

# Natural Gas as an Alternative to Diesel



Chris Kroeker,  
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Joint Task Force on Supporting Businesses in Reducing Diesel Emissions



**NW Natural®**

# Natural Gas as a Transportation Fuel



Photo source NW Natural

Photo source Bauer Compressors



Compression

Photo source NW Natural



Vehicle Fueling



Photo source Michigan State University



Photo source CNG United

# Current Market

28 million CNG vehicles, 33,000 fueling stations globally

Region	NGVs	Stations
Asia-Pacific	19,841,688	19,606
Europe	2,013,693	5,116
North America	224,500	1,856
Latin America	5,417,146	5,789
Africa	268,349	210

# Fleet Growth

CNG vehicles worldwide has grown annually at 30% for the past five years, anticipated to grow at a CAGR of 11.9% between 2018 and 2026

Currently only have about 400 CNG vehicles in Oregon – why so few?

- Diesel fuel is inexpensive
- Perceived Risk (fleet managers)
- Policy (technology specific)



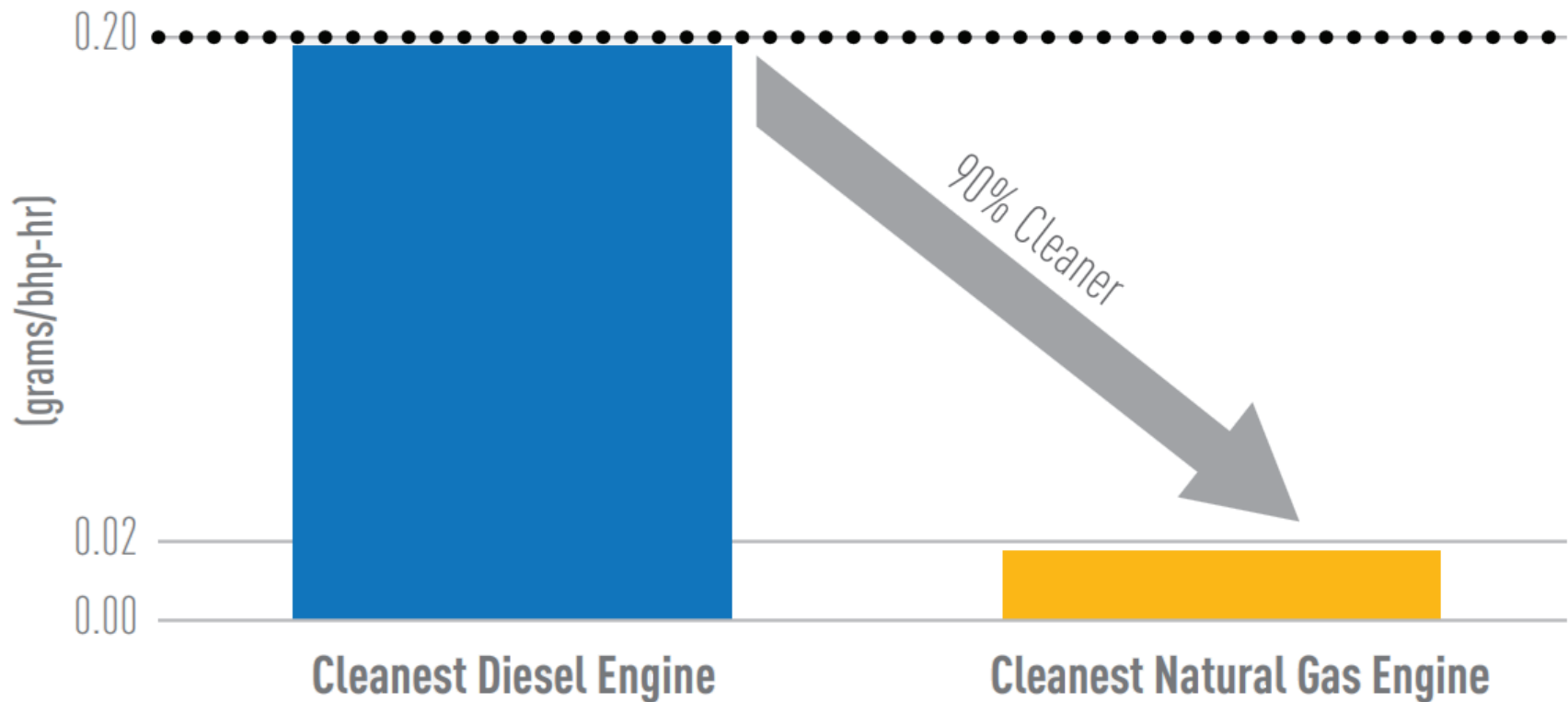
Photo source [truckinginfo.com](http://truckinginfo.com)

# Natural Gas Benefits



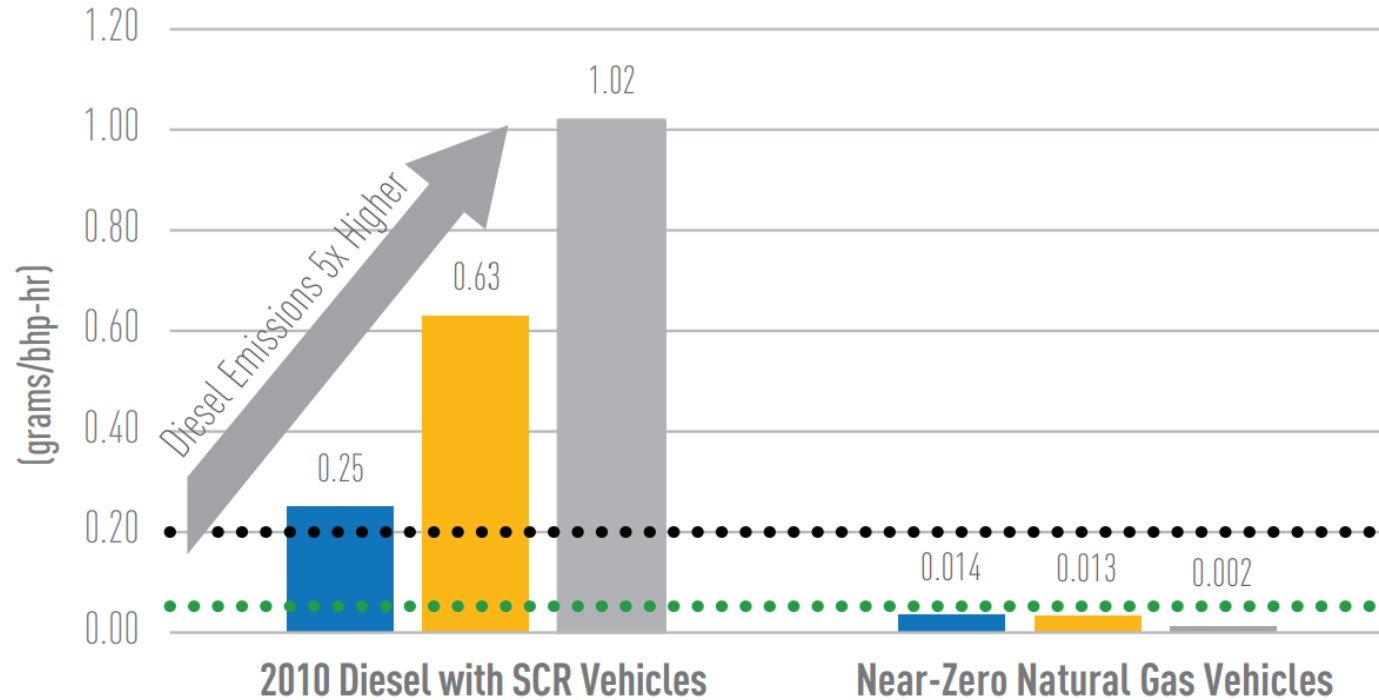
# EPA Engine Certifications

... EPA NO<sub>x</sub> Emission Standard (0.2 g/bhp-hr)



# Natural Gas Engines Stay Clean

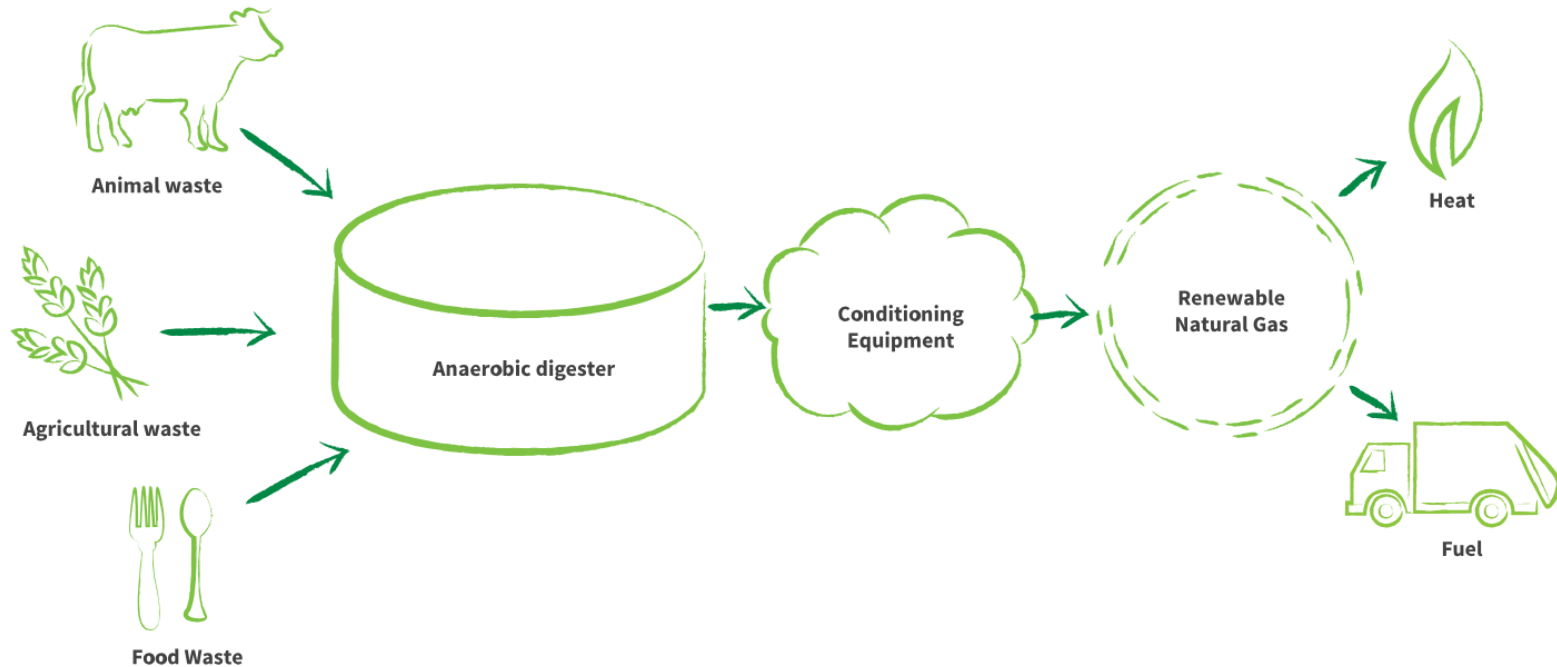
Cycle Average NO<sub>x</sub> Emissions



- EPA 2010 Certification Standard (0.2 g/bhp-hr)
- CARB Optional Low NO<sub>x</sub> Certification Standard (0.02 g/bhp-hr)

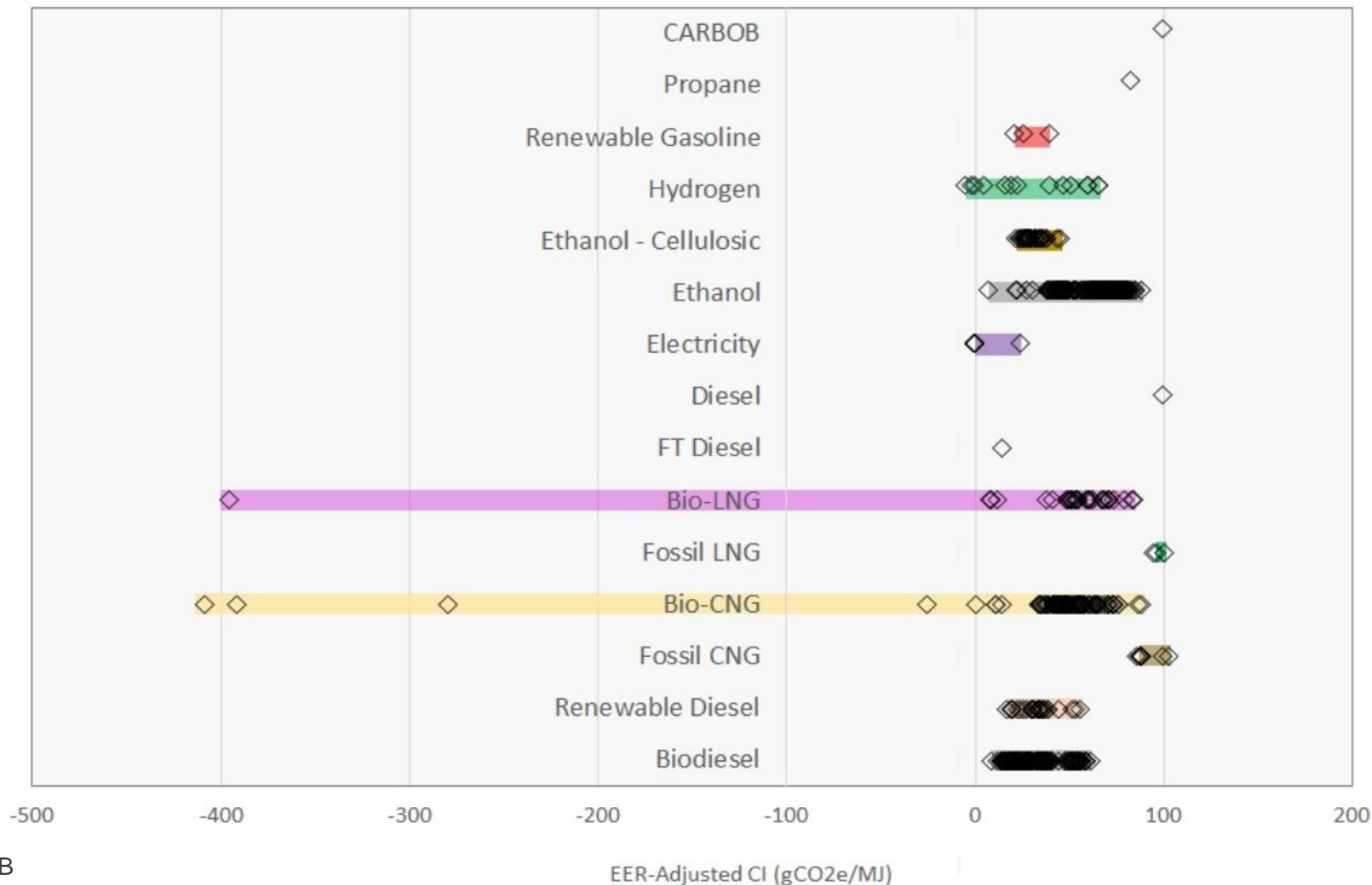
- Regional
- Local
- Near-dock

# Renewable Natural Gas (RNG)

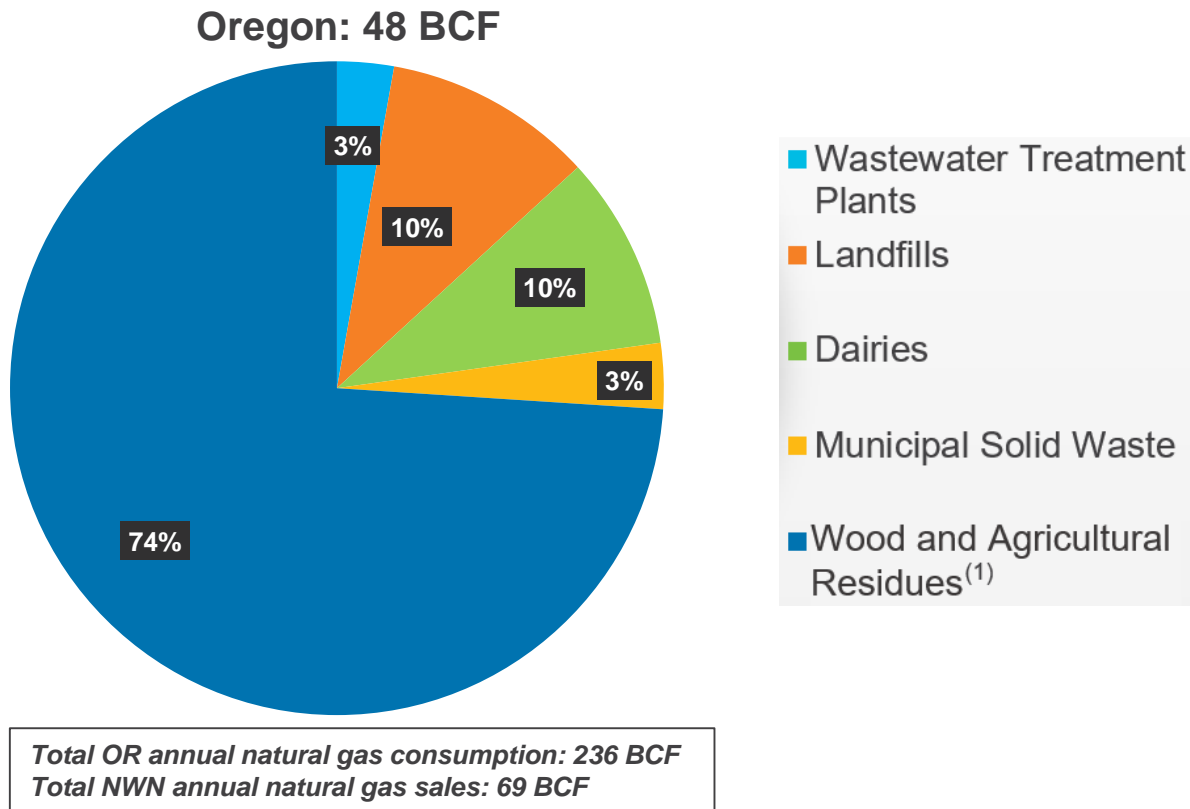




# Carbon Intensity Values of Fuels



# Annual RNG Technical Potential



(1) "Wood and Agricultural Residues" is defined differently by different studies but generally includes urban waste wood, primary and secondary mill residues, and residues left after logging operations (e.g., trees cut or killed and left on the ground). It assumes a large amount (35%-50%) is left on the forest floor to "maintain ecological functions." Sources for data: <https://www.nrel.gov/docs/fv14osti/60178.pdf#>, NREL Bioenergy Database, U.S. EPA LMOP Database, Oregon DEQ Material Recovery and Waste Generation Survey, Oregon Department of Agriculture, and Oregon Department of Energy.

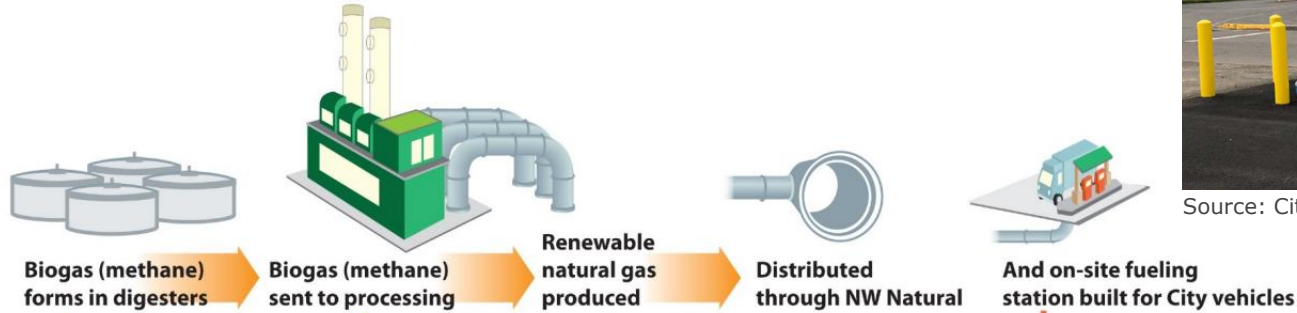
# Resilient Supply



The natural gas energy delivery system is more resilient than any other distribution method:

- **Flexible infrastructure** – performs well in earthquakes, easily reconfigured to route around damage
- **Protected** – Underground pipelines are not affected by wind and ice storms, nor road damage
- **Distributed supply** – Significant storage and renewable sources exist throughout the region

# Resiliency Hubs: City of Portland



Source: City of Portland BES



CITY OF PORTLAND ENVIRONMENTAL SERVICES

FOR ILLUSTRATION ONLY.

# Works for Med/Heavy Duty Fleets

Fuel	Specific Energy	Energy Density	Range
	kWh/kg	Wh/L	Miles/L
Diesel	13.3	9944	3.9
LNG	14.9	6167	2.4
RNG	15.4	2500	1.0
Hydrogen	39	1555	0.6
Battery	0.693	600	0.2

# Low Cost of Fuel

RNG used in vehicles creates value from RINs nation-wide

RNG used in Oregon vehicles creates value from the Oregon Clean Fuels Program

This value can be shared with fleets: \$0.30-\$0.60/GGE

Commodity cost of NG:  $\approx \$0.50/\text{GGE}$



# RNG Benefits



Photo source NGVAmerica

- Clean burning:
  - Near zero emissions
    - 90-99% less NOx and particulate matter than cleanest diesel
    - Up to 500% less GHG with RNG
  - Lower maintenance (no DPF)
  - Consistently clean
- Most cost effective NOx emissions reductions
- Renewable sources
- Resiliency solution
- Available today – proven technology



# Natural Gas Costs





# Vehicle Incremental Costs



Photo source NGVAmerica

Cost is highly dependent on range and duty cycle

# Fueling Station Costs

Size	Fill Speed	GGE/day	Cost Range ['000s]	Example Applications
Starter	Fast	20-40	\$45-\$75	Four sedans/pickups fueling 10 GGE/day
	Slow	20-40	\$35-\$50	Four delivery vehicles fueling 10 GGE/night
Small	Fast	100-200	\$400-\$600	15–25 pickups/delivery vans fueling 7 GGE/day
	Slow	100-200	\$250-\$500	10–20 school buses fueling 10 GGE/night 5–10 refuse vehicles fueling 20 GGE/night
Medium	Fast	500-800	\$700-\$900	Public retail station serving 50–80 light/medium-duty vehicles fueling 10 GGE/day
	Slow	500-800	\$550-\$850	25–40 refuse trucks fueling 20 GGE/night
Large	Fast	1,500-2,000	\$1,200-\$1,800	Large retail station serving light- to heavy-duty vehicles such as delivery vans, work trucks, refuse trucks, class 8 tractors, and local fleets

GGE = gasoline gallon equivalents

Source US DOE

# Building Accommodations

Minor garages – existing ventilation may already comply:

- Lubrication, Inspection
- Minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes, etc.

Major garages - \$75k-\$100k per bay for retrofits

- Engine overhauls, painting, body and fender work
- Repairs that require draining of the motor vehicle fuel tank



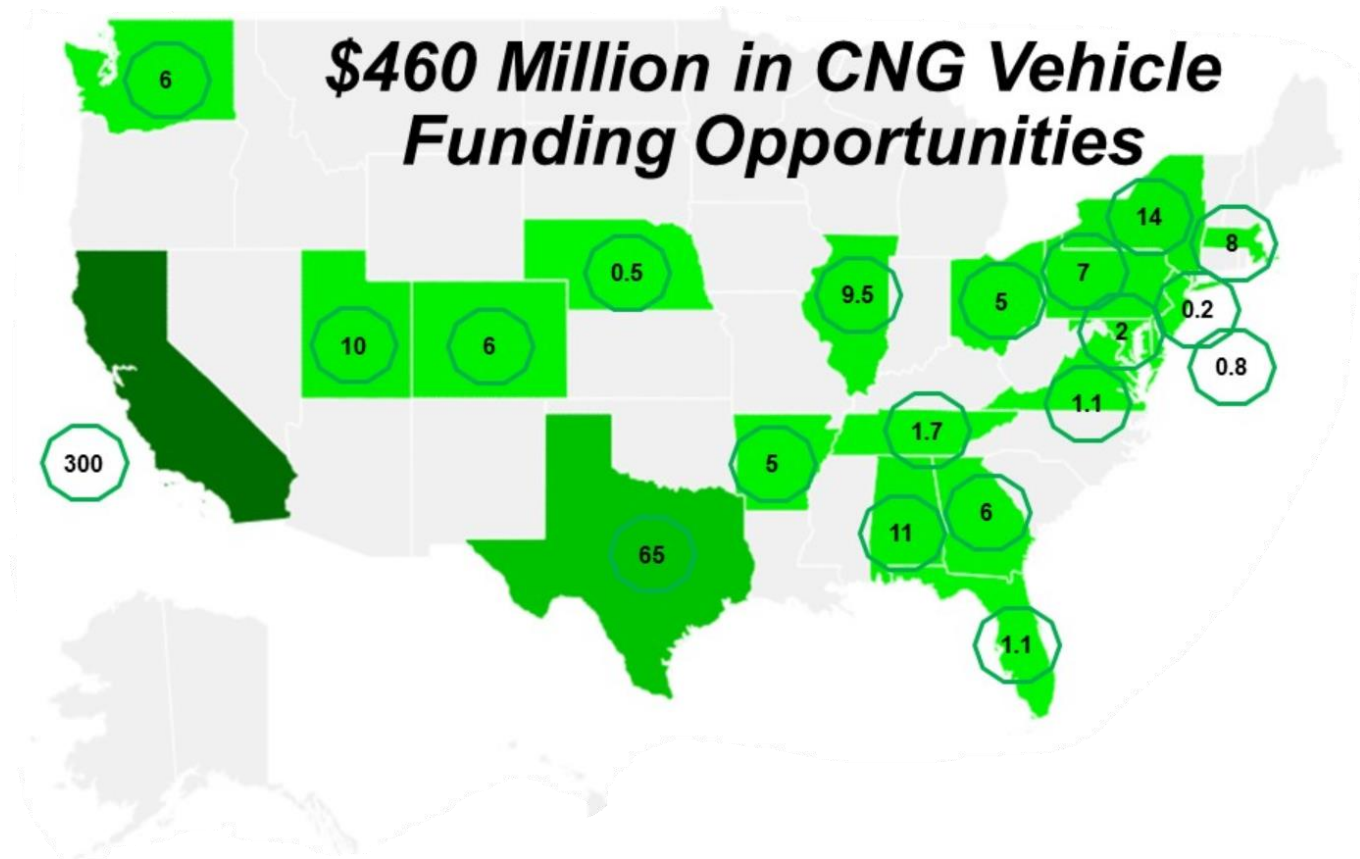
Photos source Gladstein, Neandross & Associates, NREL



# Recommendations



# Oregon Needs Funding



# Policy Strategies



Policy that supports all viable solutions for reducing carbon in transportation sector – not technology specific

Allow utilities to recover alternative fueling infrastructure costs and vehicle incentives

Use alternative fuels to improve resiliency - create policy that incentivizes essential service fleets to use them

SB 98 (RNG bill) has paved the way for supply – need to keep RNG here in Oregon through policy that supports vehicles

# Summary



Great air quality and GHG benefits

Proven, mature technology

Significant dollar savings for fleets

Need incentives or policies to grow the market



Photo source NGVAmerica

**Thank you!**

