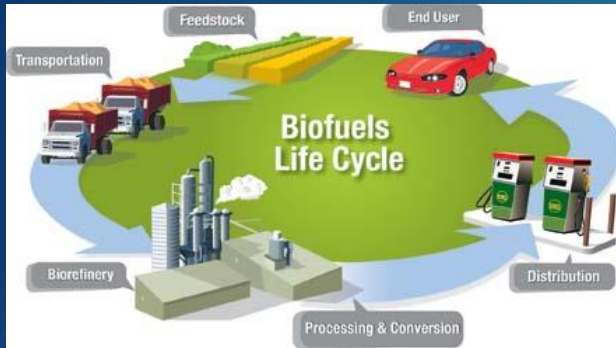
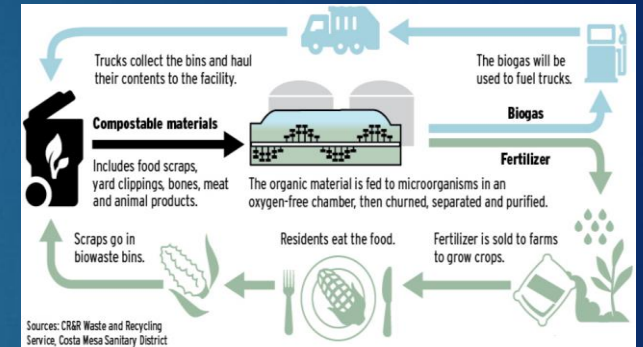


Infrastructure:

Transportation Biofuels Production and Use



South Coast Air Quality Management District
September 1, 2016
Phil Barroca, Air Quality Specialist



BioFuels

- ▶ BioFuels derived from organic biomass
- ▶ Advanced BioFuels (ABF)
- ▶ BioChemical Mechanisms
 - ▶ Aerobic Digestion, e.g. Landfills (RNG) ; Anaerobic Digestion (RNG)
- ▶ ThermoChemical Mechanisms
 - ▶ Gasification & syngas
 - ▶ Pyrolysis & syngas
 - ▶ Transesterification (biodiesel)
 - ▶ Hydrogenation (renewable diesel)



BioFuels - Drivers

- ▶ Federal and State GHG programs - Transportation Fuels
 - ▶ Renewable Fuel Standard (RFS)/Renewable Identification No. (RIN)
 - ▶ Low Carbon Fuel Standard (LCFS) / LCFS Credits
- ▶ Alternative Energy Funding
 - ▶ CEC - Alternative and Renewable Fuel & Vehicle Technology Proceedings (ARFVTP)
 - ▶ CalRecycle - Landfill Waste Diversion / Recycling
- ▶ Regulations to reduce landfill waste; increase recycling
- ▶ Lower Cost Pathway – concurrent GHG and Criteria pollutant reductions

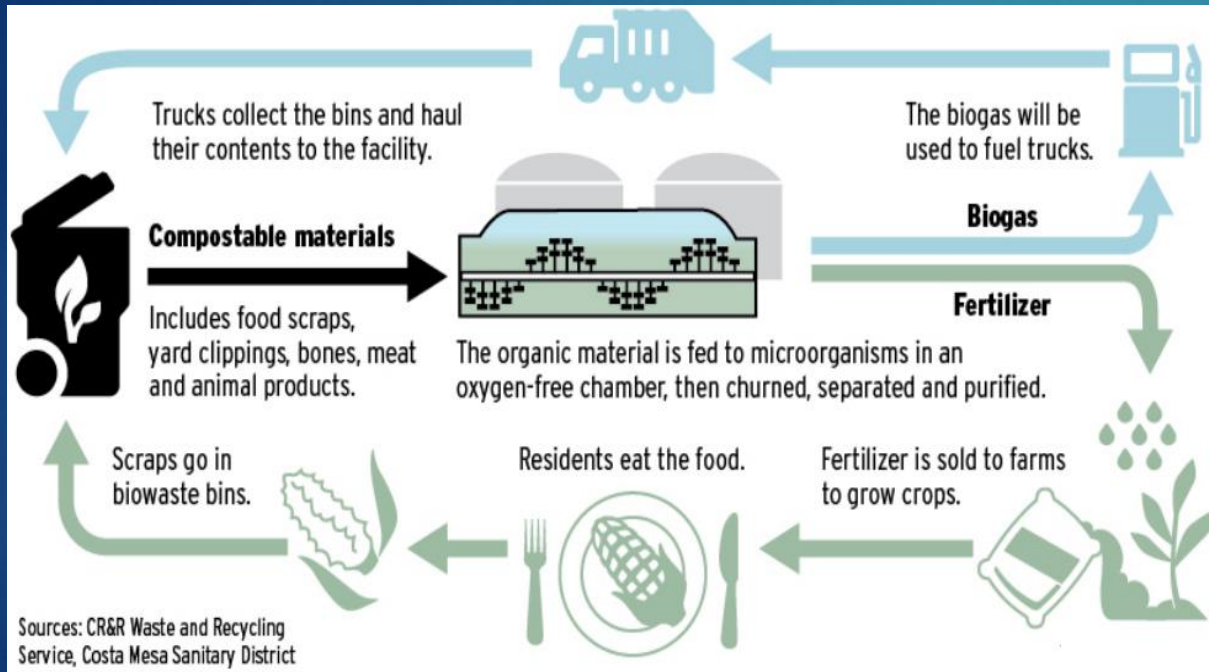


Transportation BioFuel: Projects/Concepts

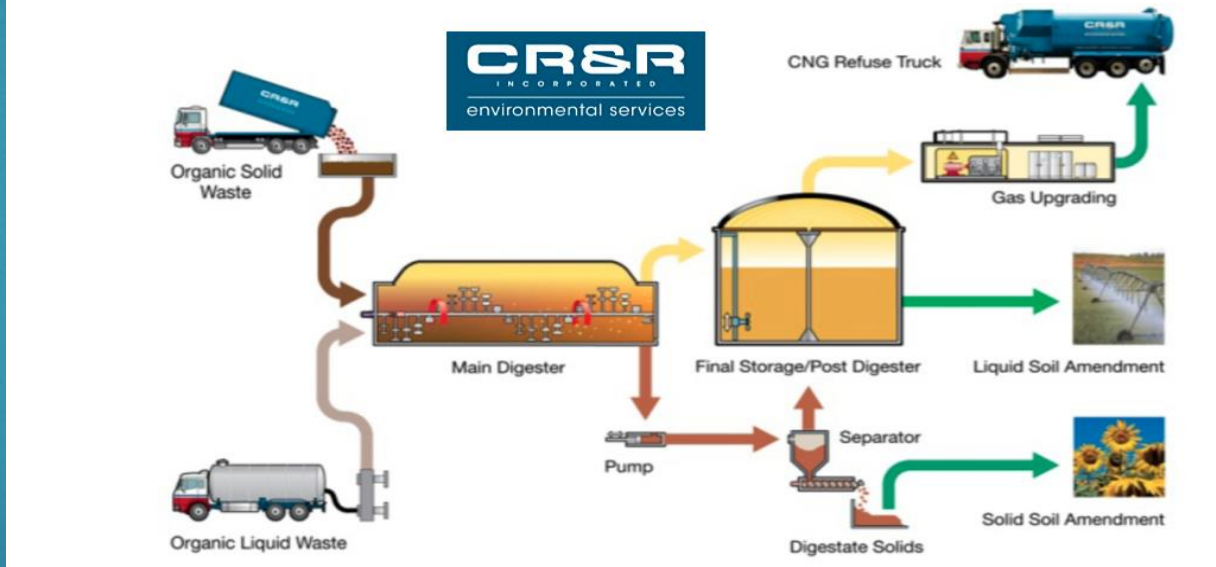


- ▶ CR&R – RNG (under contract)
 - ▶ Anaerobic Digestion of High Solids Municipal Waste; Gas Upgrading & Cleaning
 - ▶ RNG as Transportation Fuel using NZ heavy-duty engines
 - ▶ RNG distribution : SoCalGas pipeline interconnect
- ▶ KORE Infrastructure – RNG (recommending to Governing Board)
 - ▶ Pyrolysis, SynGas and Methanation of POTW biosolids
 - ▶ Demonstration of RNG as Transportation Fuel
- ▶ Volvo/Oberon (concept) – BioDME (proposal under review)
 - ▶ Biomass to Methane to SynGas to Methanol to BioDME
 - ▶ BioDME in Volvo HDDV & 0.05gNO_x/bhp-hr

CR&R: Zero-Waste Fuel Cycle



ANAEROBIC DIGESTION - FLOW CHART



CR&R ADBF – Perris, CA



CR&R High Solids Anaerobic Digestion Facility, Perris, CA – Phase 1

- 83,000 tons per year source separated green and food waste
- 1 million diesel gallon equivalents of renewable natural gas per year

CR&R: Dosing Bins



Phase 1 - Dosing Bins

highly automated feedstock
management

CR&R: — Liquids Receiving & Organics Recovery



Phase 1 & 2

System designed to sort solid food and green wastes, and meter liquid food wastes into anaerobic digesters

CR&R – Phase 2



- Additional 83,000 tons per year capacity - underway
- One gas upgrading system useable for two phases = cost savings, efficiencies

CR&R – Biogas Conditioning



- Greenlane Biogas conditioning system
- Estimated annual RNG production from Phases 1 & 2 combined – 2 million diesel gallon equivalents

CR&R – Vehicle Refueling

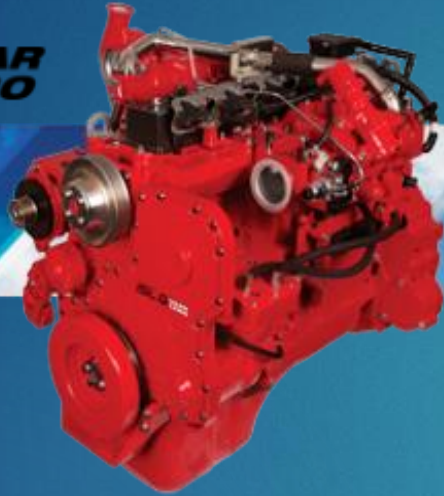


- Time fill station for CNG trucks
- System designed to refuel CR&R's fleet of CNG vehicles with the Renewable Natural Gas (RNG) produced on-site

CR&R – NZ Vehicle/RNG Demo

ISL G NEAR ZERO

8.9L



ISX12G

(near-zero)



CR&R Project Summary

▶ Anaerobic Digestion of High Solid Municipal Waste

- ▶ Feed rate: 229 Tons/Day; 80,000 Tons/Year per Phase
- ▶ RNG rate: 890,000 DGE/year per Phase

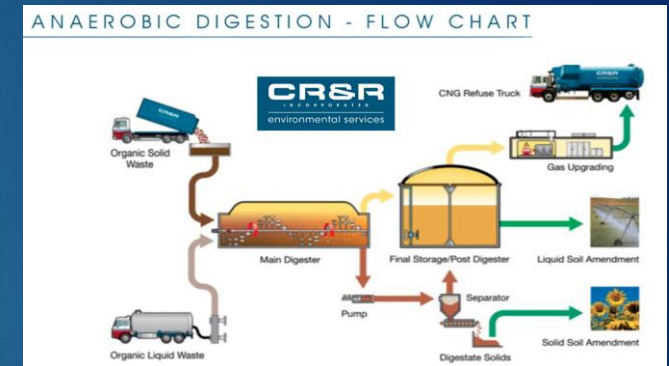
▶ Project Schedule

- ▶ 2016: Phase 1 complete; RNG to fuel 75 CR&R HDVs
- ▶ 2017: Demonstrate NZ 8.9L; SoCalGas pipeline interconnect
- ▶ 2017-19: Phase 2 complete; demonstrate NZ 11.9L

▶ Air Quality Benefits

- ▶ Carbon Intensity (gCO₂e/MJ): -25 (0.2gNO_x/bhp-hr); -28 (0.02gNO_x/bhp-hr)*
- ▶ GHG: Reduce 149,638 Metric Tons over 10 years

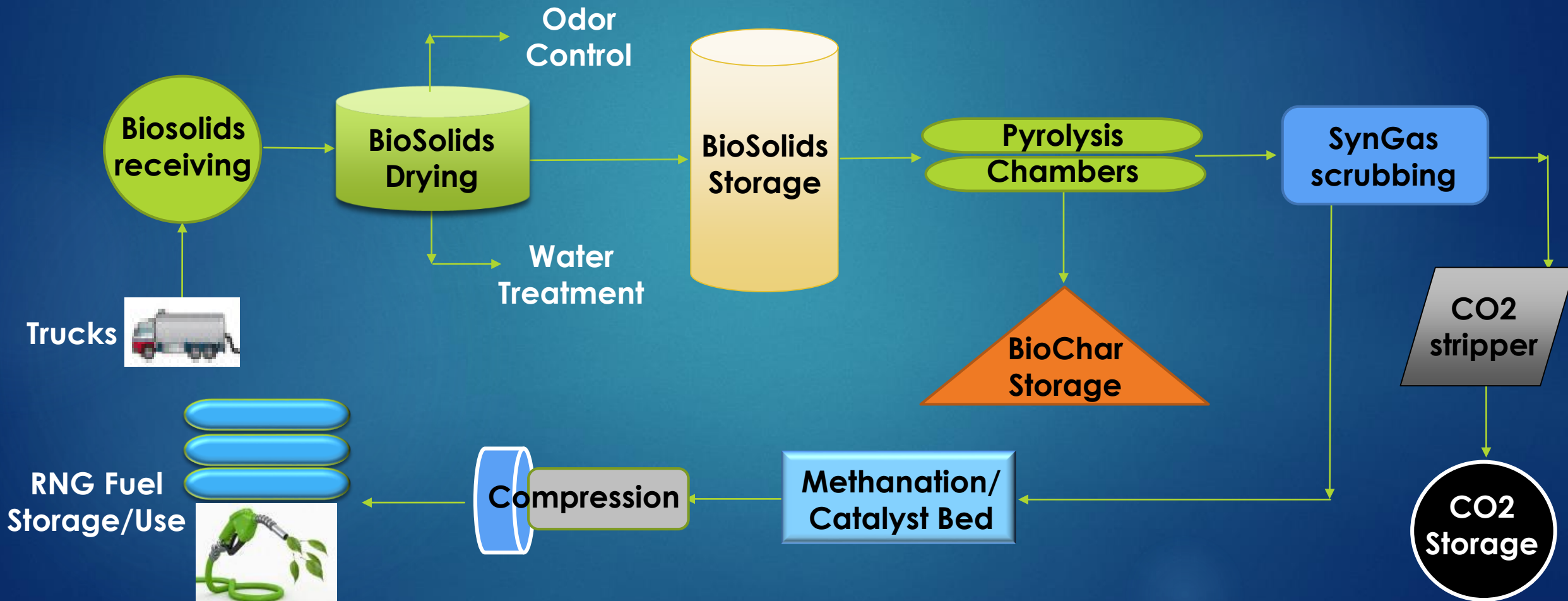
* California Air Resources Board, CA-GREET 2.0 2015 – Heavy Duty Truck Pathways



CR&R Project Development Costs (Phases I and II)

Funding Sources	Funding Amount	Percent
SCAQMD (Clean Fuels Fund)	\$ 900,000	2%
All Others	\$ 54,500,000	98%
Total	\$ 55,420,000	100%

KORE Infrastructure – Pyrolysis/Methanation FlowChart



KORE – Material Handling & Drying



Andritz indirect heat paddle dryer

Two counter-rotating shafts arrayed with paddles pass through the horizontally jacketed trough.

Heat transfer medium (steam, thermal oil, or cooling water) flows through the jacket, hollow shafts and even the paddles.

Wedgeshaped paddles ensure perfect local mixing and mechanical fluidization.

KORE – Pyrolysis: SynGas and BioChar Production



KORE Pyrolyzers for the Rialto facility



KORE – SynGas cleanup

*Kore's gas clean-up
equipment for Rialto*



KORE – Catalytic Conversion of SynGas to Methane

Methanation equipment provided by sustainable technology leader Johnson Matthey



KORE – RNG Compression & Storage

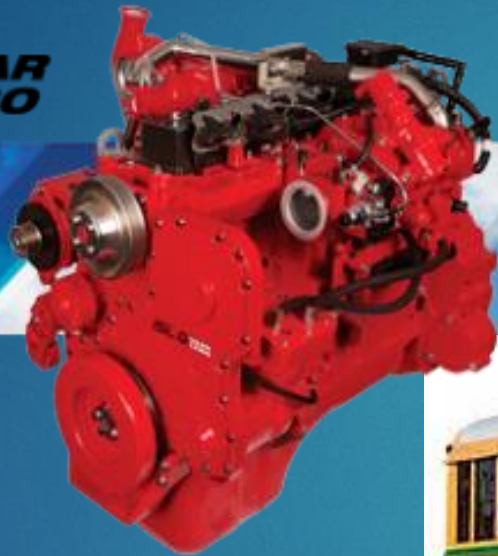


A modular, turnkey gas compression solution manufactured by GE

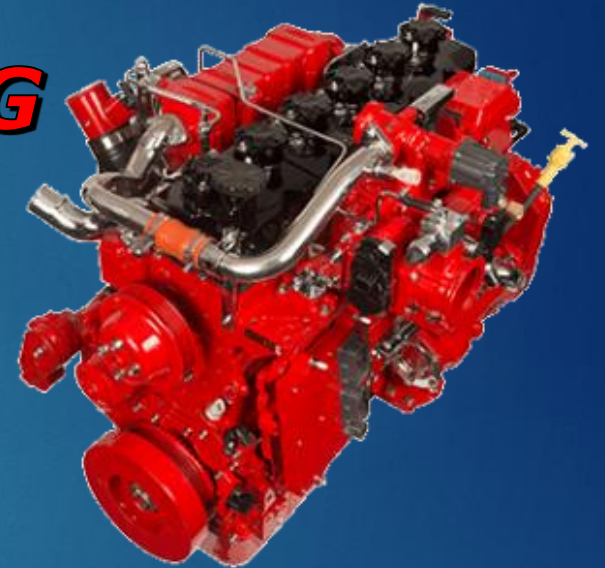
KORE – NZ Vehicle/RNG Demo

ISL G NEAR ZERO

8.9L



ISB6.7G
(near-zero)



KORE Project Summary

- ▶ Pyrolysis & Methanation of treated BioSolids (LACSD-20 yr. contract)
 - ▶ Feed rate: 300 Tons/Day; 105,000 Tons/Year
 - ▶ RNG rate: 1000-1200 GGE/Day; ~400,000 GGE/year
- ▶ Project Schedule
 - ▶ 2017-19: Plant construction; securing demand: local fleets, pipeline interconnect
 - ▶ 2018-19: RNG production; demonstrate NZ HDVs with KORE RNG (TBD)
- ▶ Air Quality Benefits
 - ▶ Carbon Intensity: TBD *
 - ▶ GHG: TBD

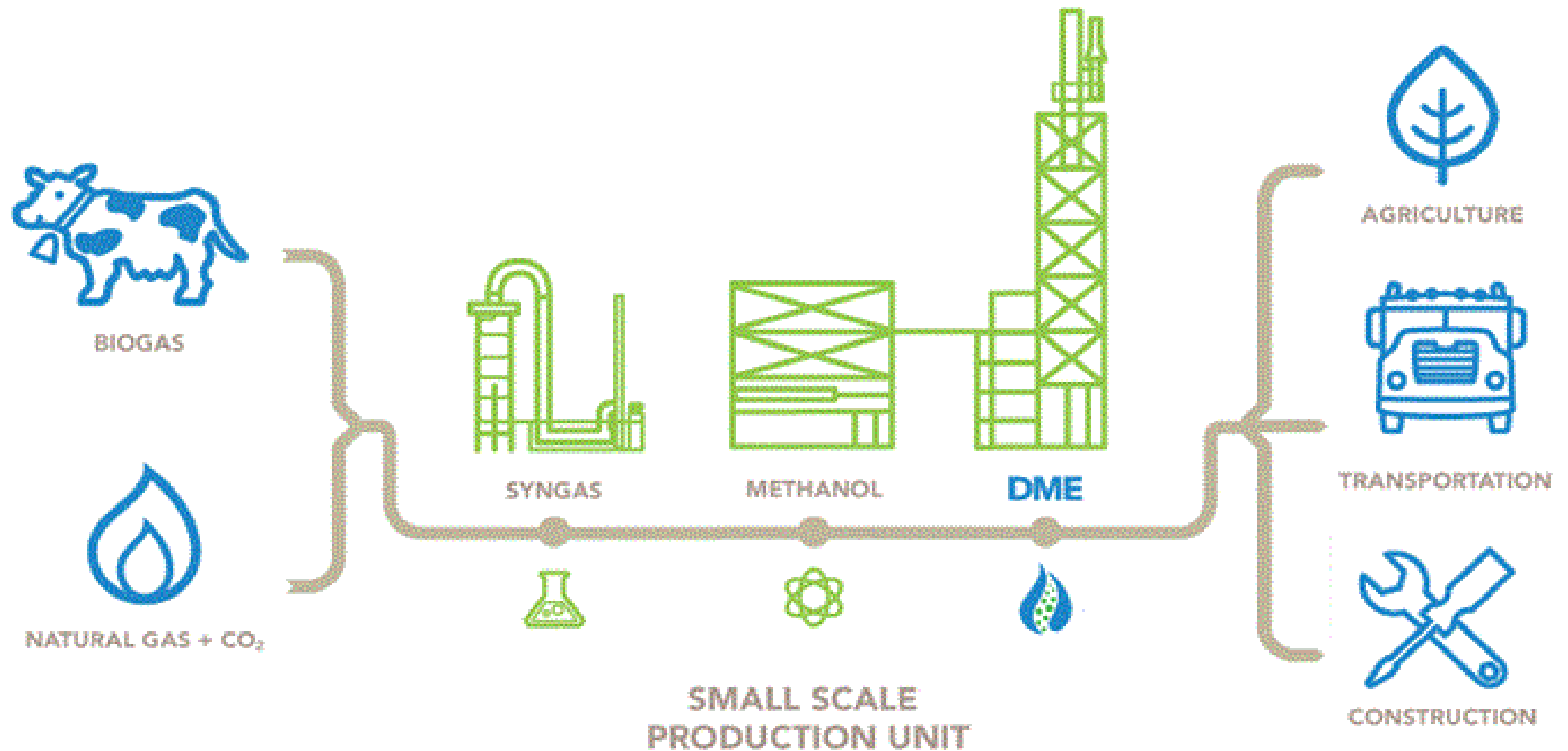
* (CNG020 pathway: medium to large AD treatment of wastewater = 7.89 gCO₂e/MJ)

KORE Infrastructure-



Funding Sources	Funding Amount	Percent
SCAQMD (Clean Fuels Fund)	\$ 1,000,000	4%
SCAQMD (BP-ARCO Settlement Fund)	\$ 1,500,000	6%
All Others	\$ 23,000,000	90%
Total	\$ 25,500,000	100%

Oberon Fuels – BioDME Plant



BioDME/HDDE – potential demonstration of 0.05gNO_x/bhp-hr

- ▶ Oberon Fuels – Brawley, CA to produce DME and BioDME from AD biogas
- ▶ Volvo Group to demonstrate HDDE+DME = 0.05 gNO_x/bhp-hr standard
- ▶ Maximum DME Production rate: 4500 DME gallons/day
- ▶ DME – C₂H₆O is the simplest ether; compressible (LPG); high cetane, low energy density (1.8:1), low lubricity, low viscosity relative to fossil diesel
- ▶ Air Quality Benefits
 - ▶ Carbon Intensity Fuel Production (gCO₂e/MJ); BioDME = -5; CA ULSD = 95*
 - ▶ GHG Vehicle Fuel (gCO₂e/MJ): BioDME = 67; CA ULSD = 75*
 - ▶ PM – 0; NO_x emission reductions of 75% (rel. to current 0.2 g NO_x/bhp-hr std.)

* California Dimethyl Ether Multimedia Evaluation 2015 for CA EPA

BioDME/HDDE (potential demonstration)

Funding Sources	Funding Amount	Percent
SCAQMD (proposed CFF)	\$ 500,000	11%
SJVAPCD (proposed)	\$ 500,000	11%
All Others	\$ 3,636,824	78%
Total	\$ 4,636,824	100%