Overview of methane in the environment

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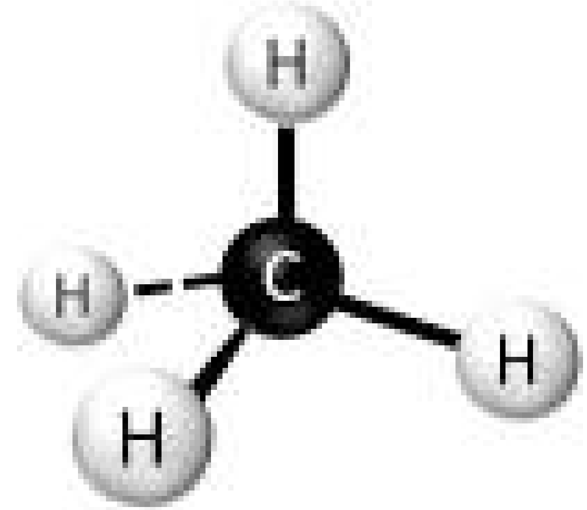
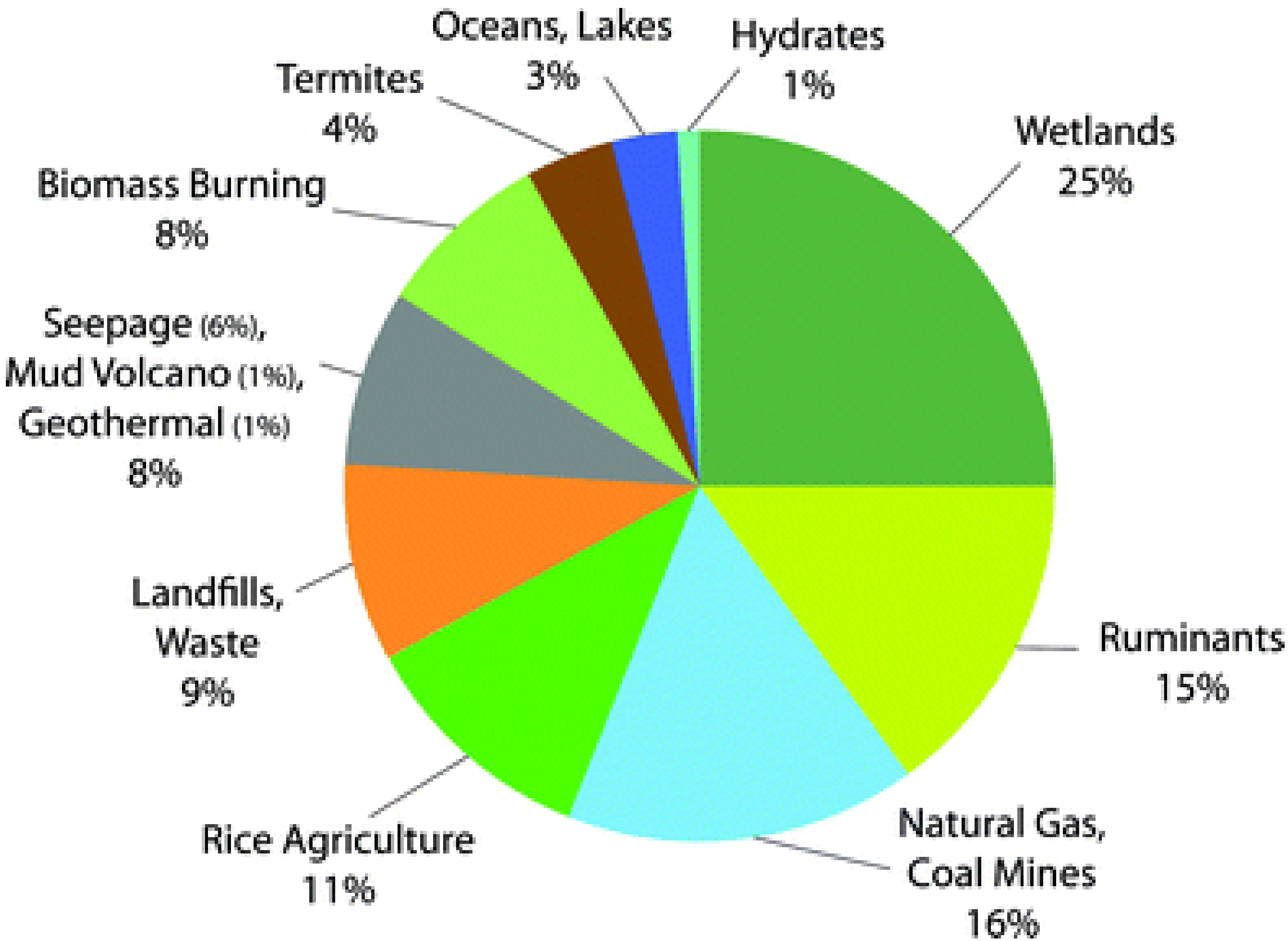
Methane (CH_4)



- Colorless, odorless gas
- Natural product produced by microbes in the sediment or by heating of deeply buried organic matter
- Discovered and isolated from marsh gas in 1776, described by Benjamin Franklin as “flammable air”

- It is the major component of natural gas, ~93% (Baltimore Gas & electric)
  - 5% ethane

Where does methane reside?

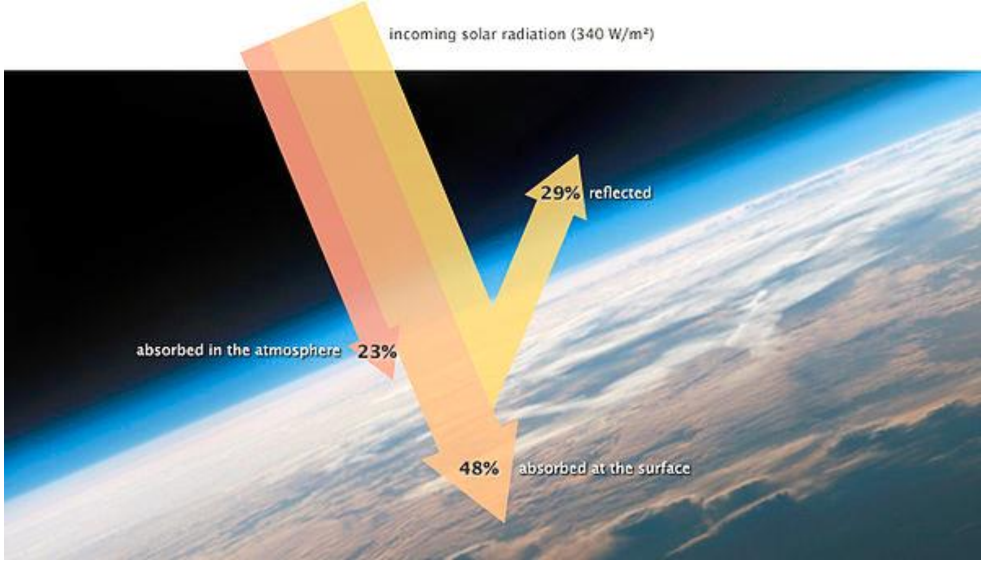


Source: Atreya et al., 2010, Faraday Discussions, 147, 9-29

Why is methane important in the atmosphere?

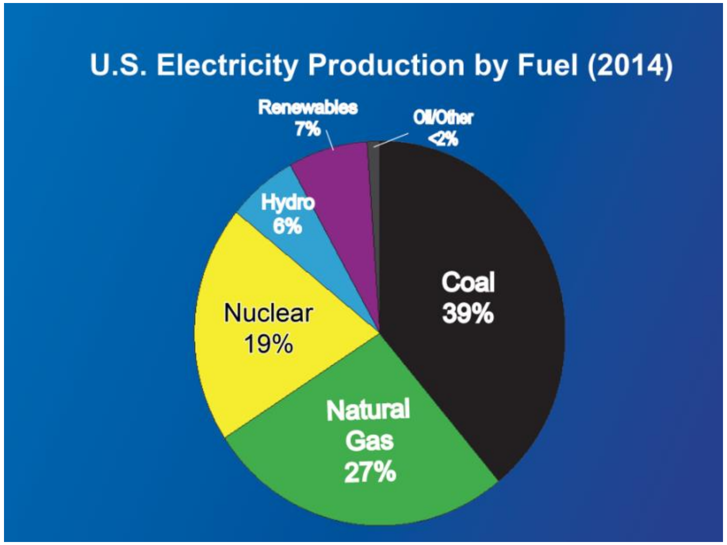
Potent greenhouse gas

- Shorter half-life in atmosphere than CO_2
- 29 times more effective at warming the planet than CO_2 over a 100-year time frame
- Even more effective over shorter time period (86x over 20 years)

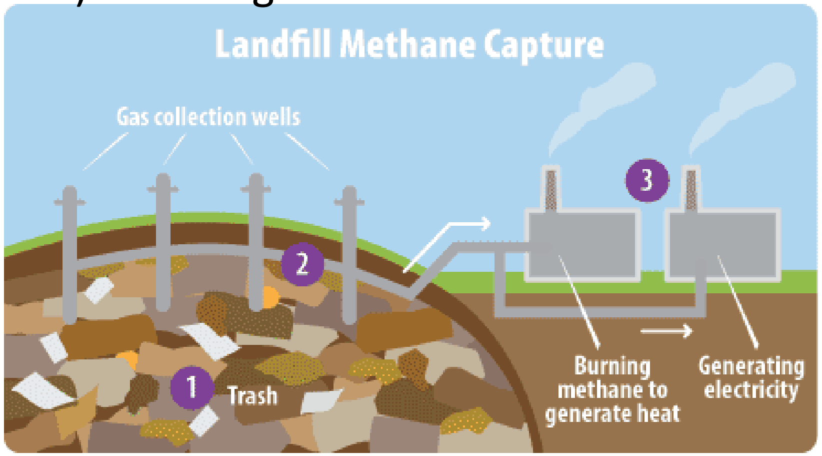


Methane usage in the US

1) Electricity



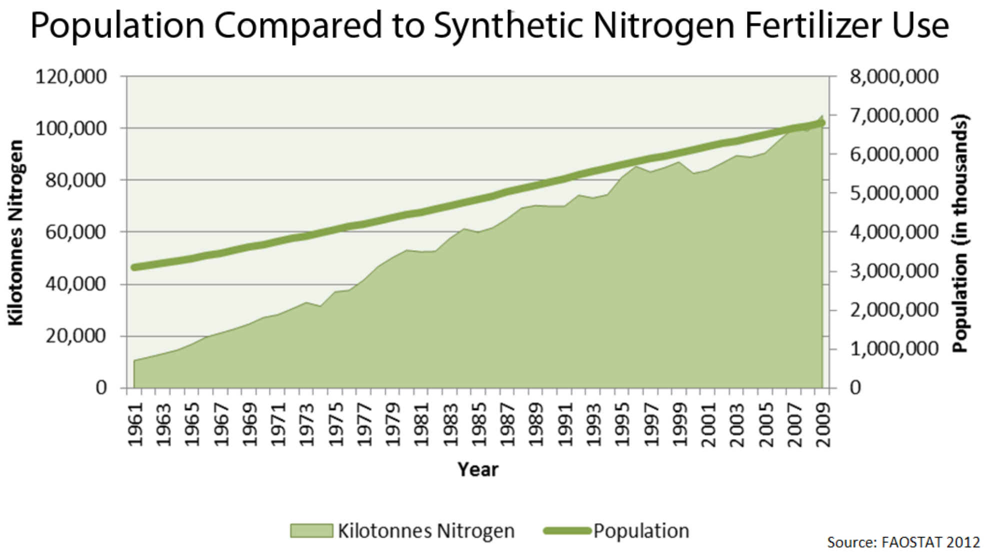
2) Landfill gas



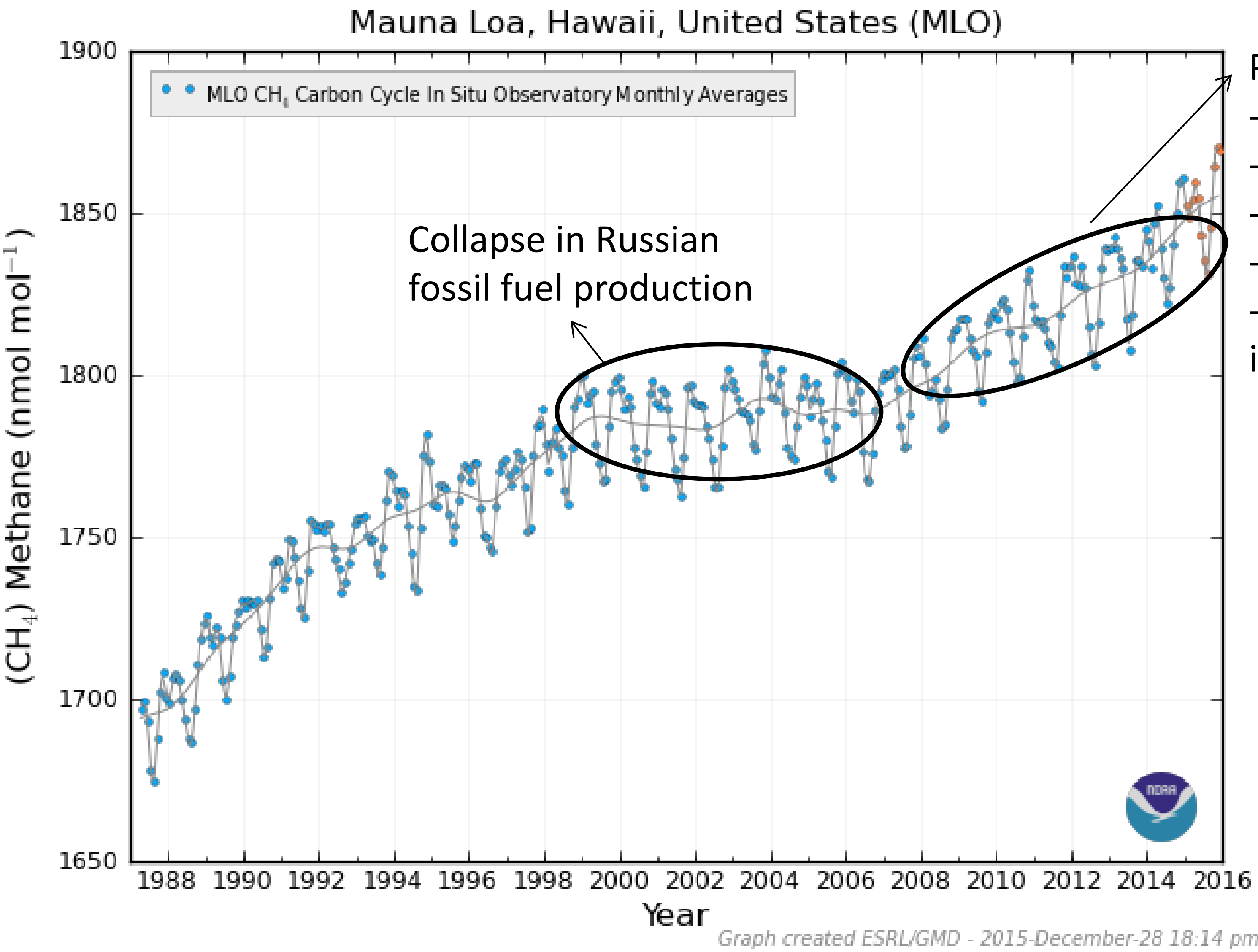
https://www3.epa.gov/climatechange/kids/solutions/technologies/methane.html

3) Production of nitrogen fertilizers

Methane is the essential feedstock in Haber-Bosch process for which demand is growing



Concentrations are increasing in the atmosphere



Possible explanations:
- -Arctic warming
- -Waste treatment
- -Tropical wetlands
- -Agricultural activities
- -Increased use, including fracking

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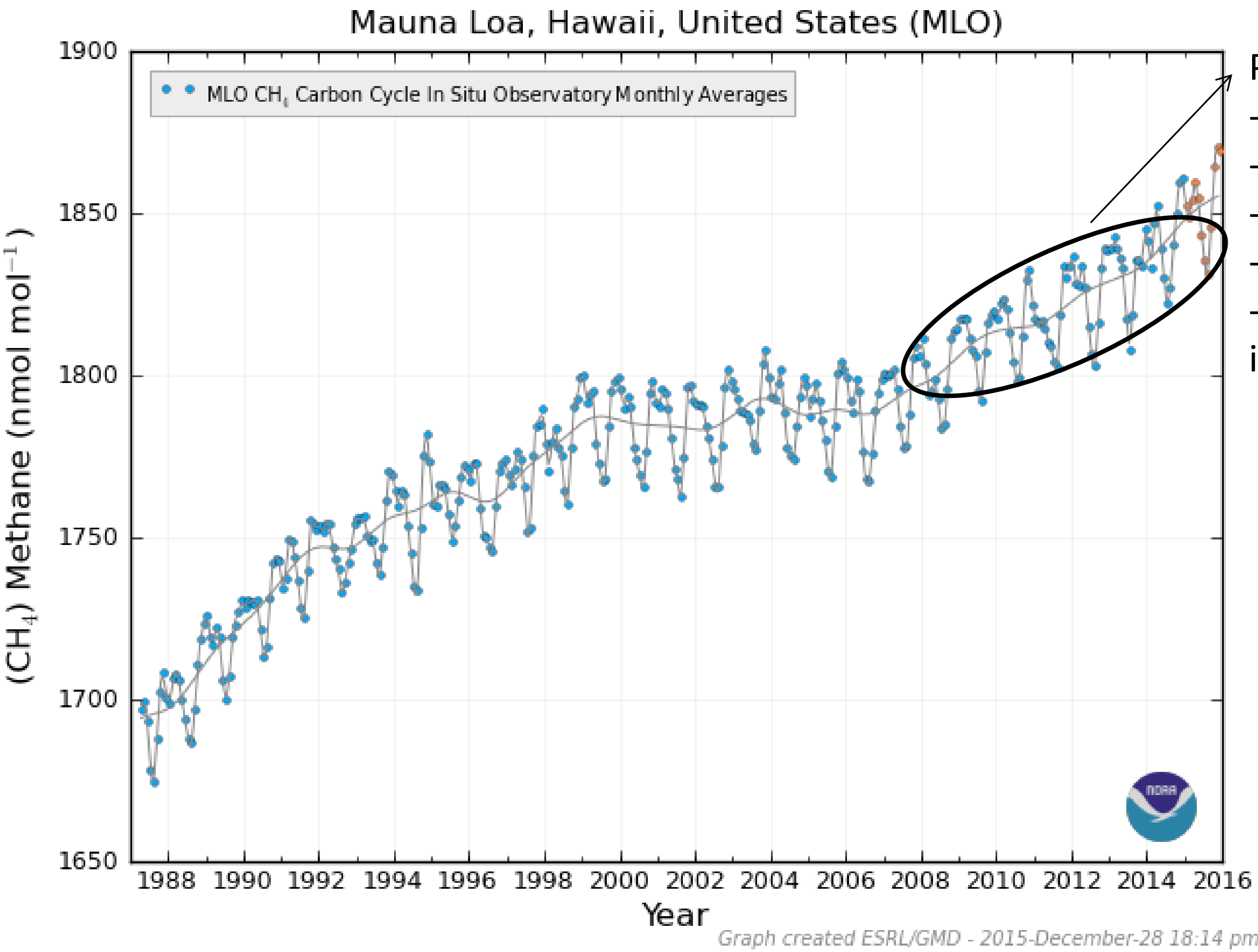

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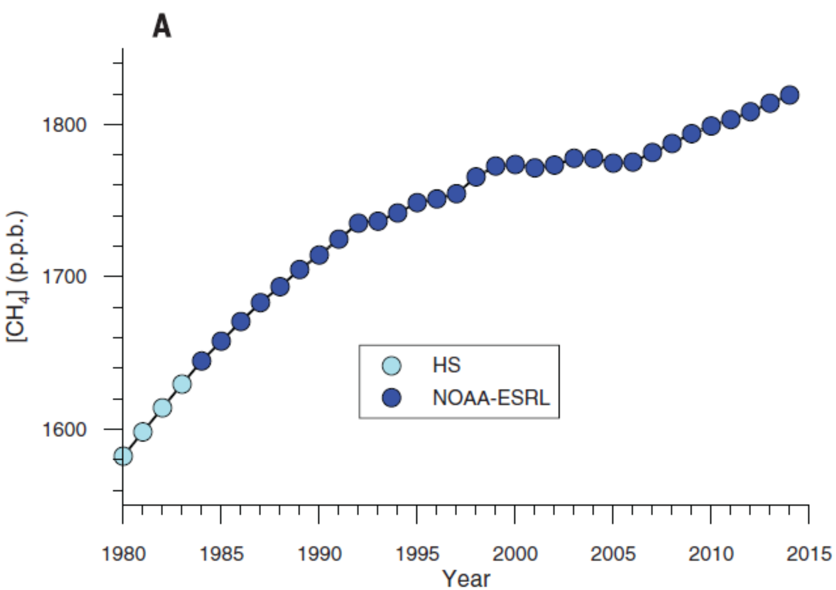
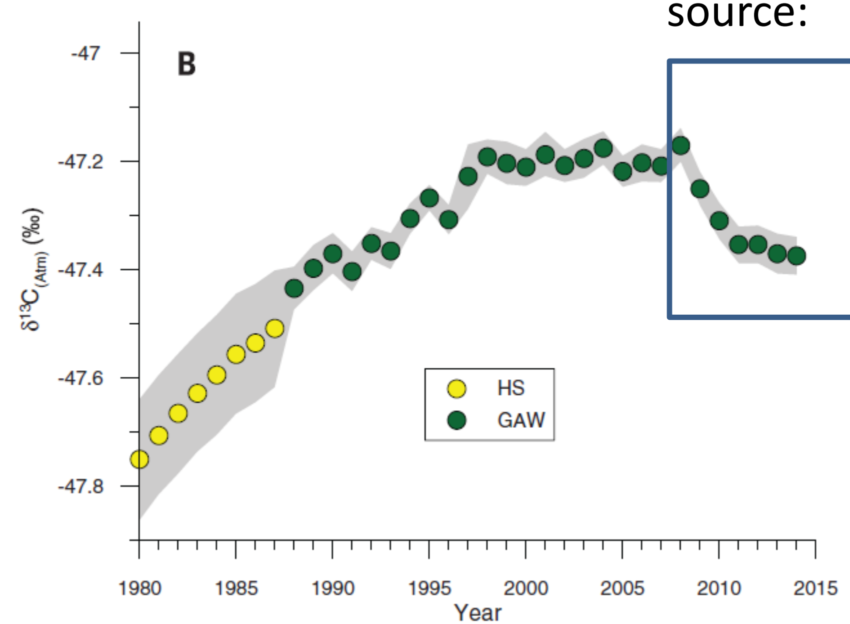
Recent work suggests recent increase due to rice agriculture and cows (Schaefer et al., 2016)

Details of Schaefer et al., 2016 study:

A 21st-century shift from fossil-fuel to biogenic methane emissions indicated by $^{13}CH_4$



Isotope shift to biogenic source:



Post-2006: natural wetlands have been implicated to give increase in CH4, but remote sensing suggests the increase is in N hemisphere, not S where most wetlands are. Rice cultivation and ruminant cows fit the isotope trend better.

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How much is increased natural gas production contributing to global warming?

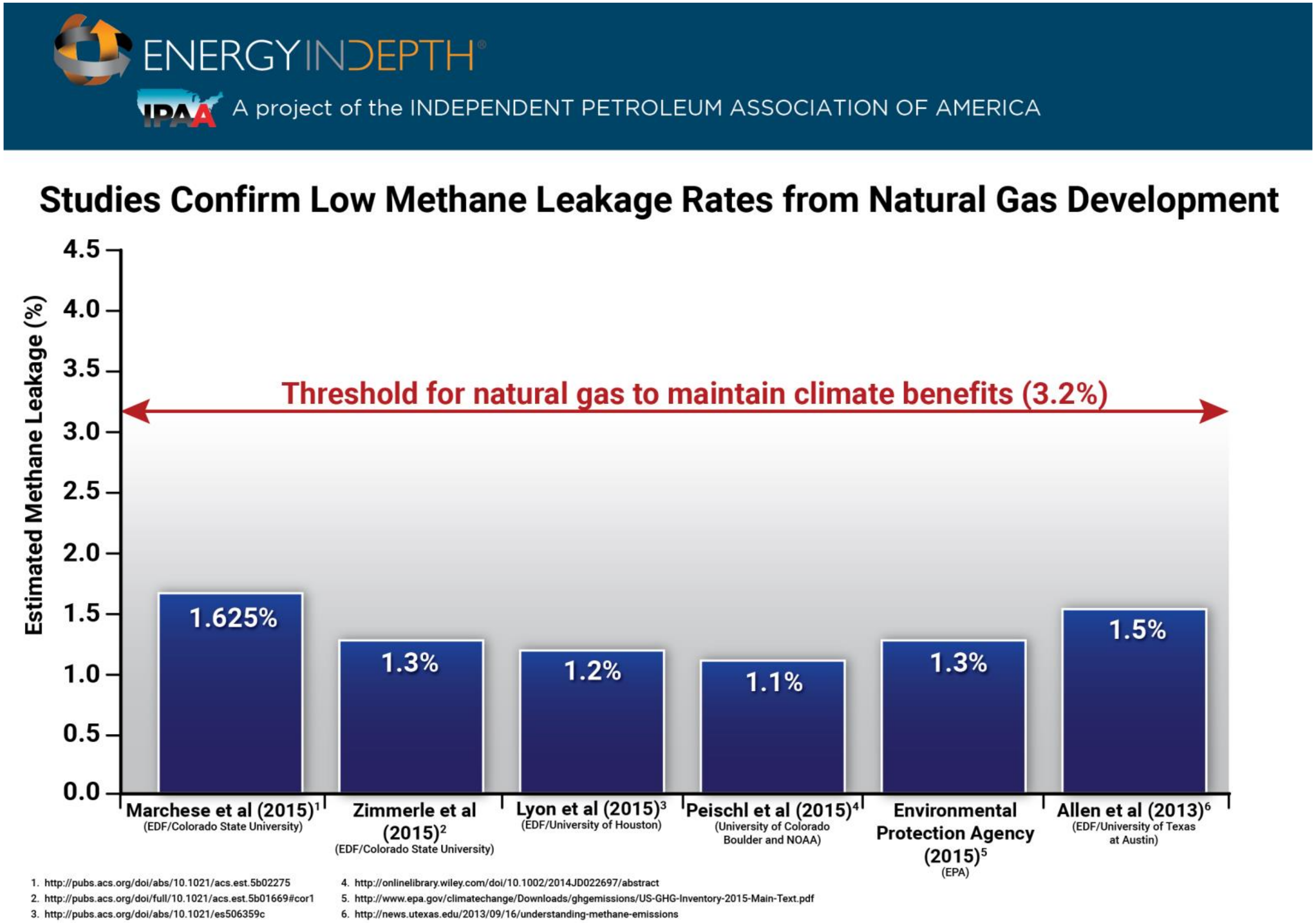
- Shift from burning coal to natural gas results in almost half as much CO_2 released.

- However, because methane is a more potent greenhouse gas than CO_2, these benefits are counteracted if there is leakage during production, distribution and utilization.

- Leakage rates of 3.2% may be the benefits threshold

Industry has argued that leakage rates are below the threshold for climate benefits

- Estimates of methane leakage rates



However other recent studies have shown that the climate benefit threshold for leakage is being exceeded.

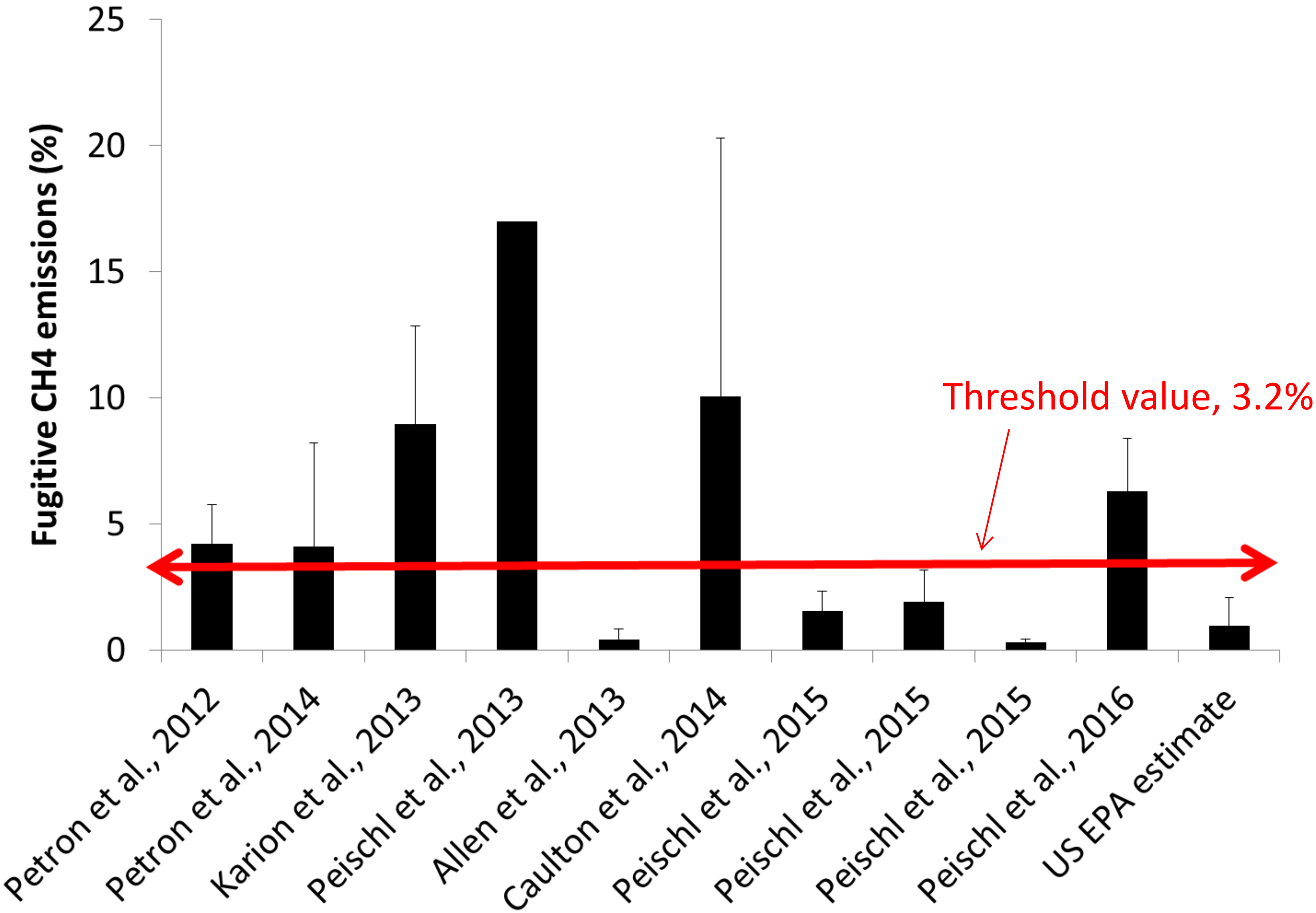


Chart generated by Lapham, error bars are standard deviation of emission ranges given in paper; also note these average values were given for a specific location, not shown here.

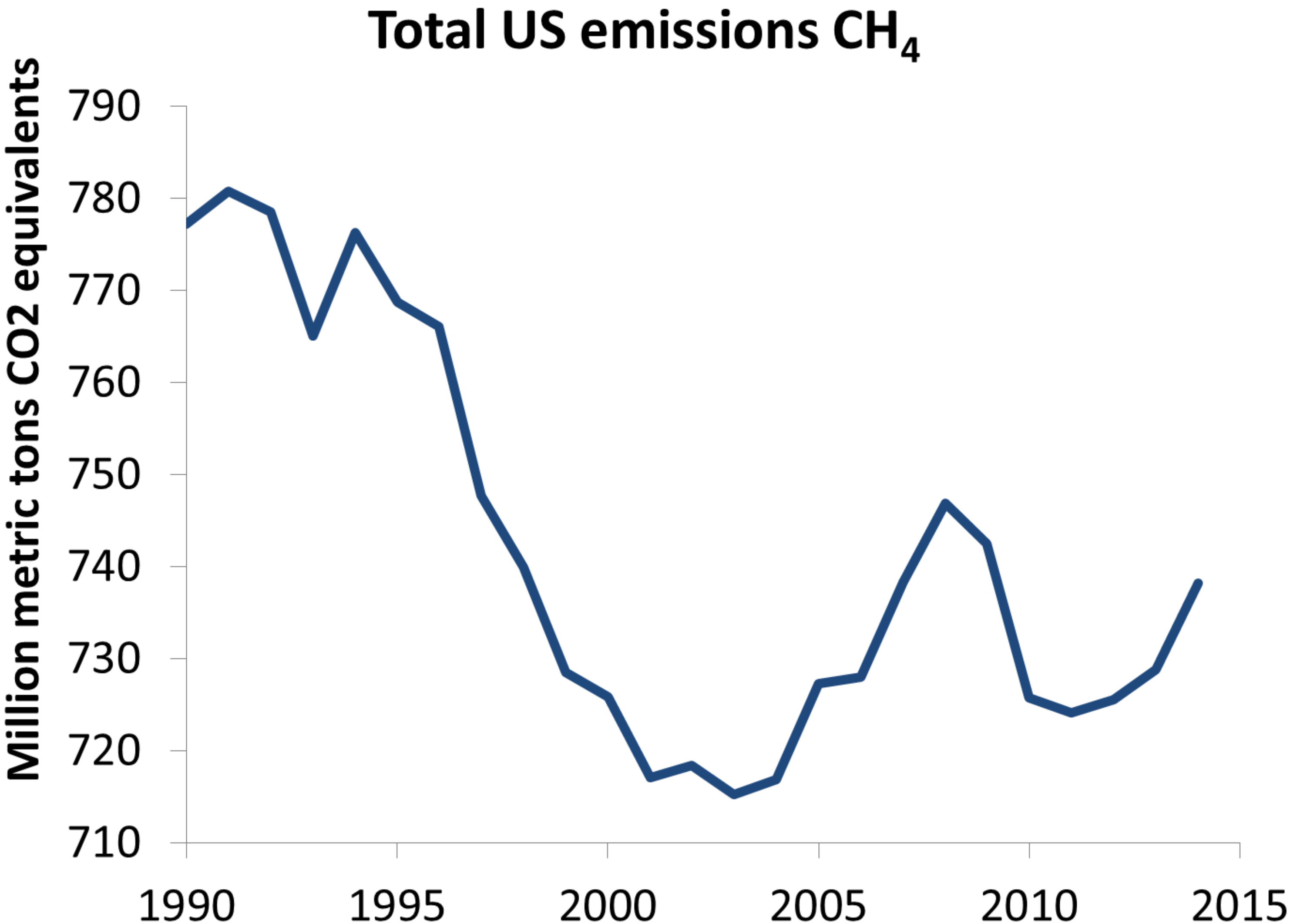
Competing Views

- By reducing reliance on coal, natural gas is an important bridge to the renewable energy future.

- Because leakage rates likely exceed climate-benefit threshold, the switch from coal to natural gas is actually accelerating global warming.

- Even if there were net climate benefits, natural gas is a "bridge to nowhere" that only forestalls the needed shift to non-fossil, renewable energy.

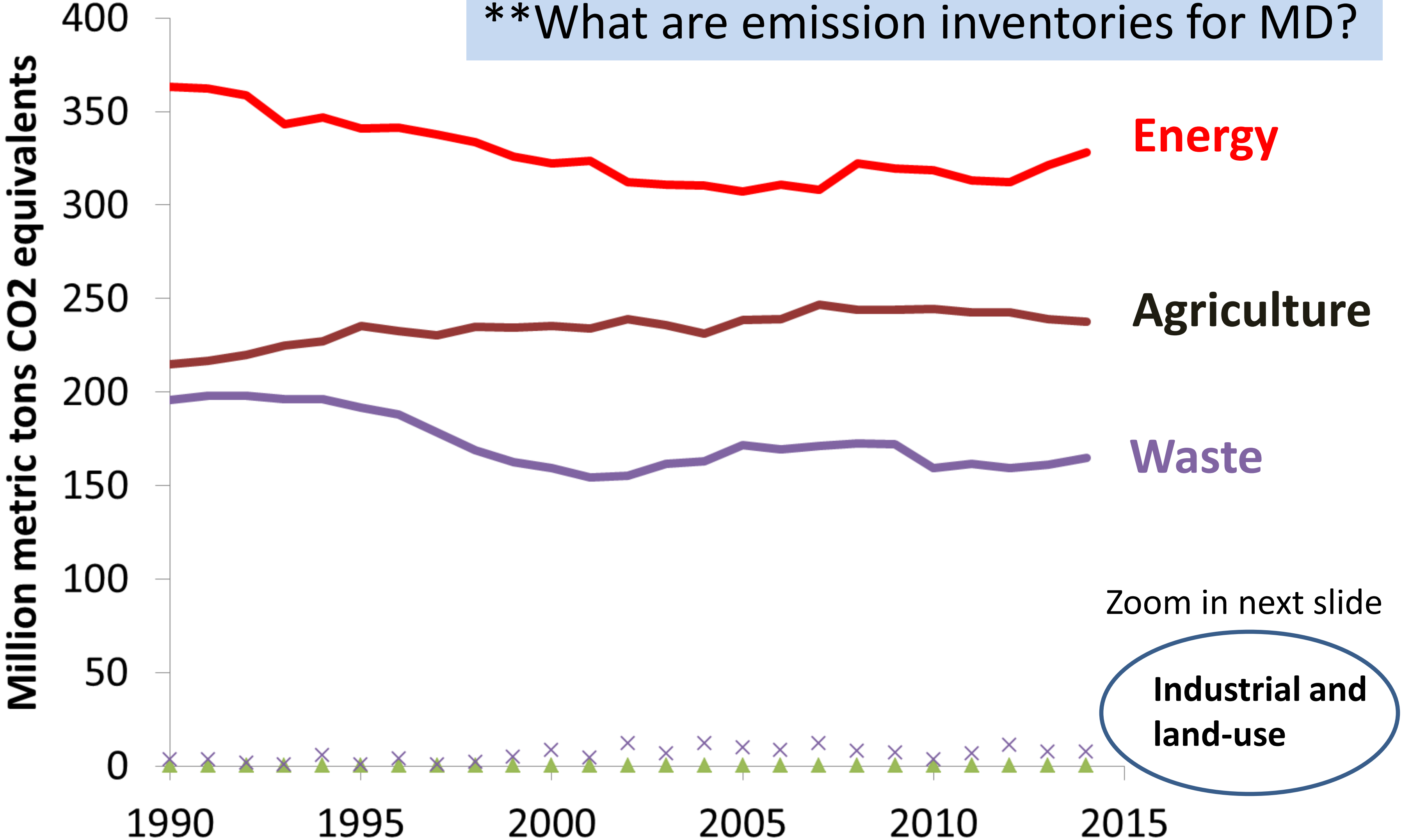
What are the opportunities for reducing methane emissions in Maryland in contrast to US?



Source: EPA inventory of US Greenhouse Gas Emissions and Sinks 1994-2014;

What are the opportunities for reducing methane emissions in Maryland in contrast to US?

**What are emission inventories for MD?



Source: EPA inventory of US Greenhouse Gas Emissions and Sinks 1994-2014

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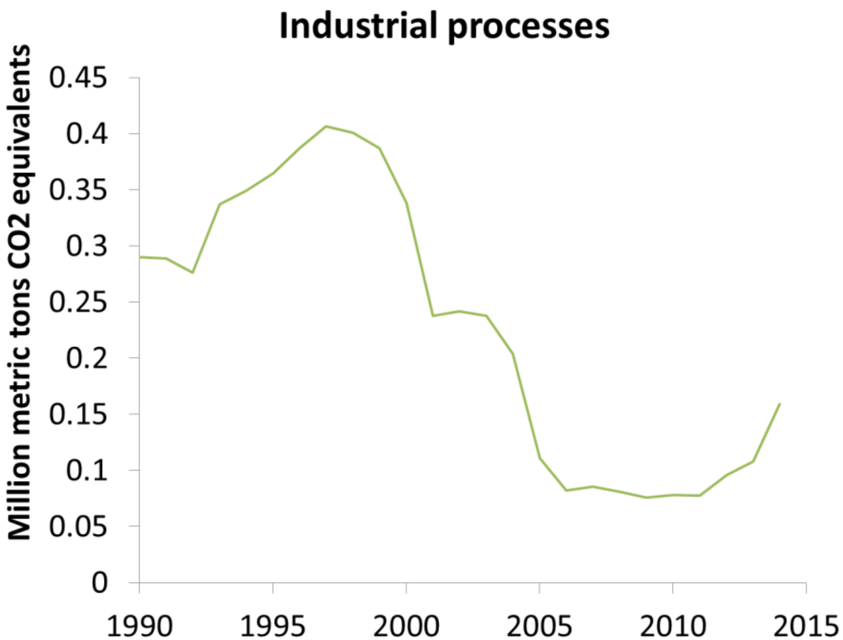

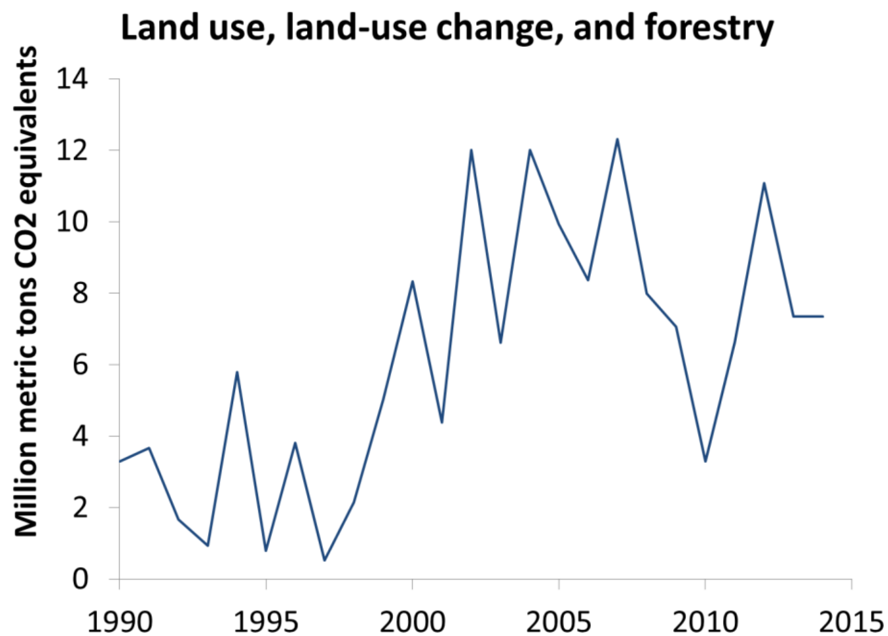

Source: EPA inventory of US Greenhouse Gas Emissions and Sinks 1994-2014

Summary

- Methane is a potent greenhouse gas that is formed by both natural and anthropogenic sources
- Trying to determine key categories for MD to focus on will be key in making efforts to decrease methane emissions in the state
  - Refer to Chris Beck's talk on MDE's efforts to constrain source categories across the state

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