

**The Power of Waste: Opportunities for Renewable Natural Gas in AZ**

# **The Role of Renewable Natural Gas in a Low Carbon Future**

Dr. Nathan Parker  
School of Sustainability  
Arizona State University  
April 30, 2019





**Animal manures**



**Waste water biogas**



**Food & green waste**



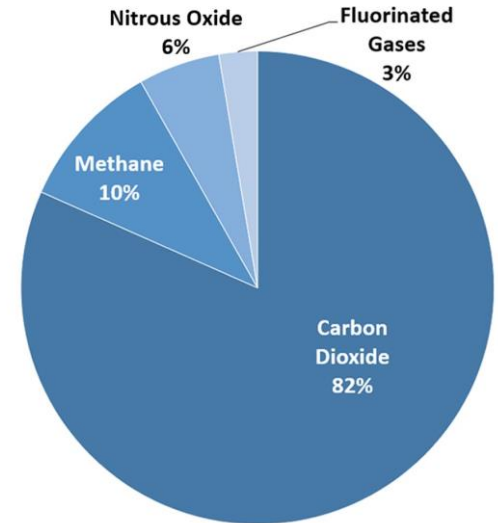
**Landfill gas**



# RNG sources = sources of fugitive methane

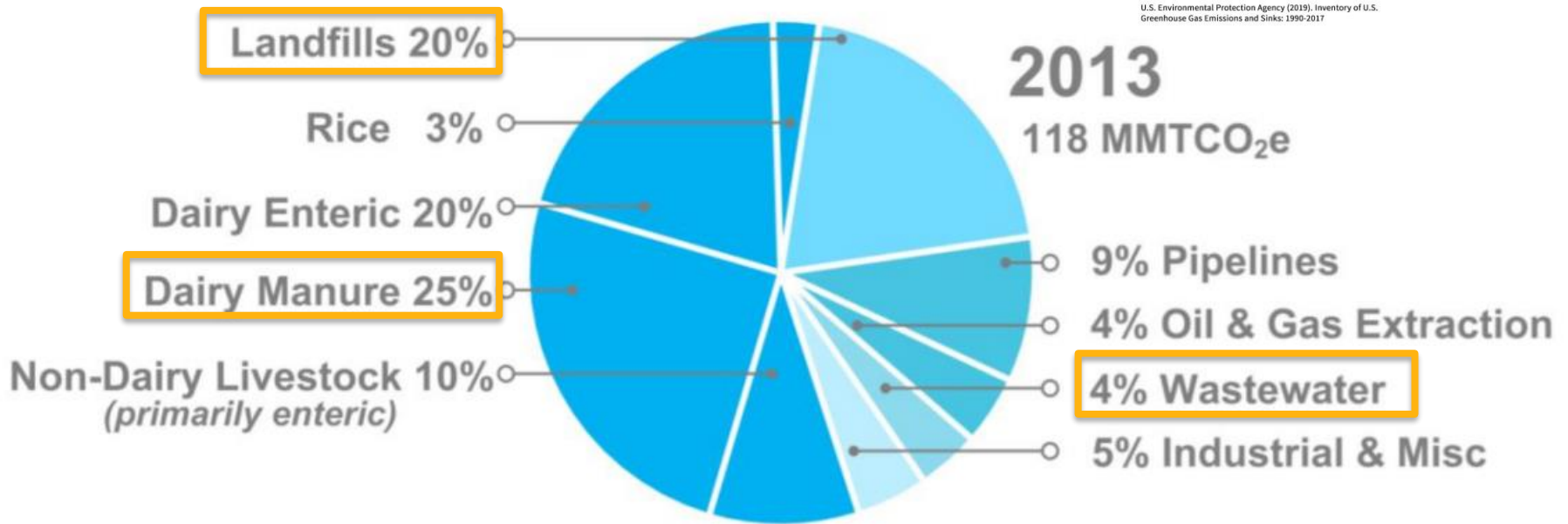
Emitting carbon as CO<sub>2</sub> instead of CH<sub>4</sub> reduces the climate impact by ~24 times over 100 years.

U.S. Greenhouse Gas Emissions in 2017



U.S. Environmental Protection Agency (2019), Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017

## 2013 methane emissions inventory for CA



Source: CARB (2017) Short Lived Climate Pollutant Reduction Strategy.

# ***RNG compliments renewable electricity***

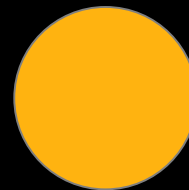
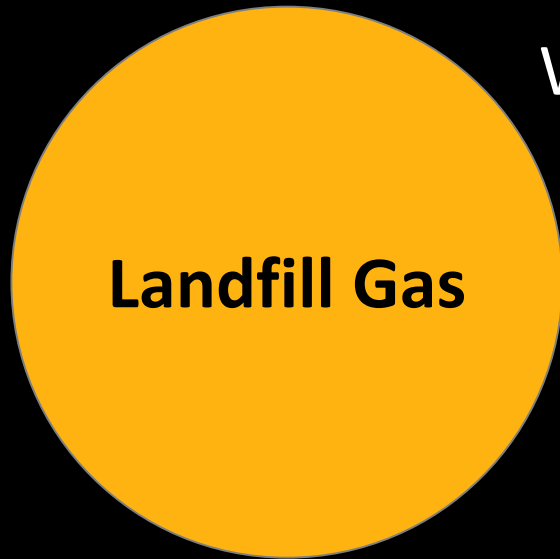
Can serve difficult to electrify demands in transportation like the heavy duty sector.

Can provide low carbon peaking power from natural gas power plants.

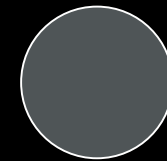


# Gross RNG Potential in U.S.A.

740 BCF/yr  
RNG potential

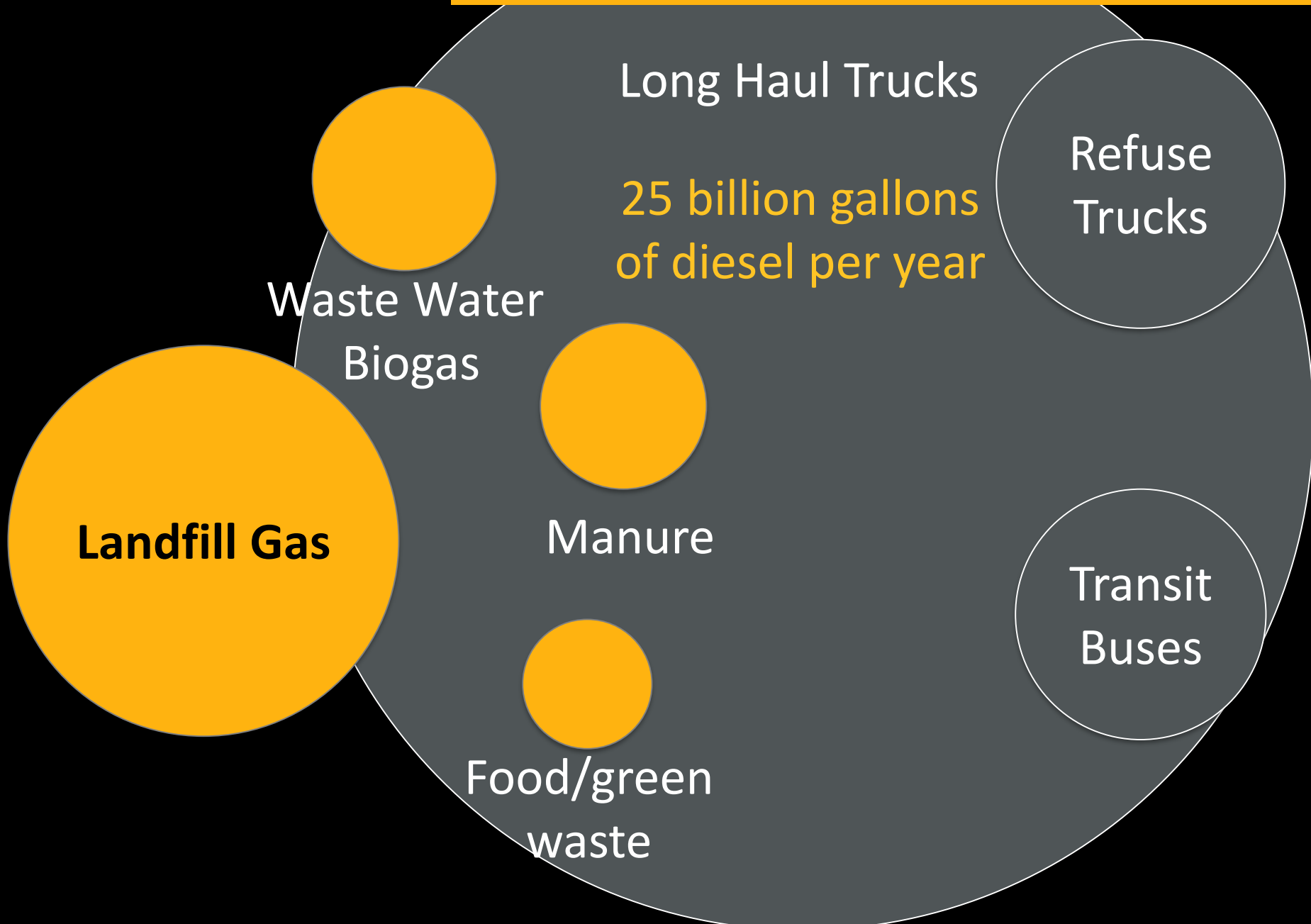


2014 natural gas  
consumption in  
transportation =  
35 BCF



Source: NREL (2014) Renewable Hydrogen Potential from Biogas in the United States. NREL/TP-5400-60283.

# RNG Potential in U.S.A.



Long Haul Trucks

25 billion gallons  
of diesel per year

Refuse  
Trucks

Waste Water  
Biogas

Manure

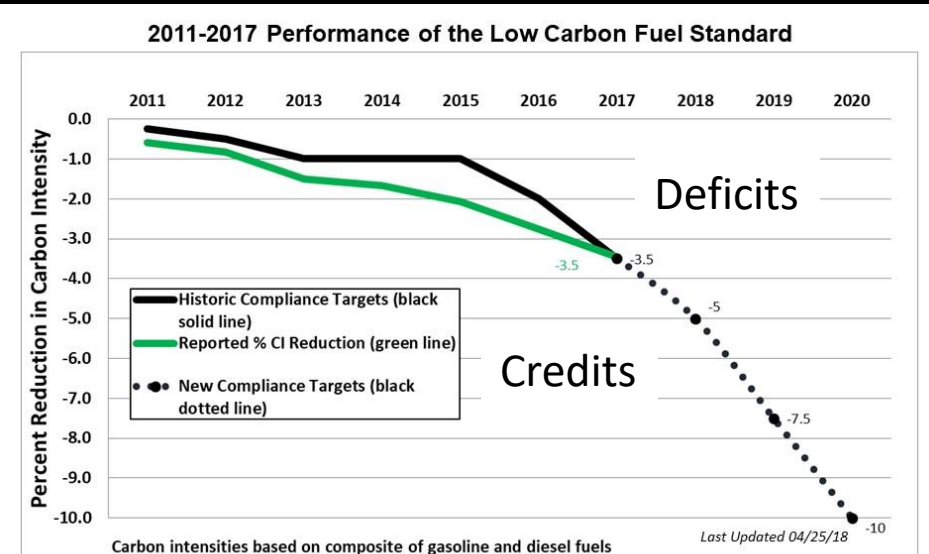
Transit  
Buses

Landfill Gas

Food/green  
waste

# Low Carbon Fuel Standard

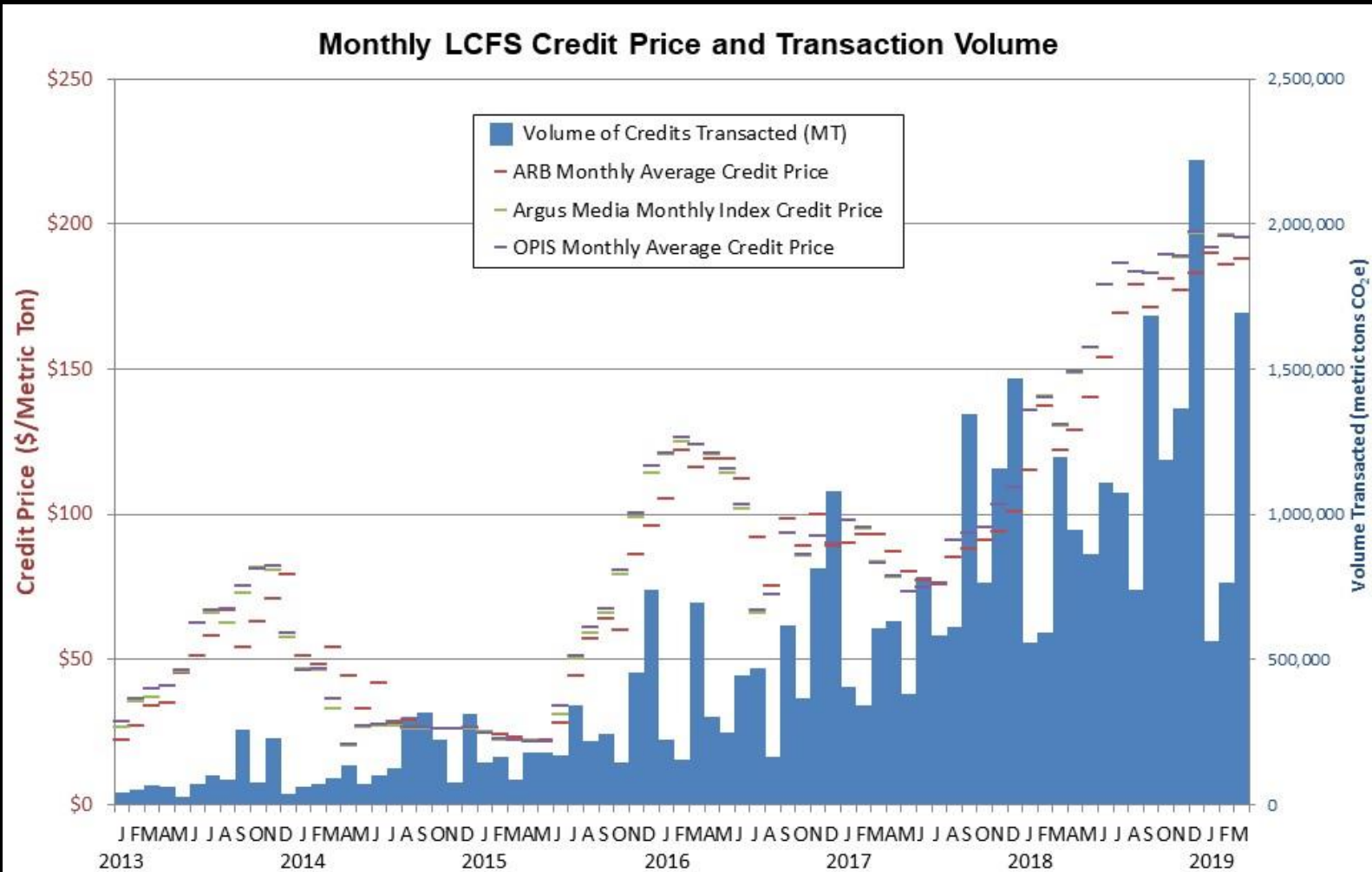
- California and Oregon
- Sets average carbon intensity targets for transportation fuels sold in CA that decline over time.
- Life cycle basis
- Obligated parties need credits to cover deficits generated by sales of high CI fuels
- Credit market



This figure shows the percent reduction in the carbon intensity (CI) of California's transportation fuel pool. The LCFS target is to achieve a 10% reduction by 2020 by setting a declining annual target, or compliance standard. The compliance standard was frozen at 1% reduction from 2013-2015 due to legal challenges, contributing to a build-up of banked credits as regulated parties bringing new alternative fuels to market continued to over-comply with the standard. The program will continue post 2020 at a to be determined stringency.

[Click to download the Excel spreadsheet of this graph.](#)

# Credit prices approaching \$200/ton CO<sub>2</sub>



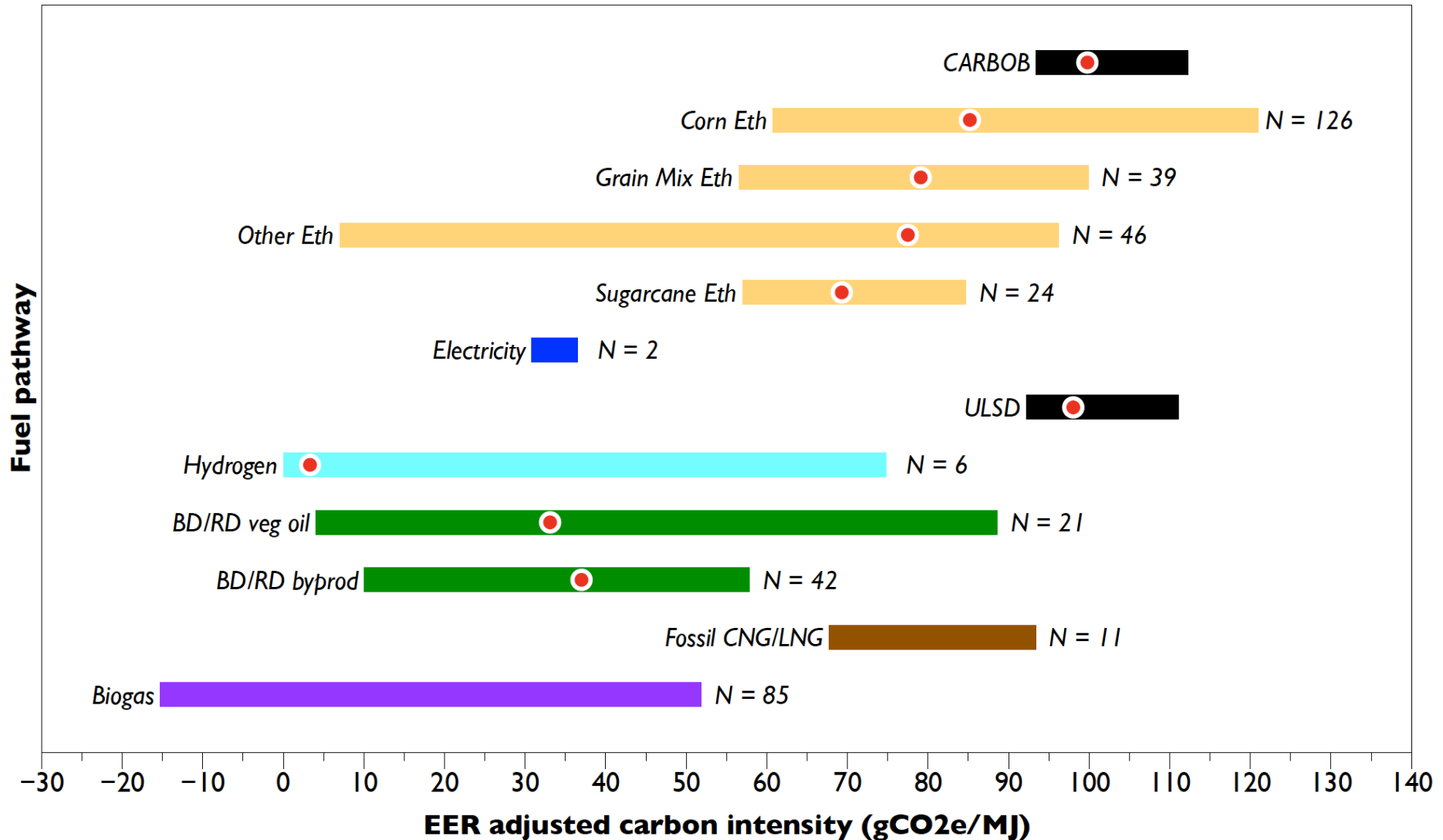
Last Updated 4/10/2019

This chart tracks credit prices and transaction volumes over time. Monthly average credit prices reported by Argus Media and OPIS [used with permission] are shown along with CARB monthly average price.

[Click to download the Excel spreadsheet of this graph.](#)



# RNG has low carbon intensities (CI)



Source: Yeh, Sonia, et al. "A review of low carbon fuel policies: Principles, program status and future directions." Energy Policy 97 (2016): 220-234.

# A Very Negative CI Pathway

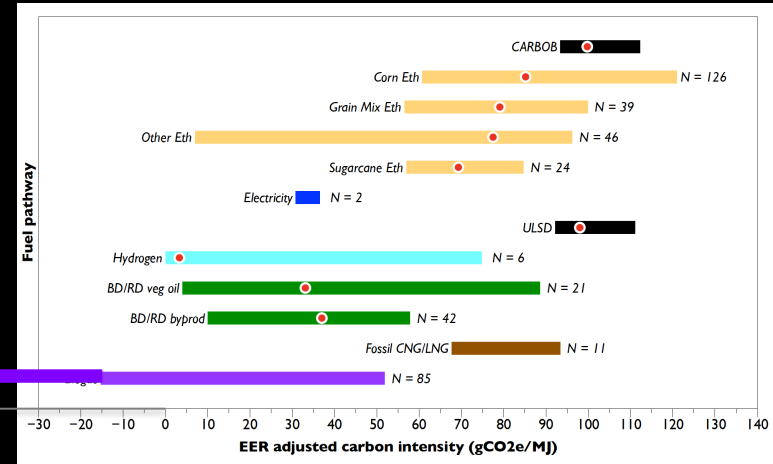


Dairy AD RNG

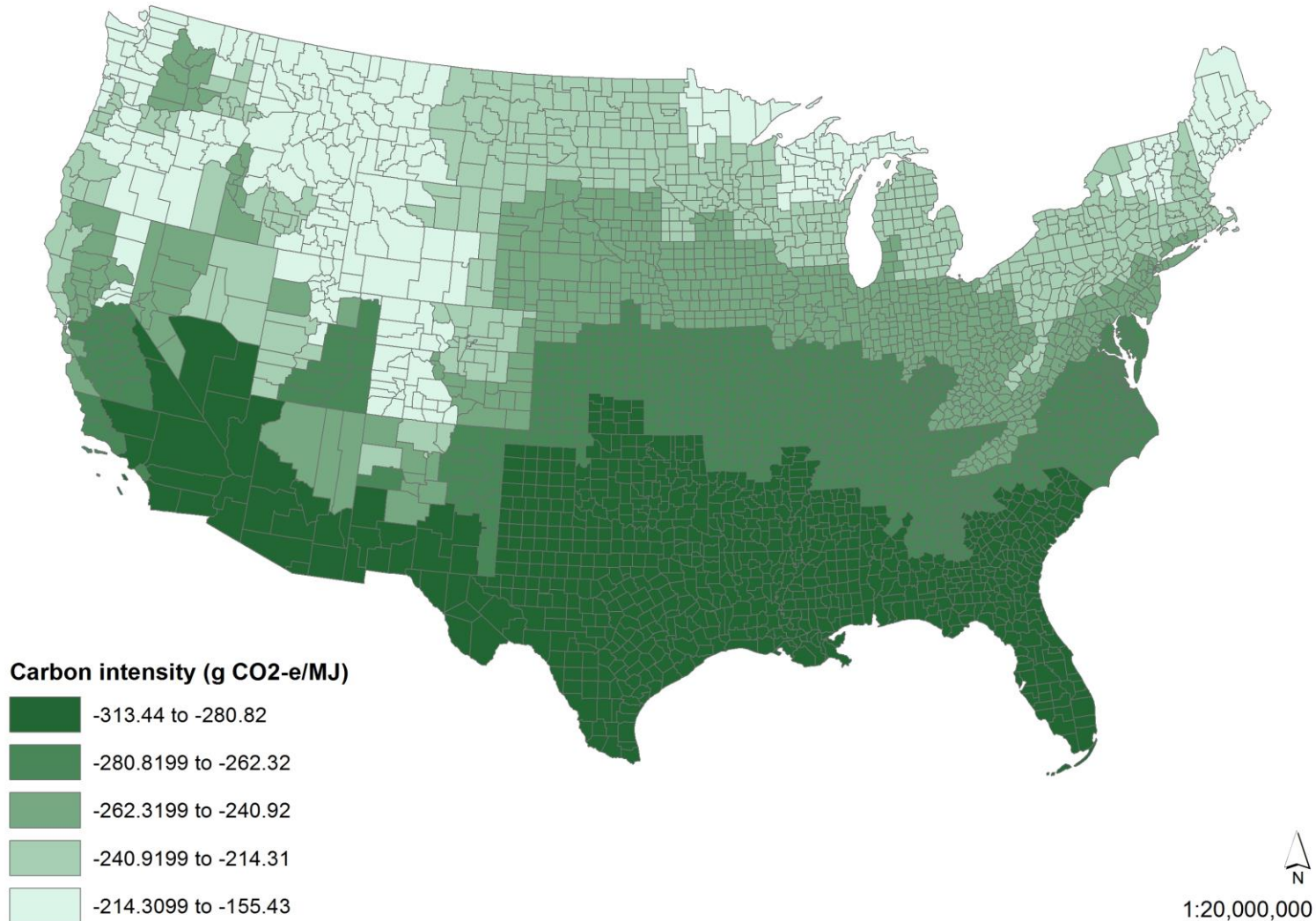
\$150/ton credit price → \$58/mmBtu

Biogas/RNG

-276 gCO<sub>2</sub>e/MJ

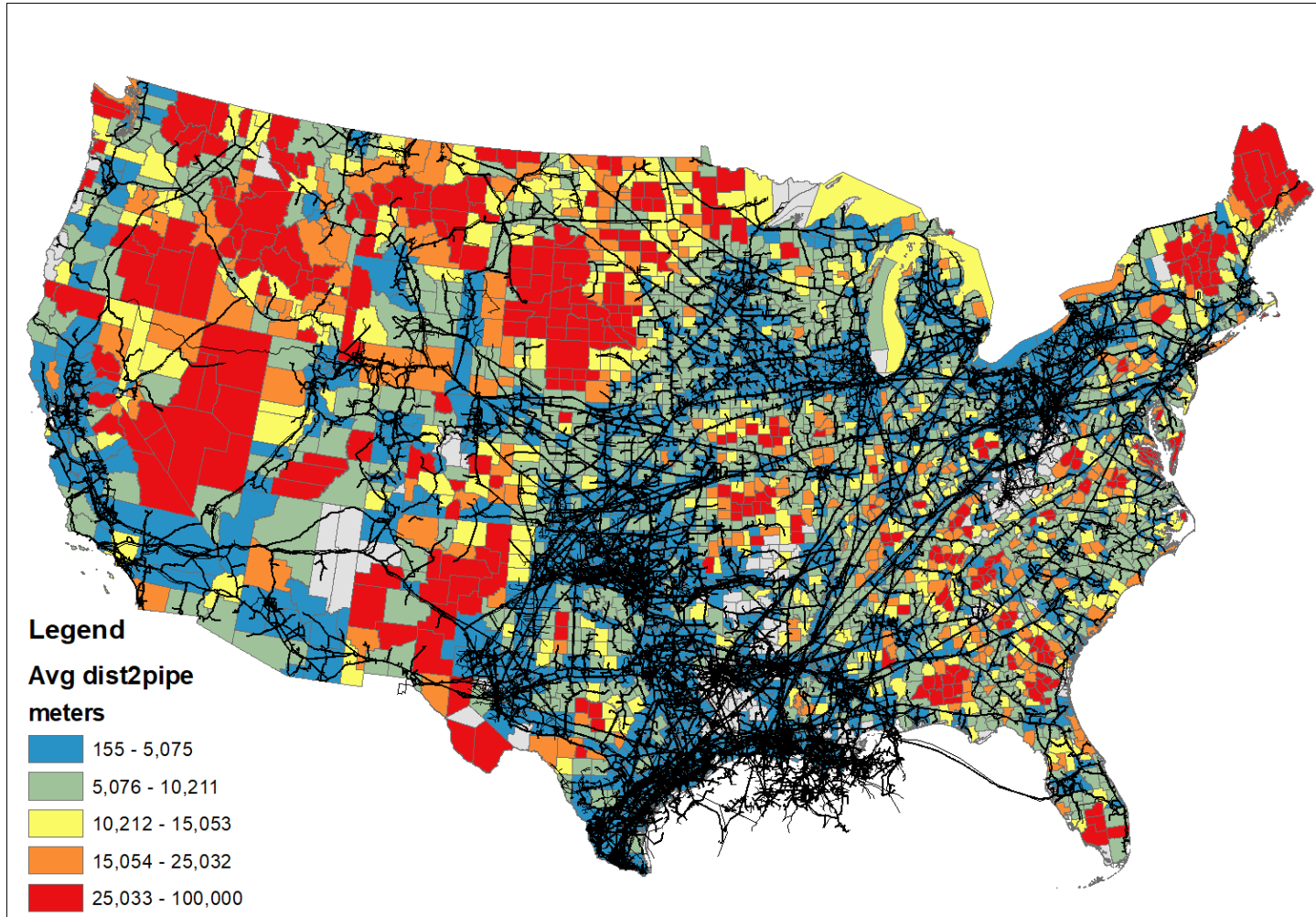


# Variation in Dairy Carbon Intensities



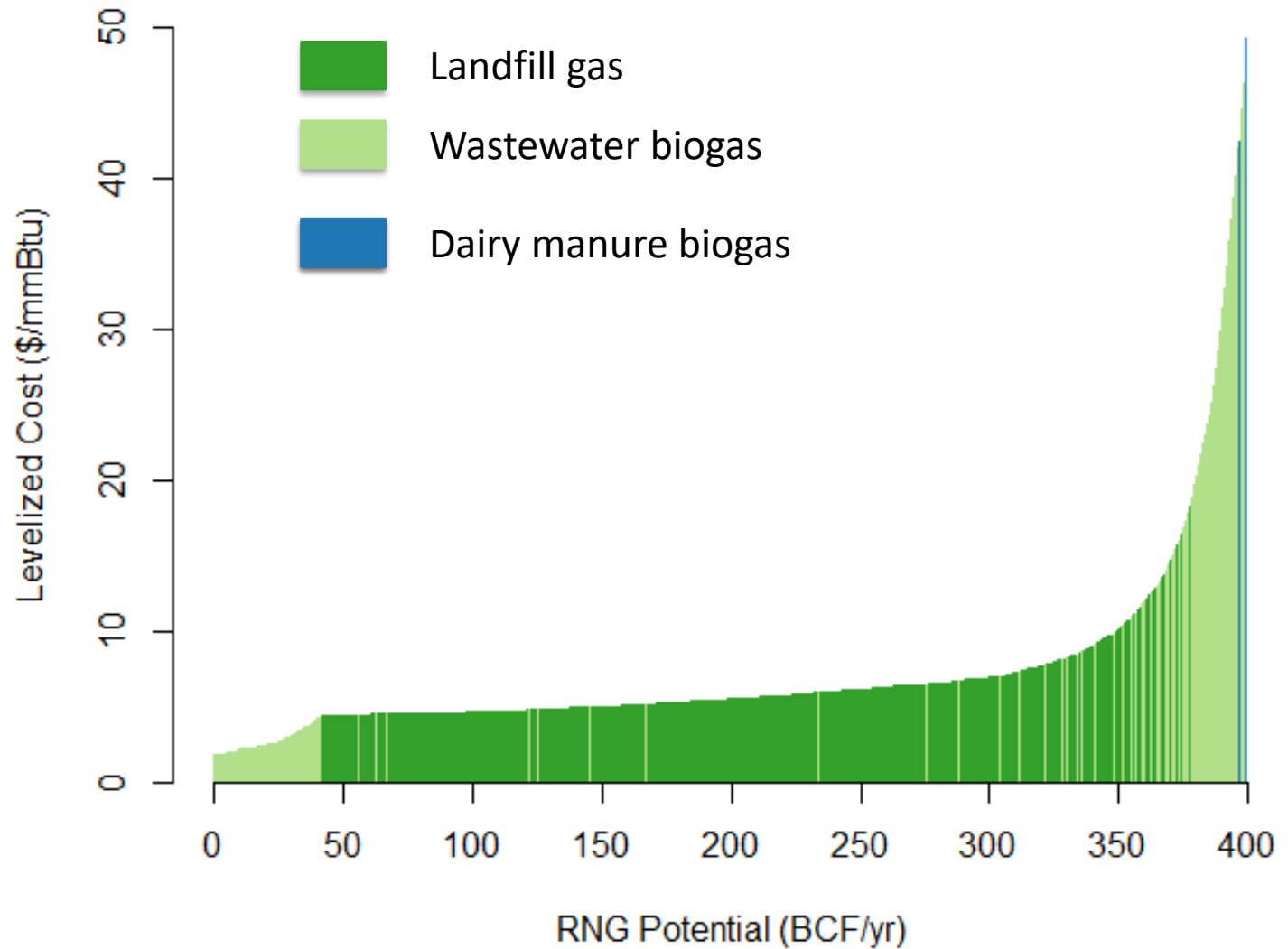
# Local factors are hugely important in the economics of RNG.

Average distance to a pipeline by county



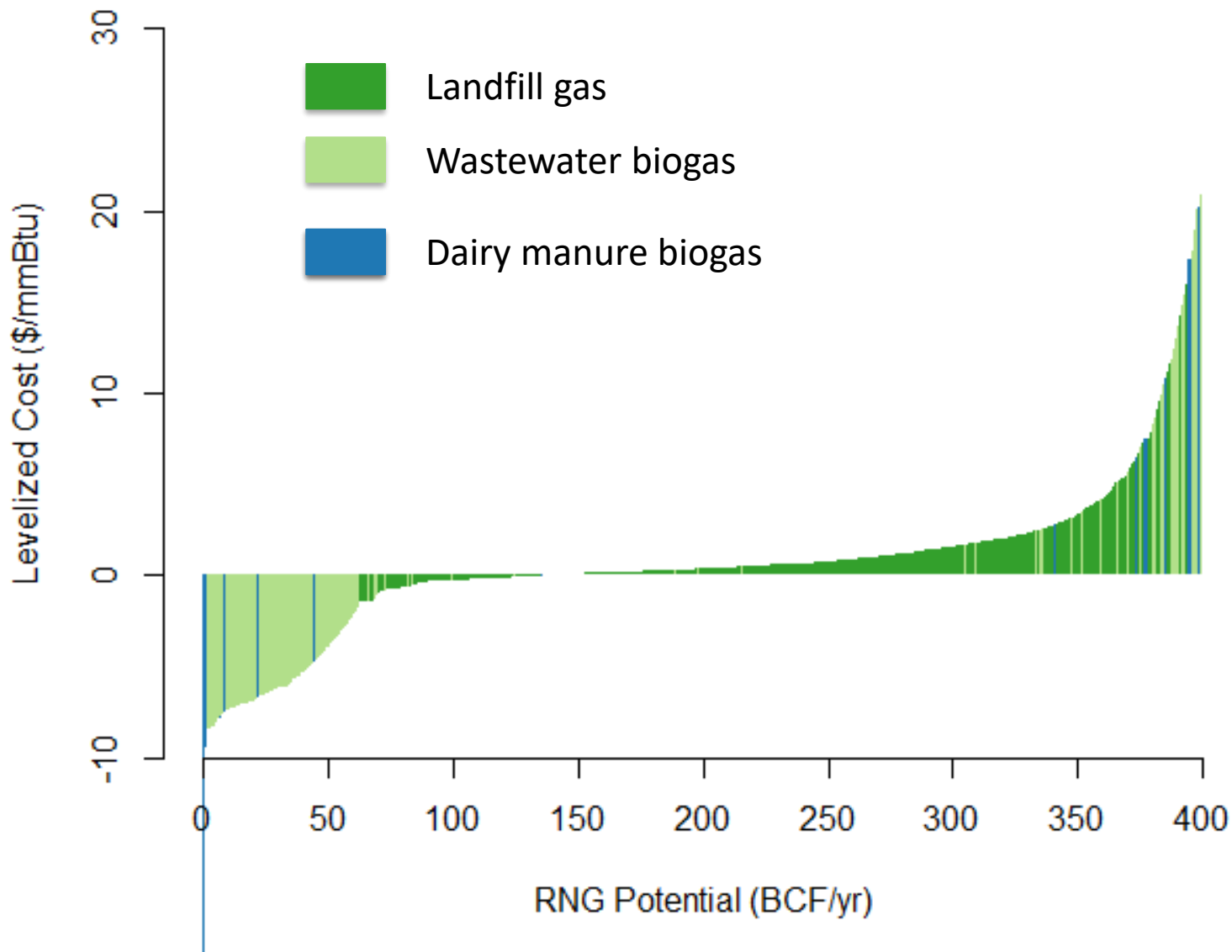


# RNG supply with no policy



# RNG supply with \$150 LCFS credit

2025 LCFS target



# What is driving these outcomes?

- Economies of scale favor large sources in landfill gas and wastewater.
- Landfill gas is more expensive to clean up and has higher carbon intensity than other sources.
- Manure biogas is expensive due to scale of facilities and need to build digesters.

# Funding



**California Air Resources Board**



**Alfred P. Sloan  
FOUNDATION**

# Collaborators

Daniel Scheitrum, University of Arizona

Rob Williams, California Biomass Collaborative, UC Davis

Nazli Uludere Aragon, Arizona State University

Jacob Bethel , Arizona State University



**Questions/Comments**  
**ncparker@asu.edu**