



From Biogas to Vehicle Fuel: *RNG for Heavy-Duty Buses & Trucks*

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Energy Vision



- **Mission:** to advance global collaboration in adoption of the low-carbon, renewable energy sources, transport fuels, and new technologies needed for a sustainable future
- **Program:** Research of alternative vehicle fuels to reduce reliance on petroleum in transportation, publication of reports on best options, newsletters, media, & educational outreach
- **Impacts:**
 - Inspired trend of truck/bus shifts to natural gas in the U.S.
 - Building awareness of U.S. policy, business, and solid waste leaders of RNG fuel as leading transportation strategy for tackling climate change
 - EV's Step-by-Step Guide to converting organic wastes into fuel, used in regional workshops, leading to expanding initiatives

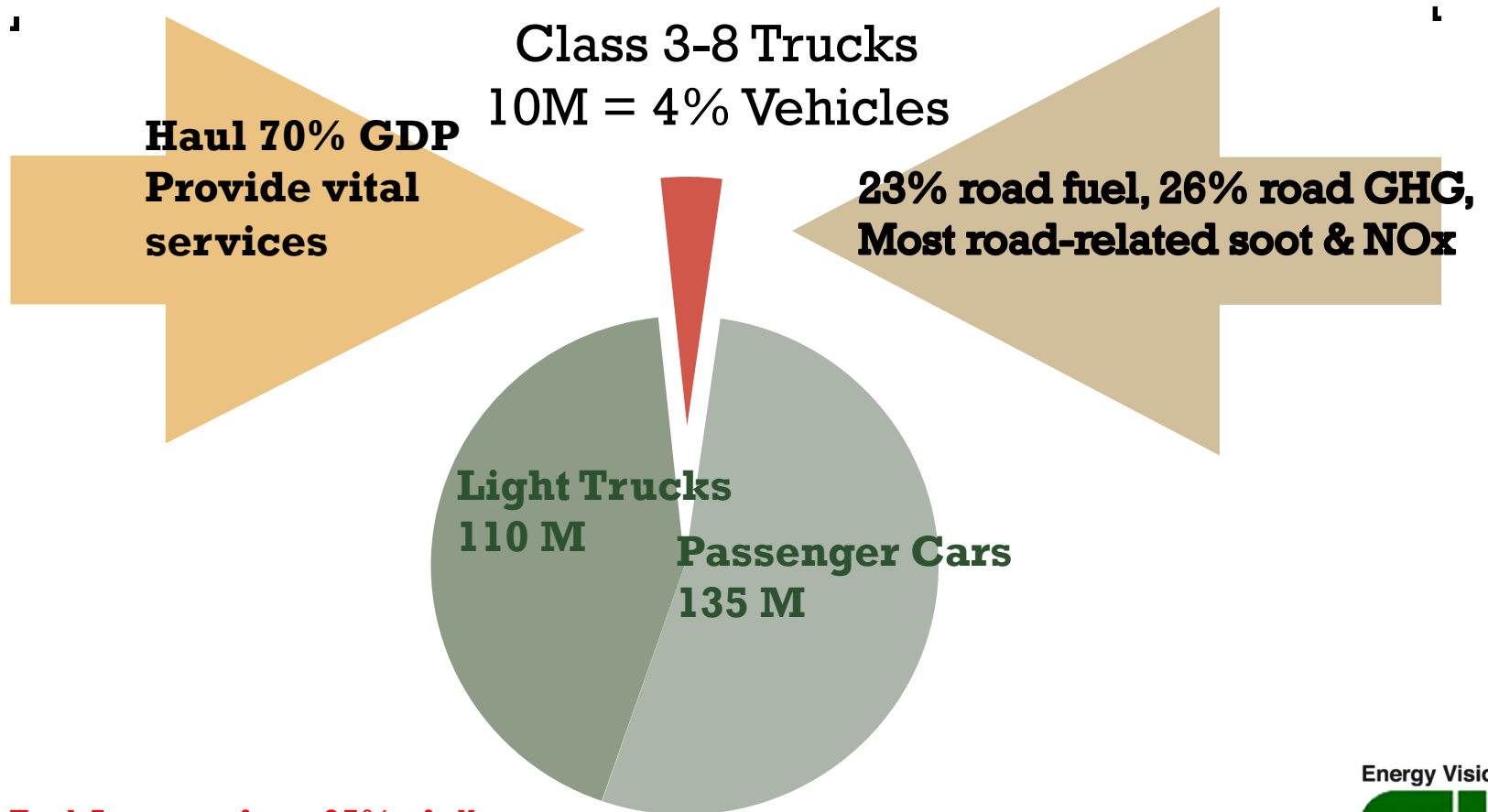
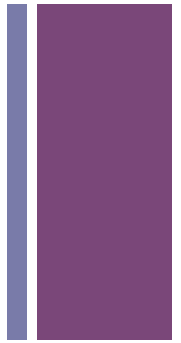




Why a Focus on Trucks & Buses?

Small Numbers, Big Impact

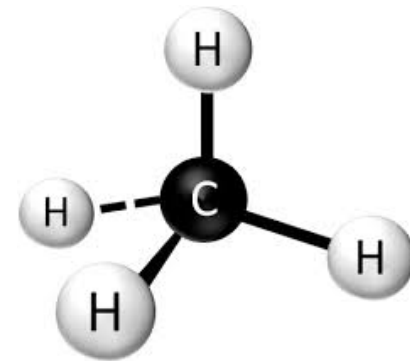
(U.S. Example)



Diesel Fuel Accounts for > 95% of all on-road heavy-duty buses and trucks

+ An Emerging Non-Petroleum Option: Renewable Natural Gas (RNG)

- RNG is chemically identical to pipeline quality natural gas, but derived from renewable sources of organic waste.
- RNG can use the same infrastructure as fossil gas: pipelines, gas compressors, refueling stations, and vehicle engine technology
- Major difference: RNG is sustainable: made from biogases emitted as organics decompose in airless environments; no drilling; virtually no soot, and much lower in carbon

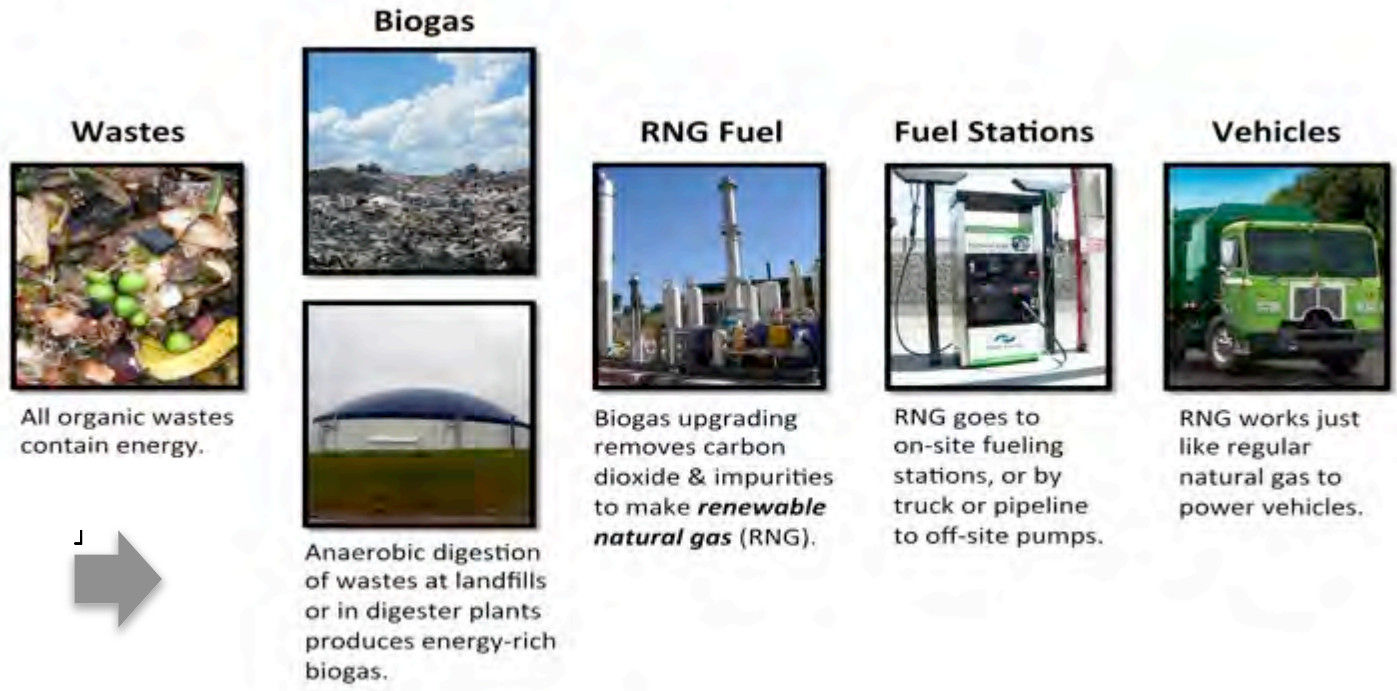


+ RNG: Multiple Sources

- Landfills
- Wastewater Treatment Plants
- Farms/Dairies
- Commercial Food Waste
- Residential Organic Waste



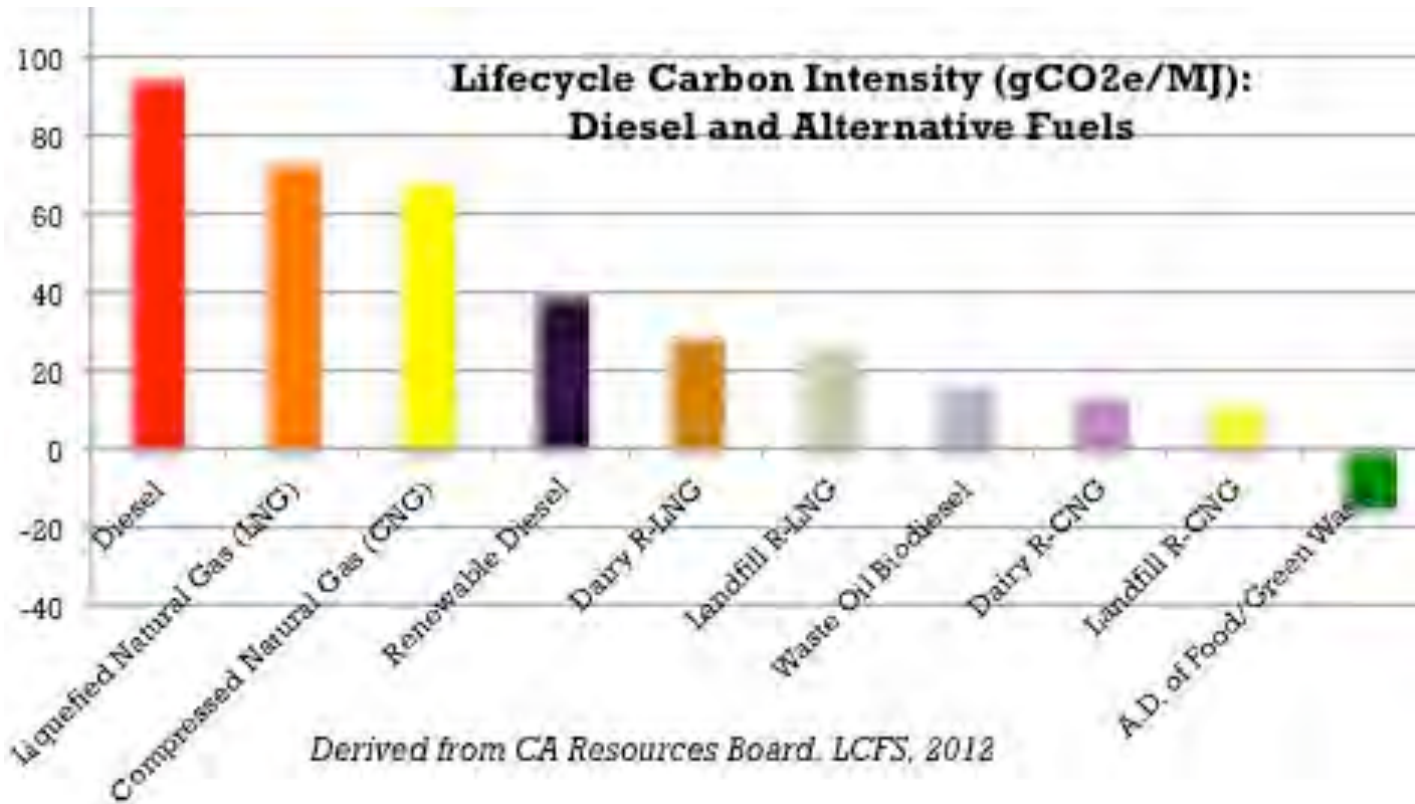
+ RNG for Transportation: How It Works



□ The Pathway from Organic Waste to RNG

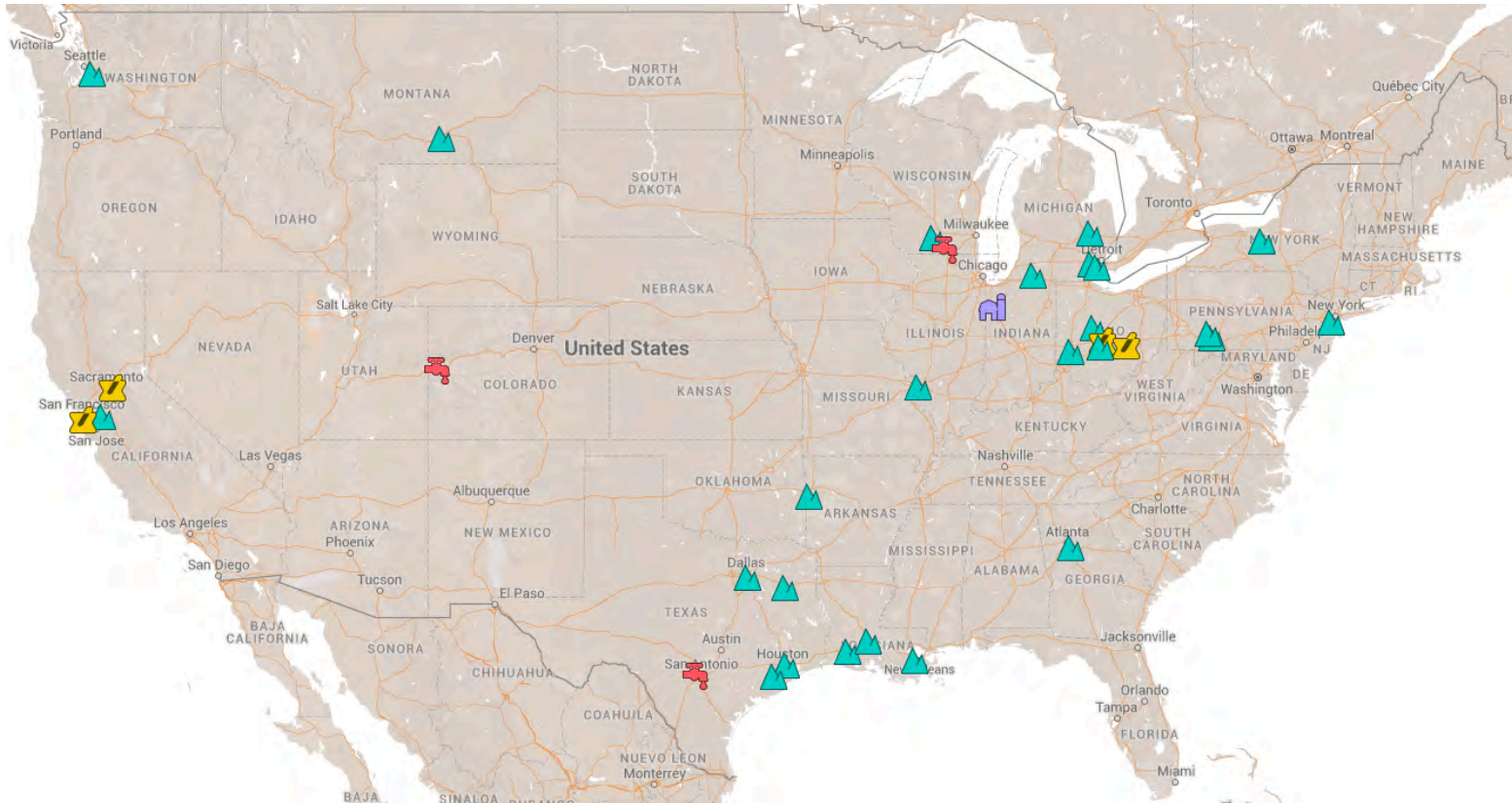


RNG: The Ultra-Low-Carbon Option TODAY



- ***RNG is a net-carbon negative fuel when made via anaerobic digestion of food and other organic waste***

+ RNG in the U.S.: 33 Projects in 15 States



- Landfill 
- Food Waste Digester 
- Wastewater Digester 
- Ag Digester 

In total, these 33 projects produced more than 90 million gallons of ultra-low-carbon RNG in 2015

Source: www.energy-vision.org/organics-to-fuel-case-studies/





Sacramento Food Waste Biodigester (CA)

CleanWorld/Atlas Disposal: First Closed-Loop Municipal Waste-to-Fuel (RNG) Initiative in U.S.; Public-Private Partnership



See Project Profile:
<http://bit.ly/1Kv1U07>



+ Pierce County Transit (Tacoma, WA)

- Pierce Transit in Tacoma, WA became the first transit fleet in the U.S. to transition from CNG to RNG by beginning to refuel **143** public transit buses on locally-produced RNG from the Cedar Hills landfill in Seattle.
- They were also the first to run a transit fleet on fossil CNG, making the switch in 1989. The transition to RNG was strictly a matter of sourcing the fuel – the pump price is unchanged.



See Project Profile: <http://bit.ly/1DCtCFJ>

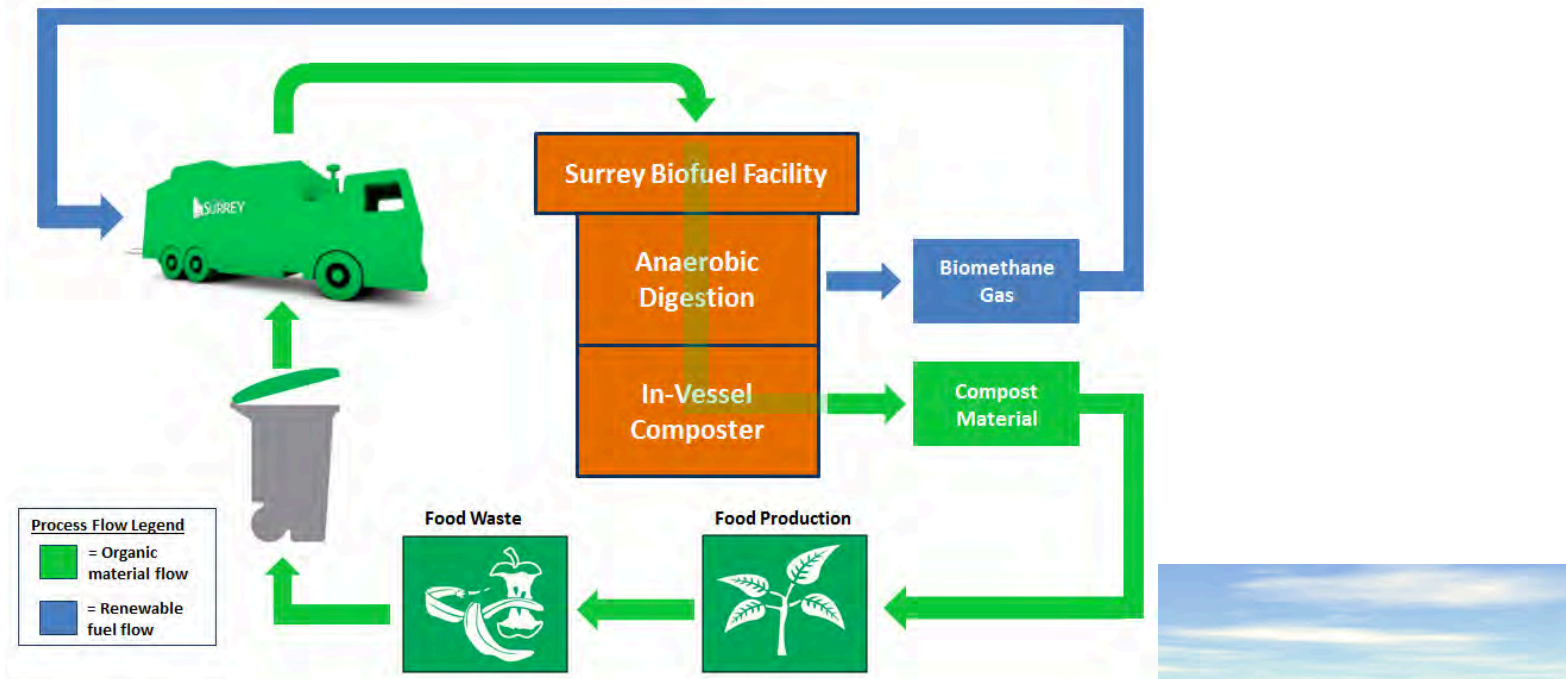
+ Persigo Wastewater RNG (Colorado)

- In 2015, the City of Grand Junction, Colorado (pop. 60,000) installed a small system to convert biogas into vehicle-quality fuel at a cost of \$2.8M USD
- The City and County now fuel 38 natural gas buses and refuse trucks with locally-produced RNG, displacing ~170,000 gallons of diesel/year



See Project Profile: <http://bit.ly/1SdbKtB>

+ Organics-to-RNG in Surrey (BC)



- Public-Private Partnership
- 110,000 tonnes residential and commercial organics processed
- Enough RNG for the entire refuse fleet + other municipal CNG vehicles once fully operational



+ REDEEM™ by Clean Energy Fuels

- Utilize Existing Natural Gas Infrastructure to Offer RNG at 40+ Retail Stations in California + stations in Texas and Tennessee (UPS is the largest customer)
- ~50 Million GGE's of REDEEM (sourced from a number of landfills across the country) hit the market in 2015
- >100,000 GGE's of REDEEM dispensed daily in California, largely because of the state's Low Carbon Fuel Standard (carbon program)



For more on REDEEM, visit:

<http://redeem.cleanenergyfuels.com/images/redeem-clean-energy-factsheet.pdf>



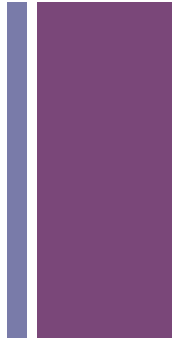
+ RNG Policy Drivers & Hurdles

- Current Policy Drivers Include:
 - US EPA Renewable Fuel Standard
 - California Low-Carbon Fuel Standard
 - Natural Gas Vehicle/Infrastructure Incentives
 - City & State Level Landfill Diversion Laws
- Primary Hurdles to RNG are **Logistics & Financing**:
 - All Technologies are Proven & Commercial
- ***Carbon Price/Tax would greatly incentivize RNG***



Conclusions

- **RNG: A Winning Climate Change Strategy for Transportation.** Supportive energy and environmental policy and private sector investment can turn one of the world's major waste burdens & sources of anthropogenic methane into a clean close to carbon-free fuel using commercial technology
- **RNG: A fully sustainable fuel to displace diesel in heavy-duty fleets.** Many other renewables exist for power generation.
- **Growing a Waste-to-Fuel Industry is an economic winner:** displaces diesel with a modestly priced, secure, homegrown fuel; cuts waste disposal costs, creates permanent high and low level jobs, while protecting our environment.
- **Quebec has an immense opportunity** to take advantage of its organic waste resource(s)



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