Pipeline Transport in a Decarbonizing Economy
Meeting Environmental Needs

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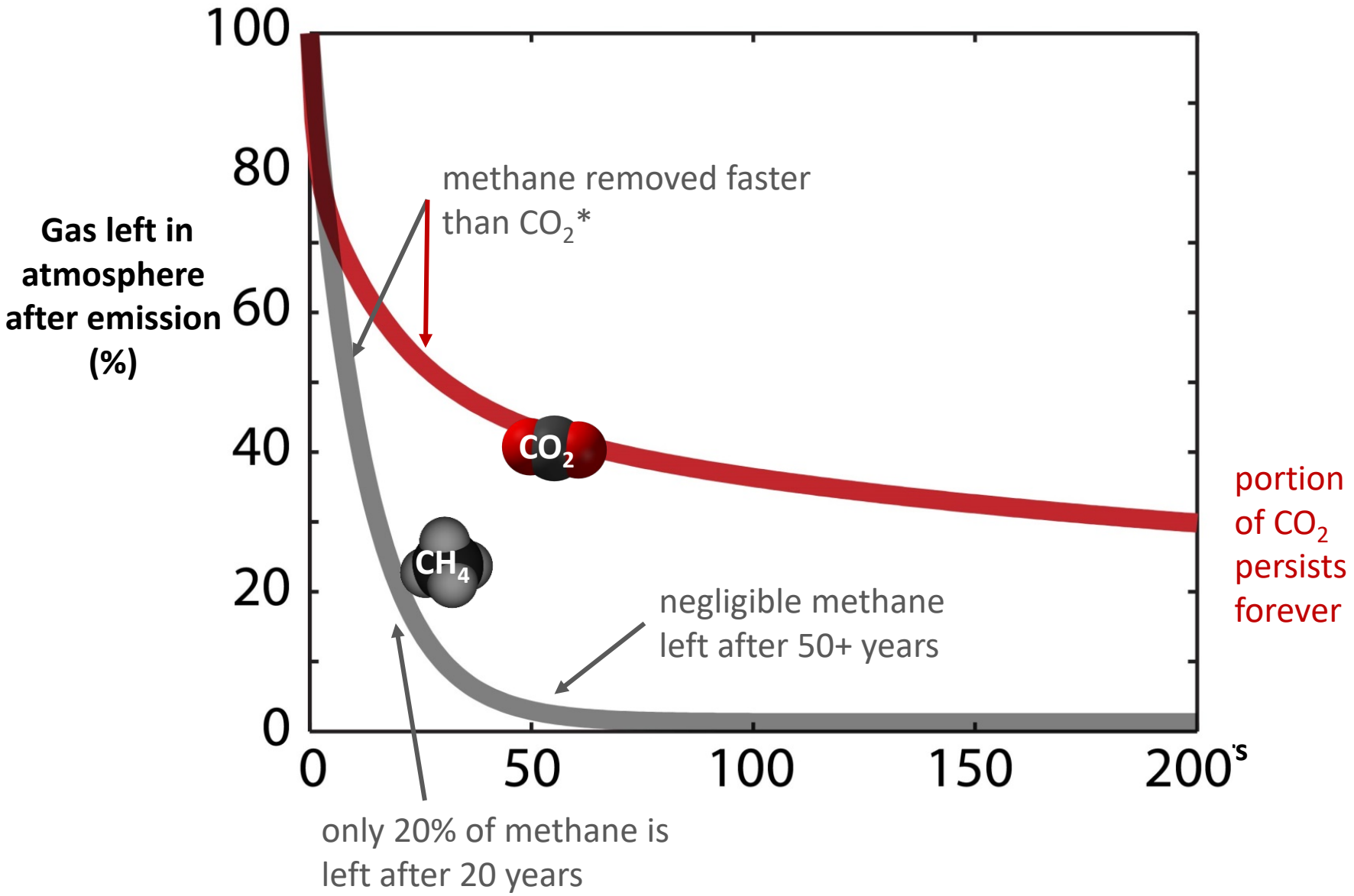
Protecting people and the environment requires minimize emissions: methane (natural gas), carbon dioxide, hydrogen, oil

PHMSA “has substantial authority to protect people and the environment by reducing or eliminating leaks or ruptures of oil and gas pipelines, at underground natural gas storage facilities, and from liquified natural gas (LNG) operations.”

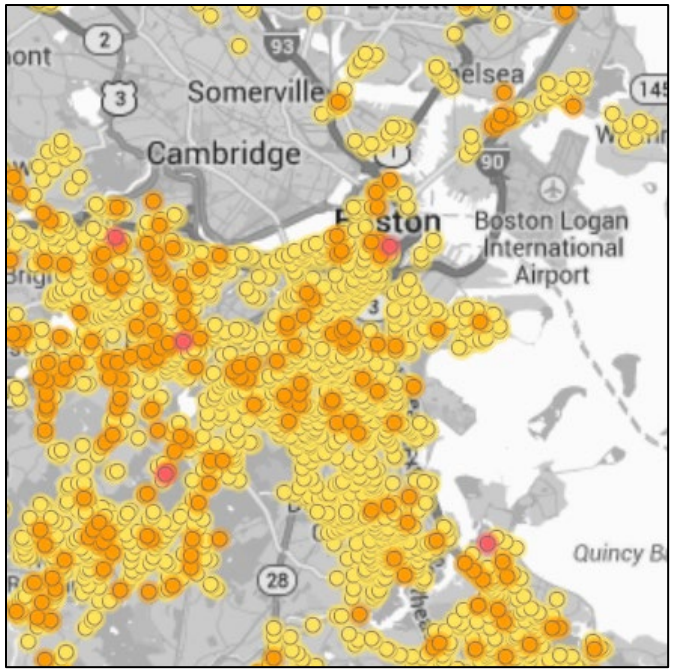
https://www.whitehouse.gov/wp-content/uploads/2021/11/US-Methane-Emissions-Reduction-Action-Plan-1.pdf

CO_2 last centuries longer than methane…

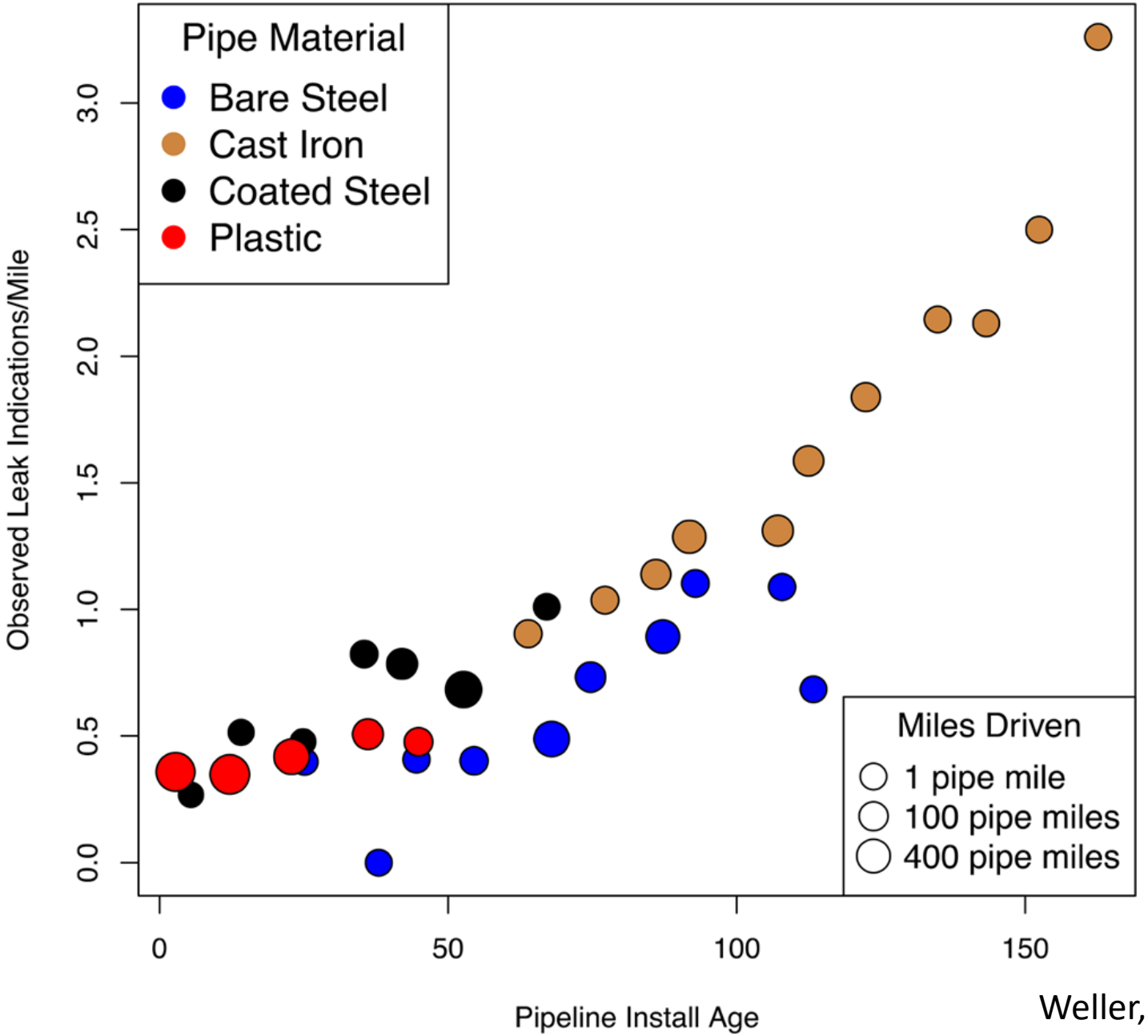


Technological improvements key to minimizing leakage

Boston vs. Indianapolis



City	Miles driven/ leak found
Boston, MA	1
Indianapolis, IN	200



Weller, Hamburg, von Fisher 2020 ES&T

Table 3. Estimated Emissions Factors in g/min from Our Study Compared to EPA/GRI 1992 and Lamb 2015

material	EPA/GRI 1992[a] (g/min) estimate (90% UCL)	Lamb 2015 (g/min) estimate (95% UCL)	this study (g/min) estimate (95% cr int)
bare (unprotected) steel	1.91 (3.70)	0.77 (2.07)	2.24 (1.22, 3.40)
	n = 20	n = 74	n = 826
cast iron	3.57 (5.60)	0.90 (3.35)	1.72 (0.94, 2.64)
	n = 21	n = 14	n = 1664
coated (protected) steel	0.76 (1.40)	1.21 (4.59)	2.00 (1.10, 3.05)
	n = 17	n = 31	n = 911
plastic	1.88 (8.20)	0.33 (0.67)	2.03 (1.10, 3.12)
	n = 6	n = 23	n = 819
total	n = 64	n = 142	n = 4220

[a]The EPA/GRI 1992 estimates are taken directly from those reported in Lamb 2015.

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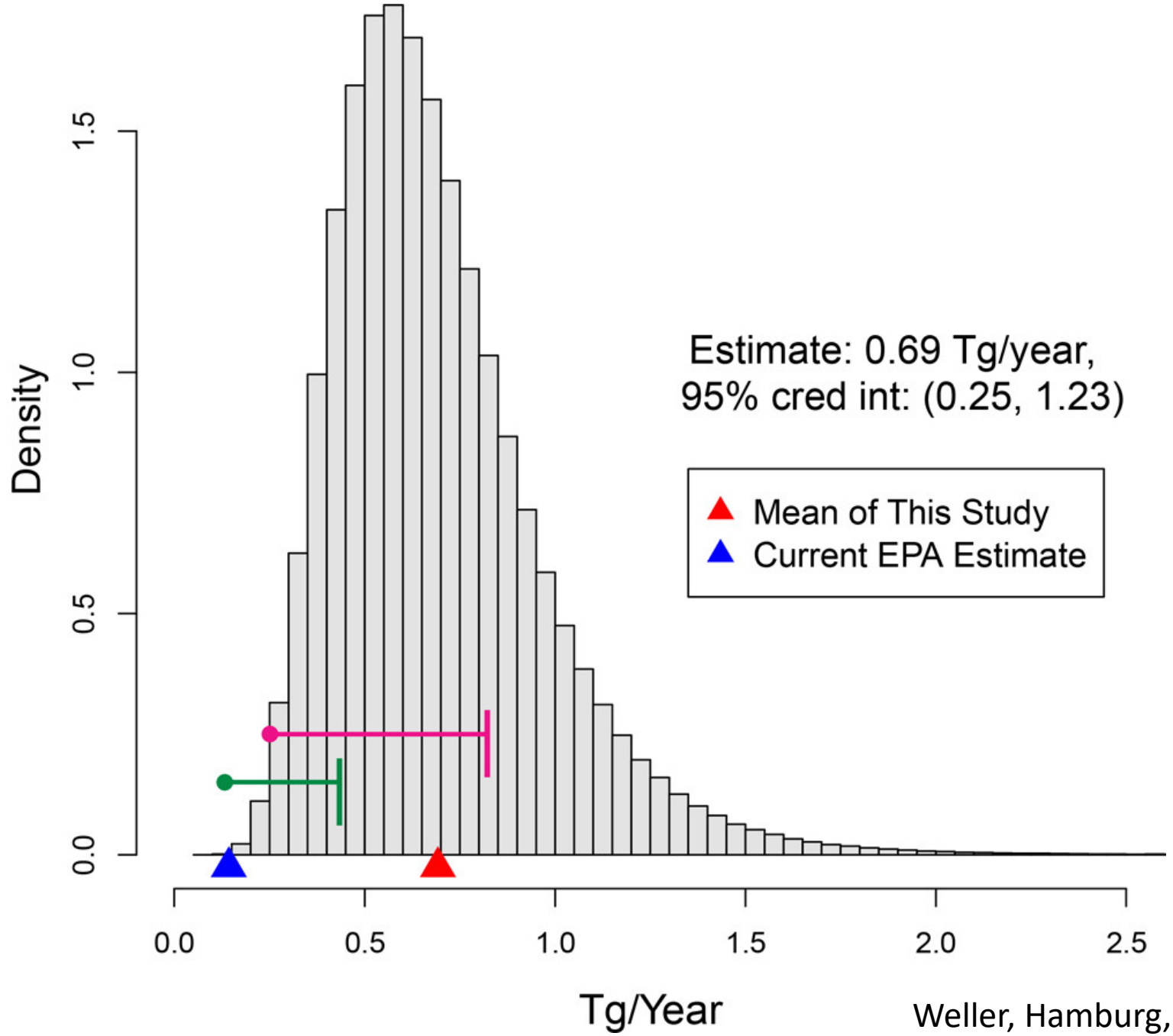
We need better data

- Pipeline characteristics, spatial distribution by age and pipe type
- Regular high accuracy quantification surveys of leaks from all types of pipelines and storage systems
- Balanced budgets – e.g. urban thermogenic methane, hydrogen
- *In situ l*eak rate assessments of new materials and new applications before wide-spread deployment



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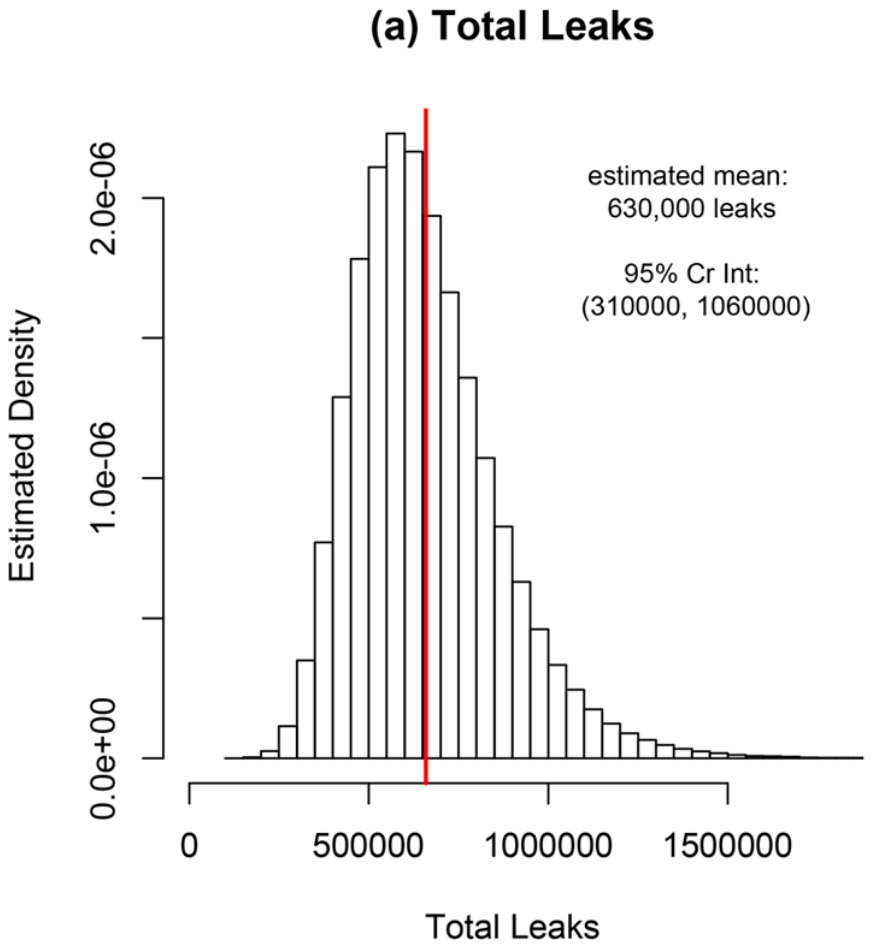
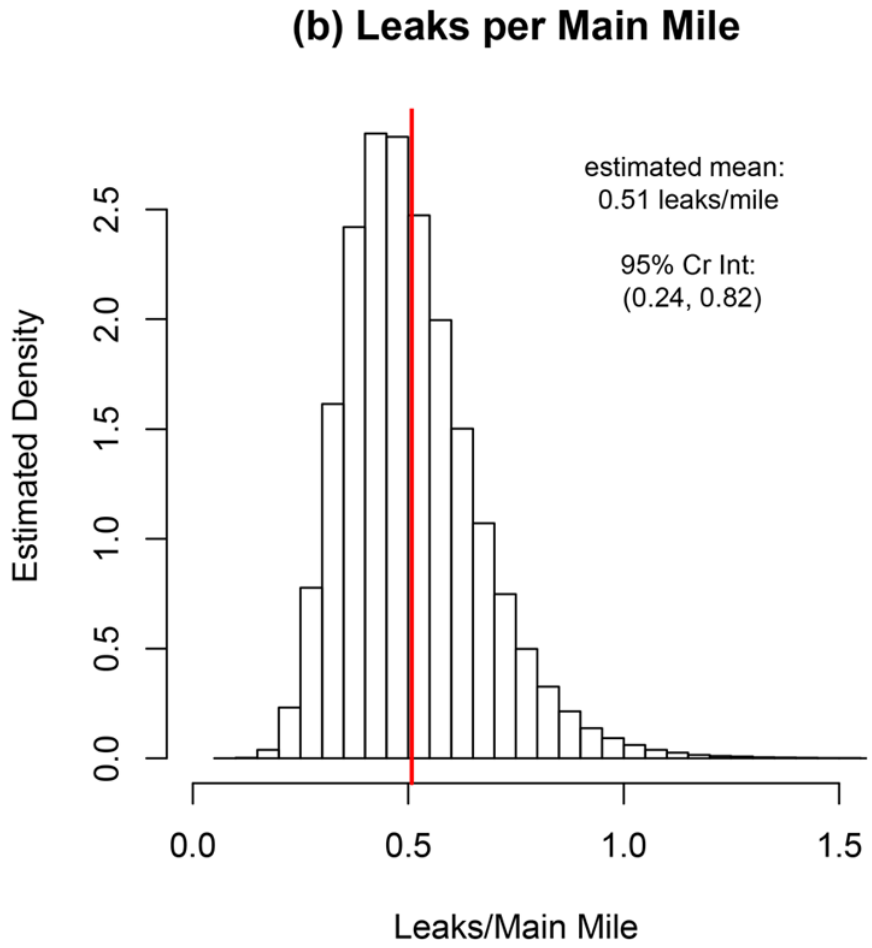
Local Distribution System Methane Emissions





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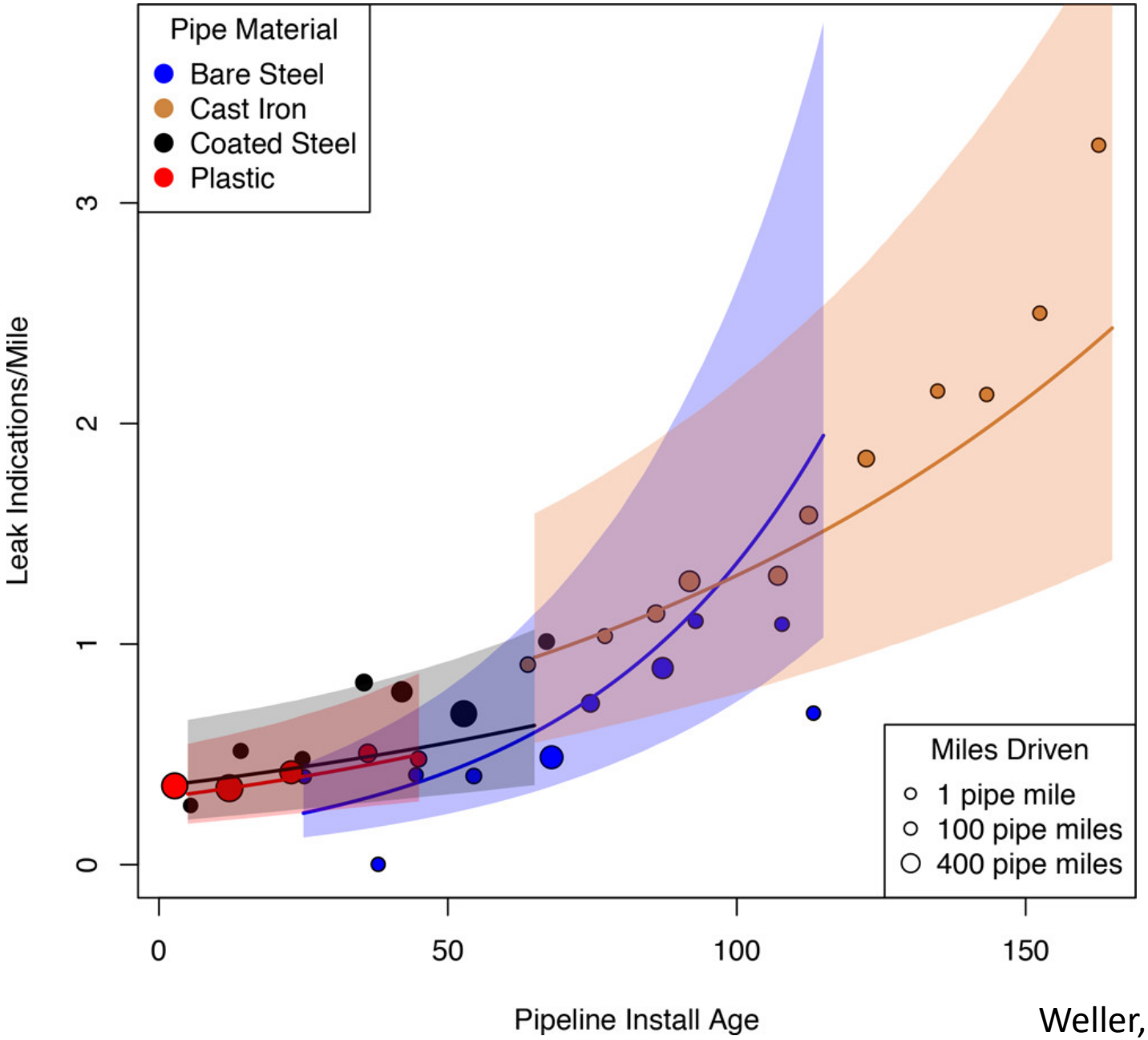

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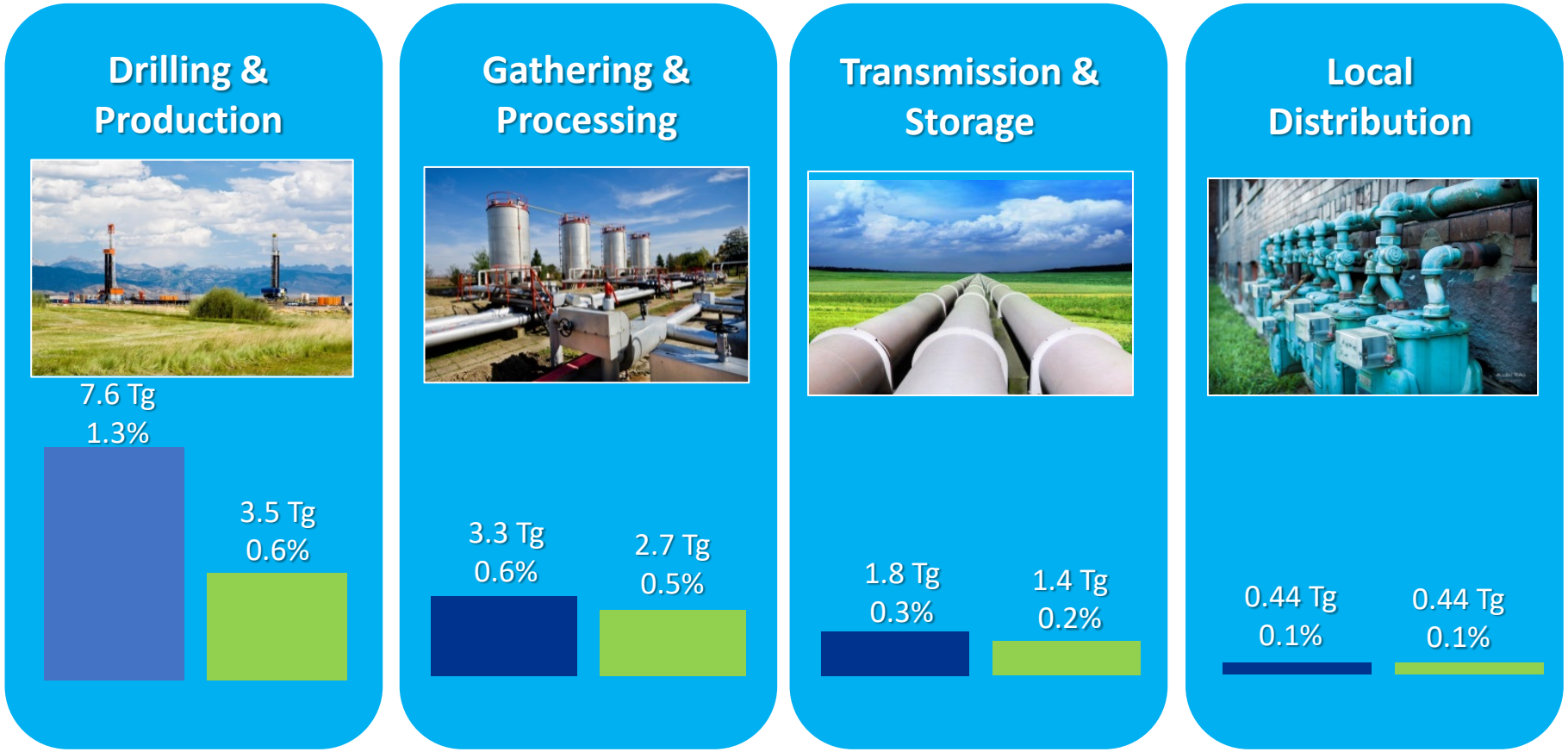
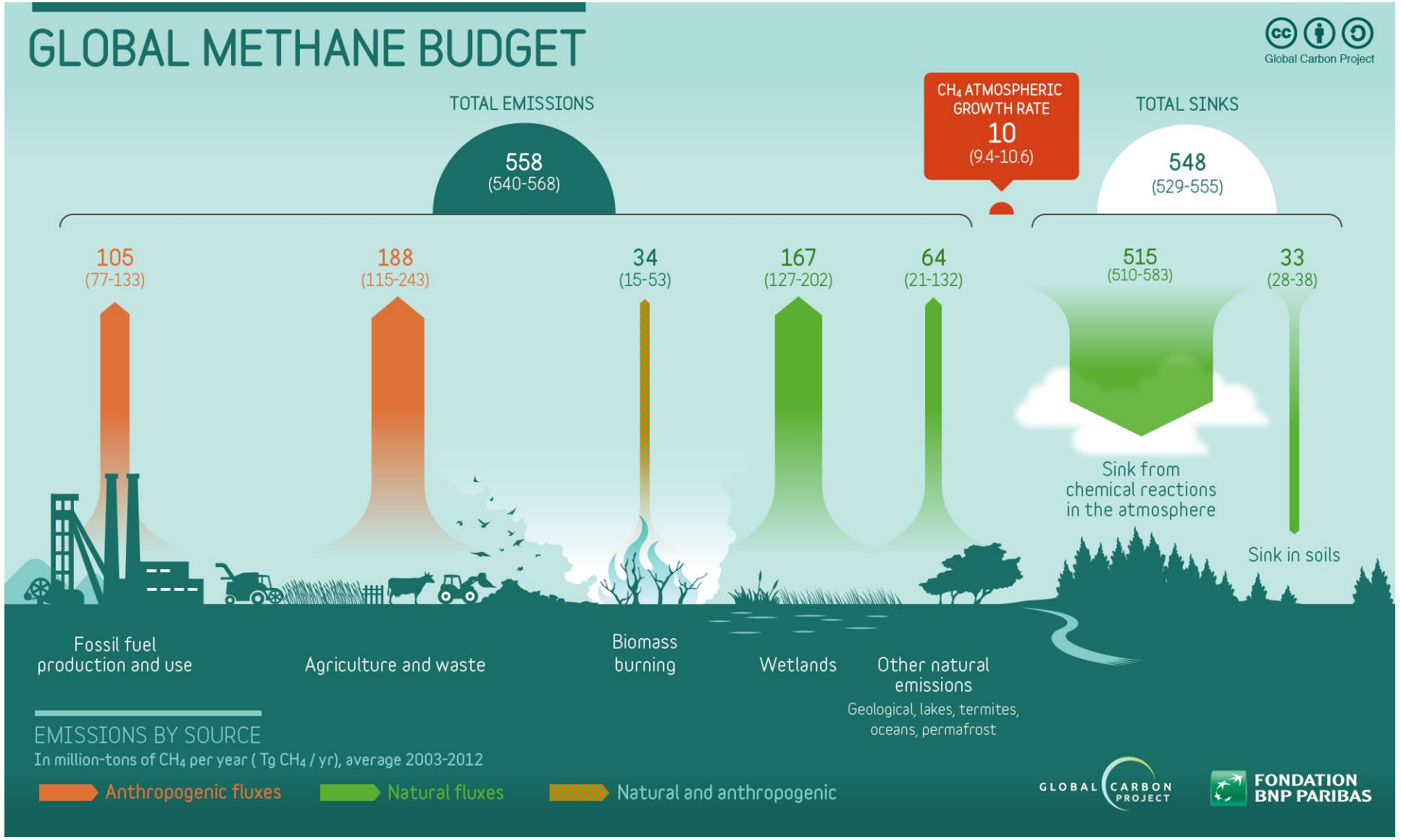
U.S. oil and gas supply chain emissions

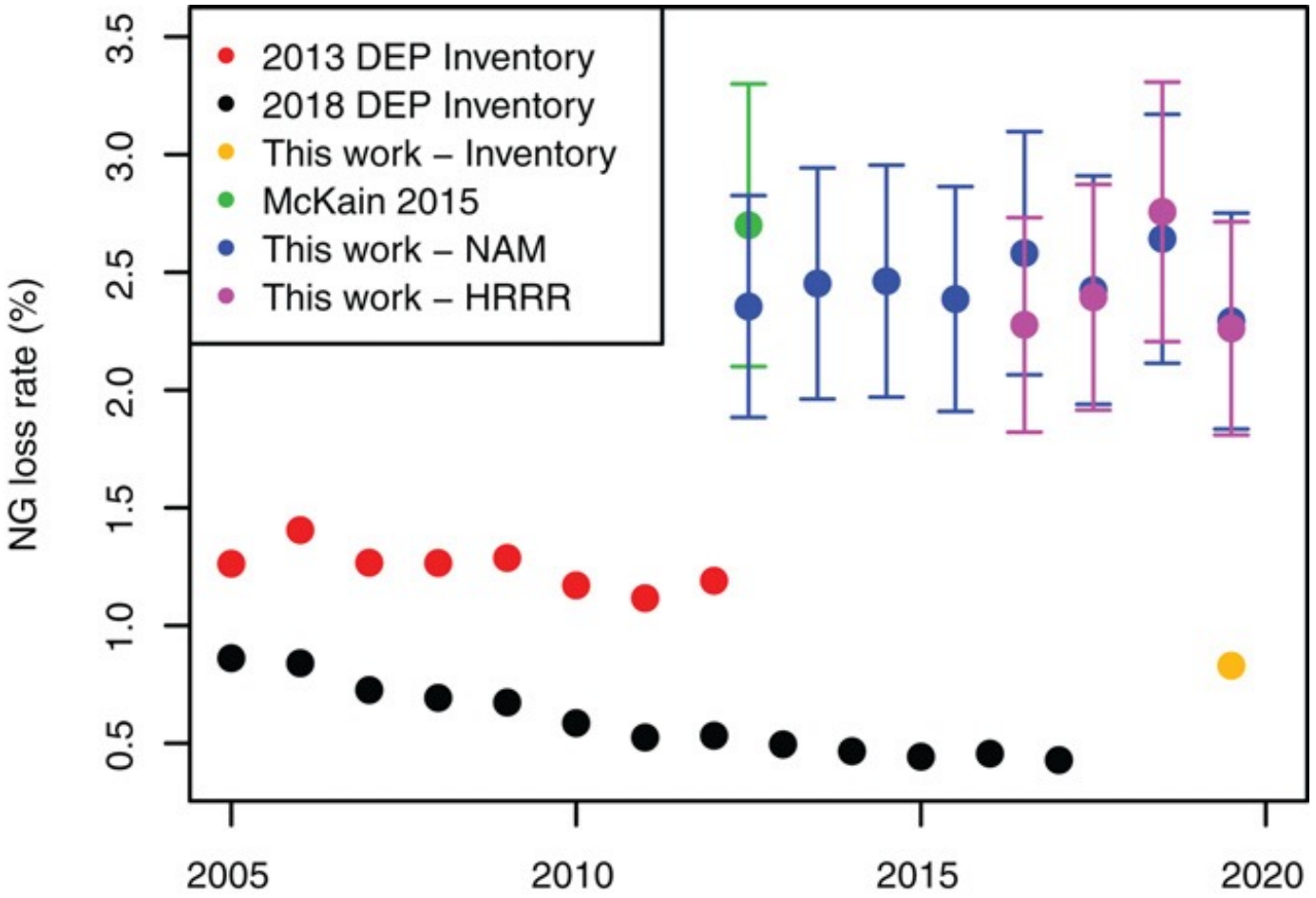


Global Methane Budget 2003-2012



http://www.globalcarbonatlas.org

Urban methane budgets are unresolved

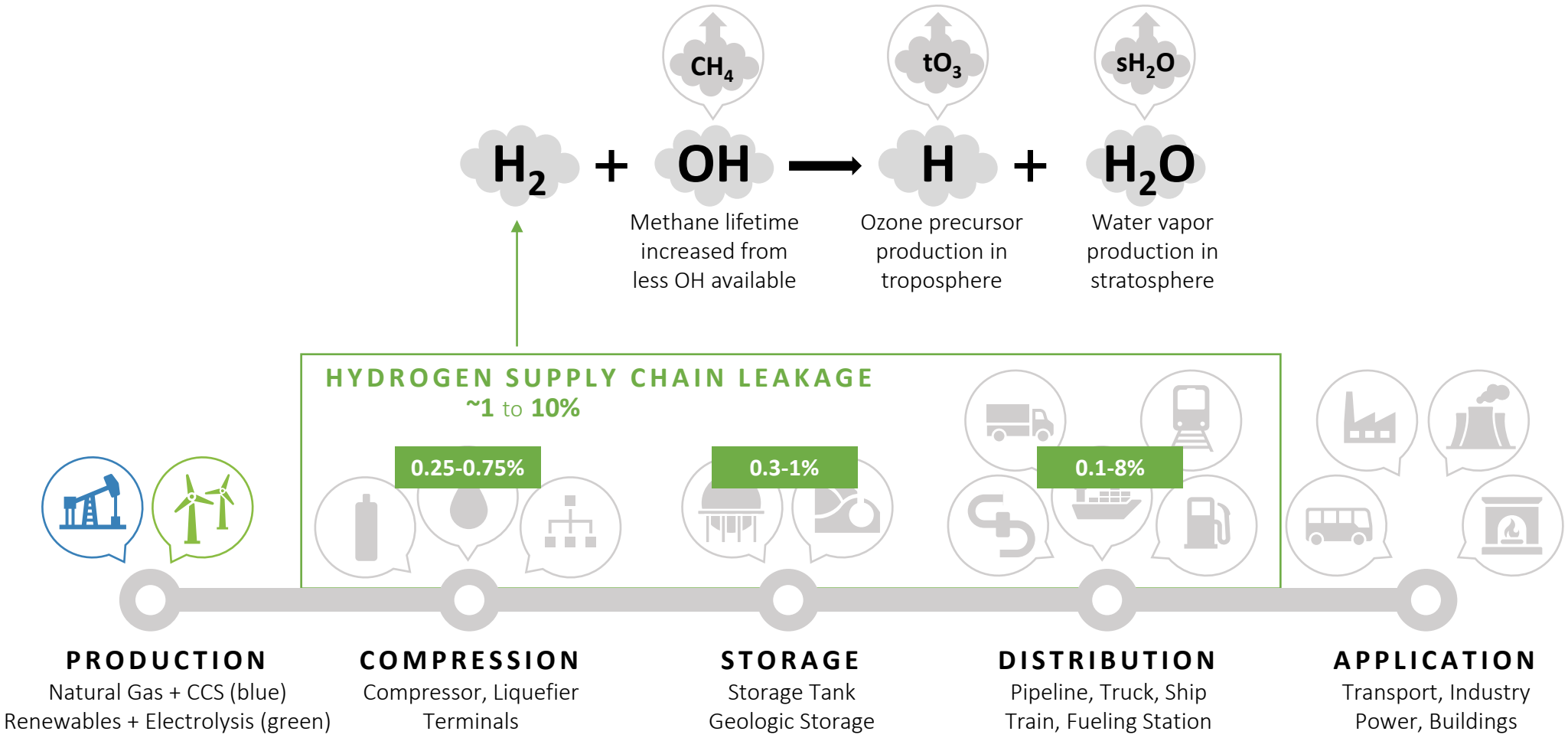


Methane budget for **Boston Metropolitan Area** – roughly half of the sources of thermogenic methane are unknown

Sargent et al PNAS 2021

H_2 leakage can decrease decarbonization benefits of hydrogen usage

Hydrogen is an indirect short-lived greenhouse gas



Paulot et al. 2021

DOE 2015 & van Ruijven et al. 2011

What is the future of existing pipelines?

- Repurposed?
  - What is the criteria for when it makes sense
  - Methane and hydrogen characteristics differ - leakage rates are unlikely to be the same
- Phased out?
  - Are local distribution systems needed in a decarbonized economy?
- Replaced?
  - At what cost relative to alternative energy distribution systems?
- Repaired?
  - Can repairs meet the need during the period during which they are needed?

Research needs

- Development of low-cost fast response high precision instruments for gases being transported and stored – e.g. H_2
- Determining in situations where pipelines are unlikely to be needed in a decarbonized economy how can the life of existing pipelines be extended safely and effectively until they can be retired?
- Determining how emissions data can be collected cheaply and routinely across the full spectrum of infrastructure and materials being transported?

Thank you