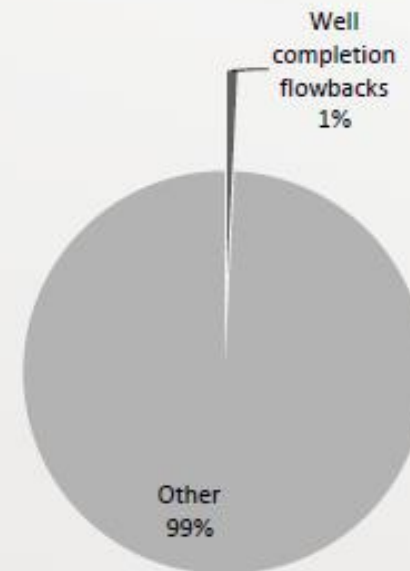


# Completion flowbacks: Comparison of EPA national methane emission inventory for natural gas production to estimates based on this work

Emissions reported in 2011 greenhouse gas inventory (654 Gg annual emissions, inventory released in 2013)



Emissions estimated based on measured data from this work, 18 Gg/yr

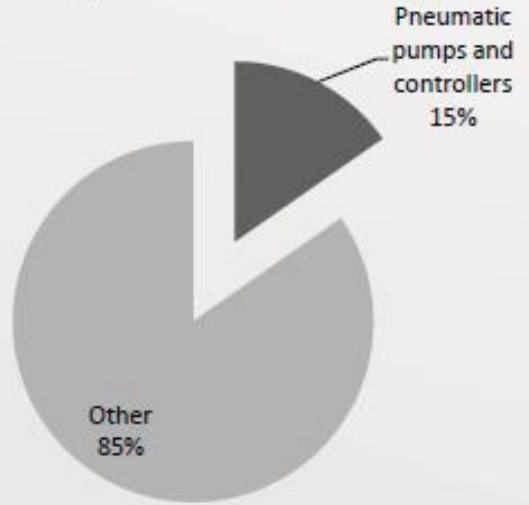


67% of the completion flowbacks that were sampled captured or combusted 99% of potential methane emissions

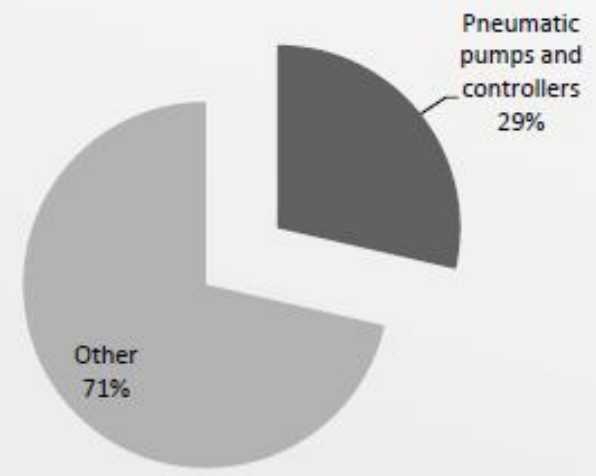
For the 33% of completion flowbacks without controls or capture, the vented emissions were low (comparable or lower than many of the completions with capture or control)

# Pneumatics: Comparison of EPA national methane emission inventory for natural gas production to estimates based on this work

Emissions reported in 2011 greenhouse gas  
inventory (389 Gg annual emissions,  
inventory released in 2013)



Emissions estimated based on measured  
data from this work, 648 Gg



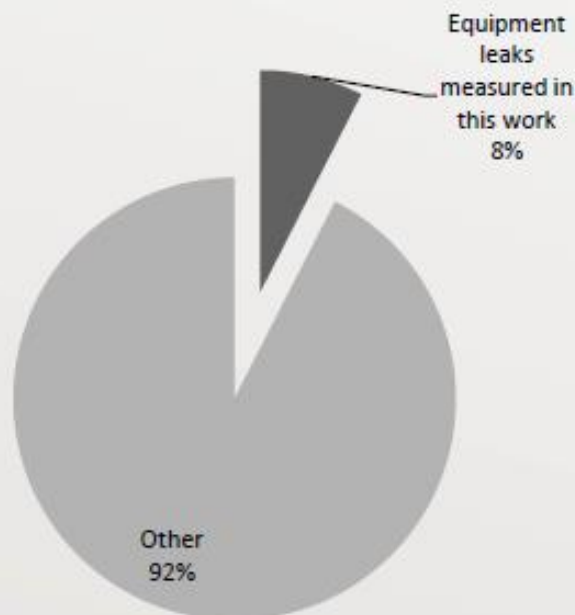
Emissions per pump were within 10% of potential emissions estimated using EPA methods

Emissions were higher for intermittent controllers (29% higher) and low bleed pneumatic controllers (270% higher) than estimated using EPA emission factors

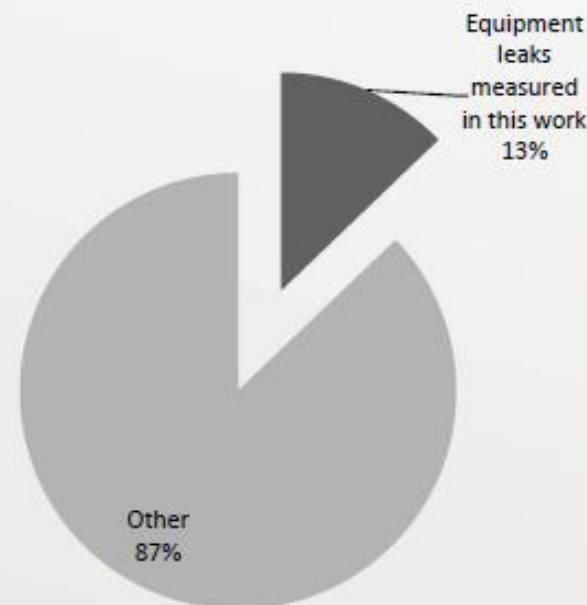
National emission estimates are sensitive to the assumed populations of low-bleed, high bleed and intermittent devices

# Equipment leaks: Comparison of EPA national methane emission inventory for natural gas production to estimates based on this work

Emissions reported in 2011 greenhouse gas inventory (191 Gg annual emissions, inventory released in 2013)

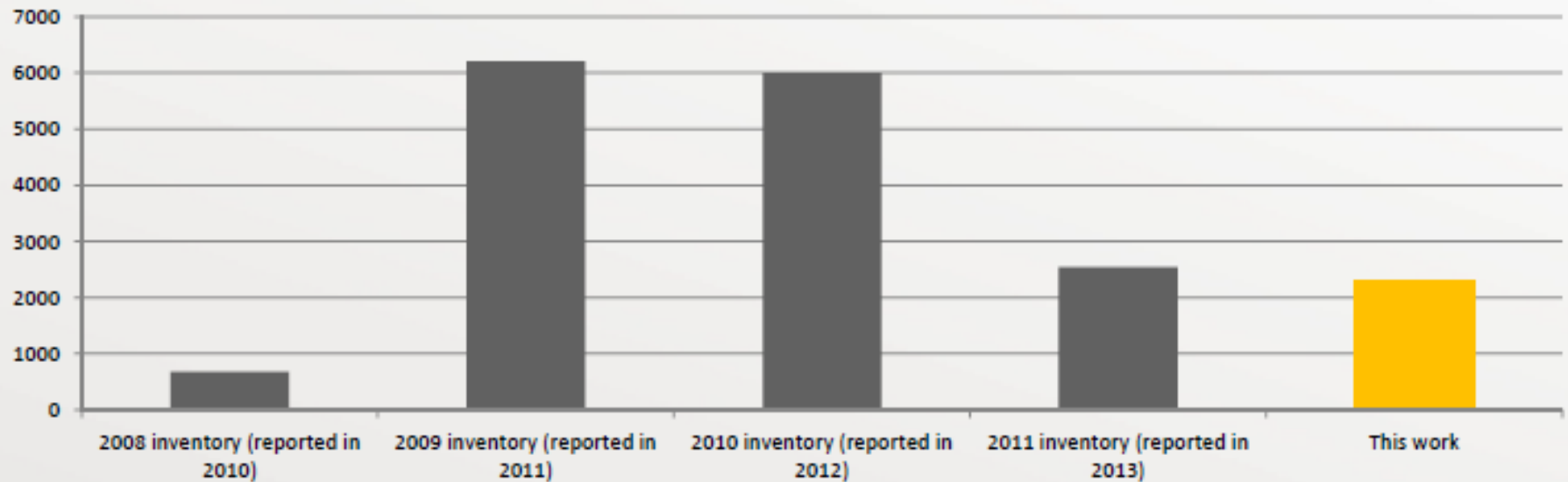


Emissions estimated based on measured data from this work, 291 Gg



Emissions of methane per well from equipment leaks were ~50% higher than net EPA estimates

# Natural Gas Production: Comparison of EPA national methane emission inventory to estimates based on this work (Gg/yr)





**Stay tuned for lots more data**

**Across the natural gas supply  
chain**

**Diversity of methods**



# NATURAL GAS

## FOR VEHICLES

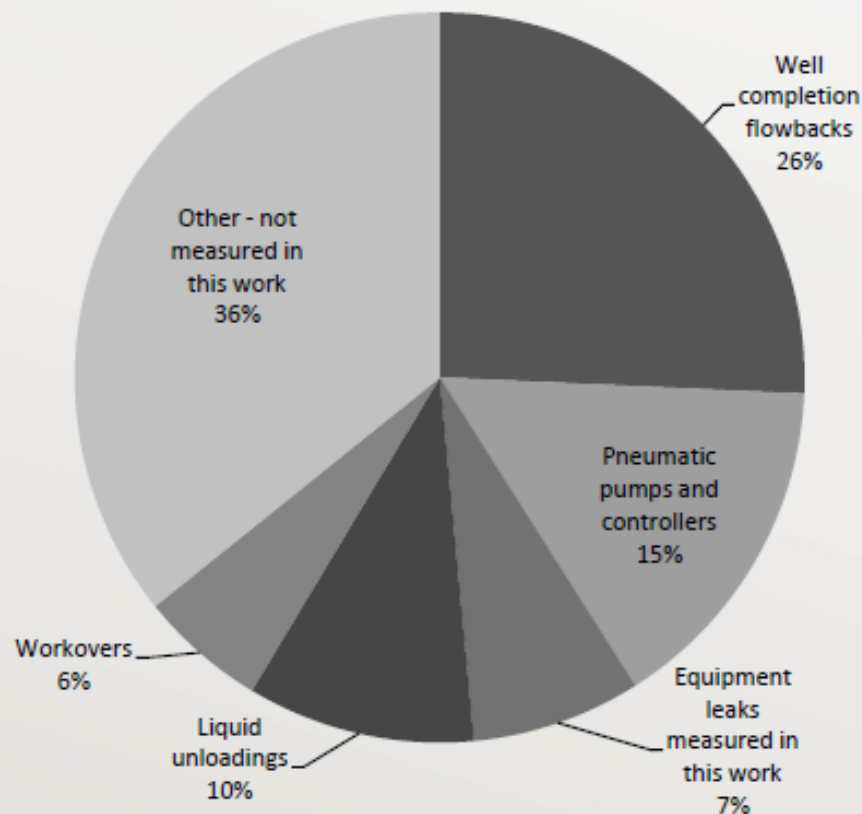


**Pump to wheels module**



# Natural Gas Production: Comparison of EPA national methane emission inventory to estimates based on this work (Gg/yr)

**Production emissions reported in 2011 greenhouse gas inventory (annual emissions in Gg, inventory released in 2013), 2545 Gg**



**Production emissions estimated based on measured data from this work, 2300 Gg/yr**

