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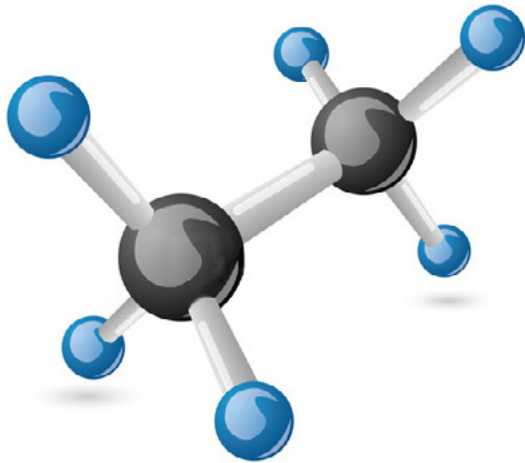
# goEthane, inc.

## Ethane

*Low carbon, Low cost, High-performance Transportation Fuel*

15 October 2015

Prepared for CARB



Lindsay Leveen  
Chairman

GoEthane, Inc.

Email: [lleven@gmail.com](mailto:lleven@gmail.com)

Mobile: +1 415 336 5508

Danilo Gardi

CEO

GoEthane, Inc.

Email: [dany@imegausa.net](mailto:dany@imegausa.net)

Mobile: +1 415 832 9084

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Contact:

Lindsay Leveen, Chairman, GoEthane, Inc.

+1 415 336-5508

lleveen@gmail.com

Danilo Gardi, CEO, GoEthane, Inc

+1 772 600 4423

dany@imegausa.net

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**I. Introduction | The Ethane Truck**

**II. The Story of Ethane | The Science, The Reality**

**III. Business Outline & Model | Summary**

**IV. Why Ethane? | Ethane Can Meet Low Carbon  
Transportation Fuel Requirements**

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# the ethane truck

1st vehicle in the world to run on Ethane



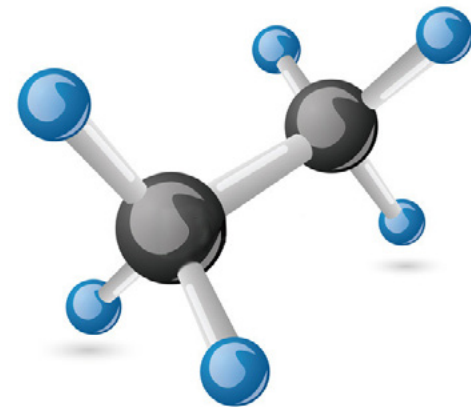
# the story of ethane

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## What is Ethane?

- Chemically stable hydrocarbon
- Liquifies when compressed
- Combustion products  $\text{CO}_2$  (g),  $\text{H}_2\text{O}$  (l)
- 1<sup>o</sup> use in manufacture of plastics (ethylene)
- Operates @ lower pressure than CNG

- Less  $\text{CO}_2$ /mile than gasoline (**cleaner**)
- Residence time in the atmosphere:
  - $\text{C}_2\text{H}_6$  (78 days)<sup>(1)</sup> (**greener**)
  - $\text{CH}_4$  (~10 years)
  - $\text{CO}_2$  (100s of years)

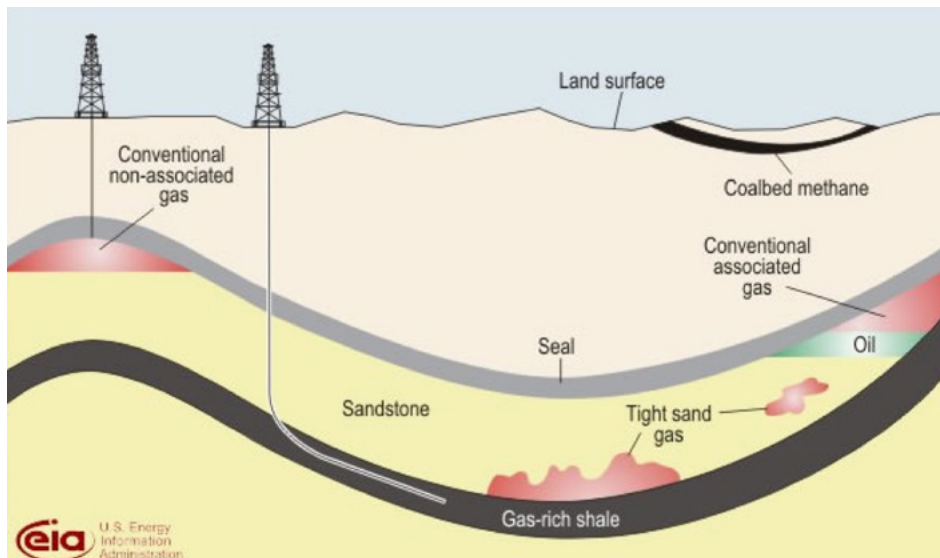


# the story of ethane

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## Where is Ethane?

- Shale gas deposits in the USA (largest worldwide)
- Oil refineries (off-gas, re-injected, used in boilers)
- NG well heads (unprocessed)



# the story of ethane

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## Why use Ethane?

- Alternative transportation fuel vs. sending offshore (plastics manufacturing)
- Decomposes 'quickly' in the atmosphere compared to  $\text{CH}_4^{(1)}$

↑ Energy independence



## Incorporation

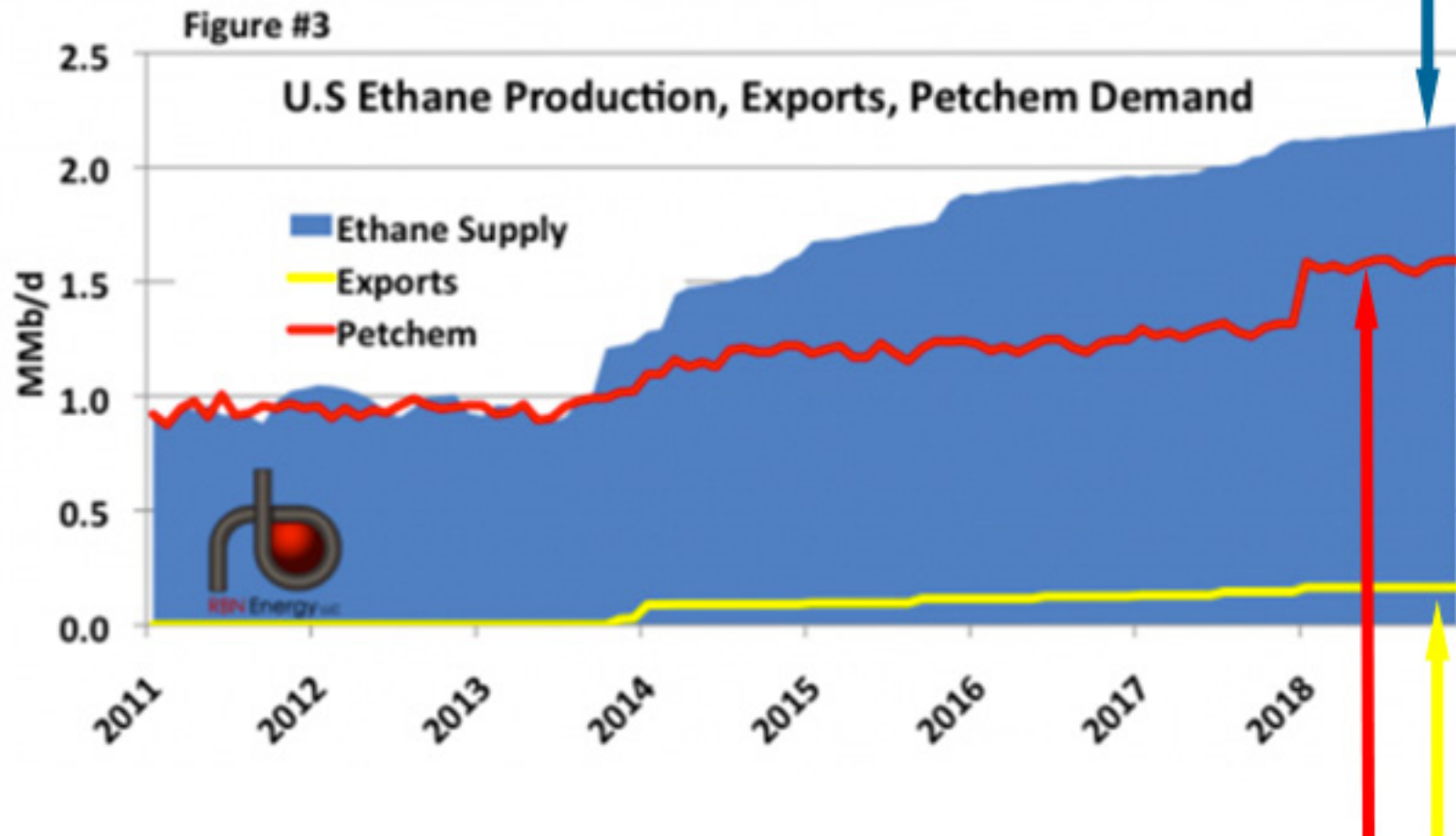
- Incorporated as a C Corporation 05/31/15 in DE
- Three equal shareholders:
  - Dany Gardi, CEO
  - Joe Marcellino, CFO
  - Lindsay Leveen, Chairman
- Kilpatrick Townsend (KT) firm lawyers:
  - Fees deferred; taking 1% stock in the company
  - Filing various patents, trademarks, incorporation services



## GoEthane IP

- Hardware IP relates to:
  - Controlling the flow temperature
  - Controlling the pressure of the Ethane entering the engine
- Software IP relates to engine control
- Additional IP relates to the filling of the:
  - Tube trailers for bulk supply
  - Filling of the onboard storage tanks with Ethane

## Ethane Supply Far Exceeds Demand



Sad To Waste Ethane To Make More Plastics

## Ethane's Future

- USA Ethane surplus ~500,000 bbl/day next 10+ yrs
- 1.6 bbl ethane == 1 bbl gasoline ~300,000 bbl/day
- GGE to market
- Petrochemical manufacturing:
  - Uses all the Ethane consumed today
  - Going forward - Cannot grow to consume all the Ethane to be produced
- Exports of Ethane may come about—will not bring demand into balance with supply

## Ethane's Value

- **The business:** To use some of the surplus Ethane as a transportation fuel
- The Mt. Belvieu price of Ethane:
  - 19.8¢/gal (today)
  - Futures price in Dec 2019 is <25¢/ gal
- Value of Ethane @ fractionators distant from petrochemical markets:
  - Is below 10¢/gal
  - Ethane is almost worthless in the Bakken Formation



## GoEthane will:

- Sell hardware and software to fleet owners at a moderate profit—**The Shaver**
- Make money providing logistics, transporting Ethane from the fractionator to the fleet (high-value add)—**The Blades**
- Have IP protection on vehicle hardware software for Ethane as the fuel

## GoEthane will:

- Have IP protection for rapid filling of Ethane:
  - At the fractionator into the bulk truck
  - At the customer site into vehicle fuel tank; rapid refuelling
- GoEthane will be first in class as the logistics company for Ethane
- **GoEthane | The UPS of Ethane**

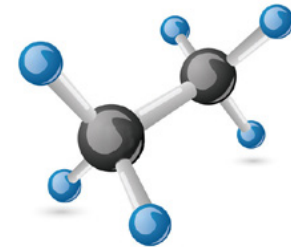


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# why ethane? it works well 15 in engines

Ethane ( $C_2H_6$ ) is a great transportation fuel

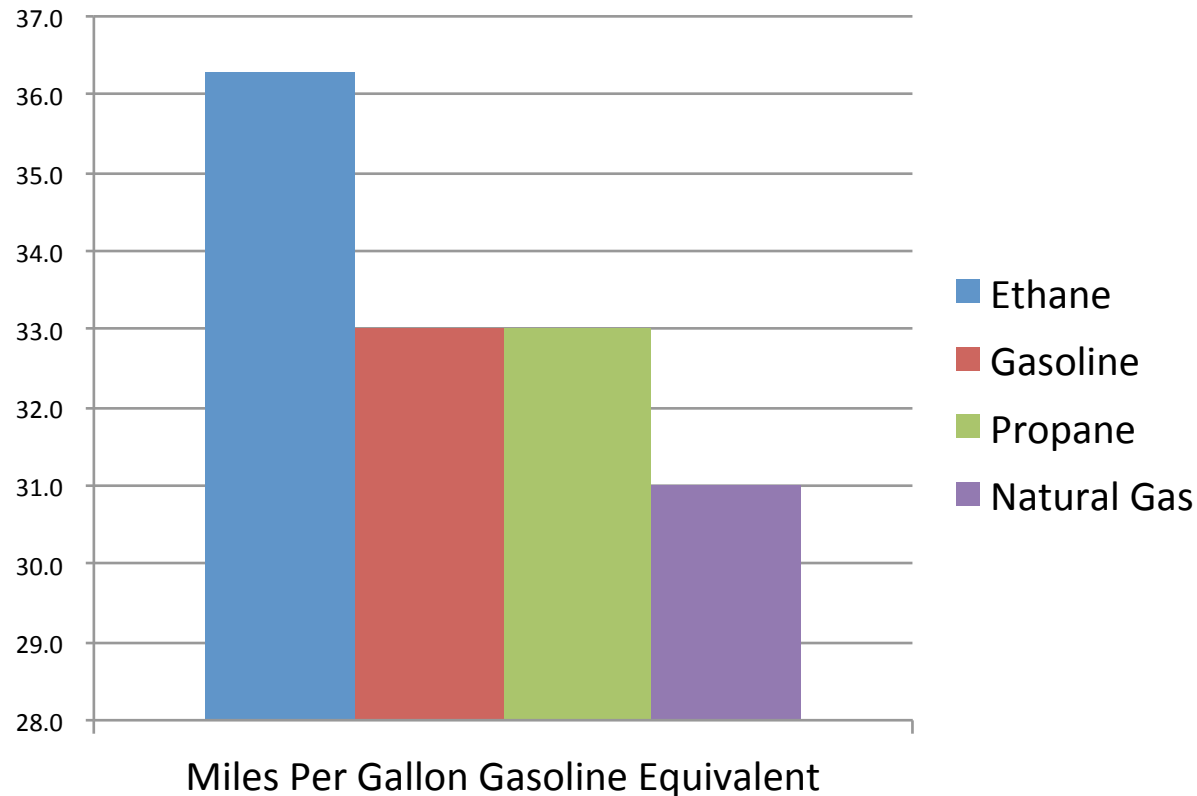
- **1st tests:** 9%-17% incr. in miles/GGE vs Gasoline
- Ethane:
  - Is a high powered fuel, high octane fuel
  - Burns completely in an engine
  - Is superior to propane as a transportation fuel
- CNG (methane):
  - Is a high powered, high octane fuel
  - Does not burn completely in an engine
  - Is not a great fuel in ICEs (much higher activation energy)



# ethane is the best fuel

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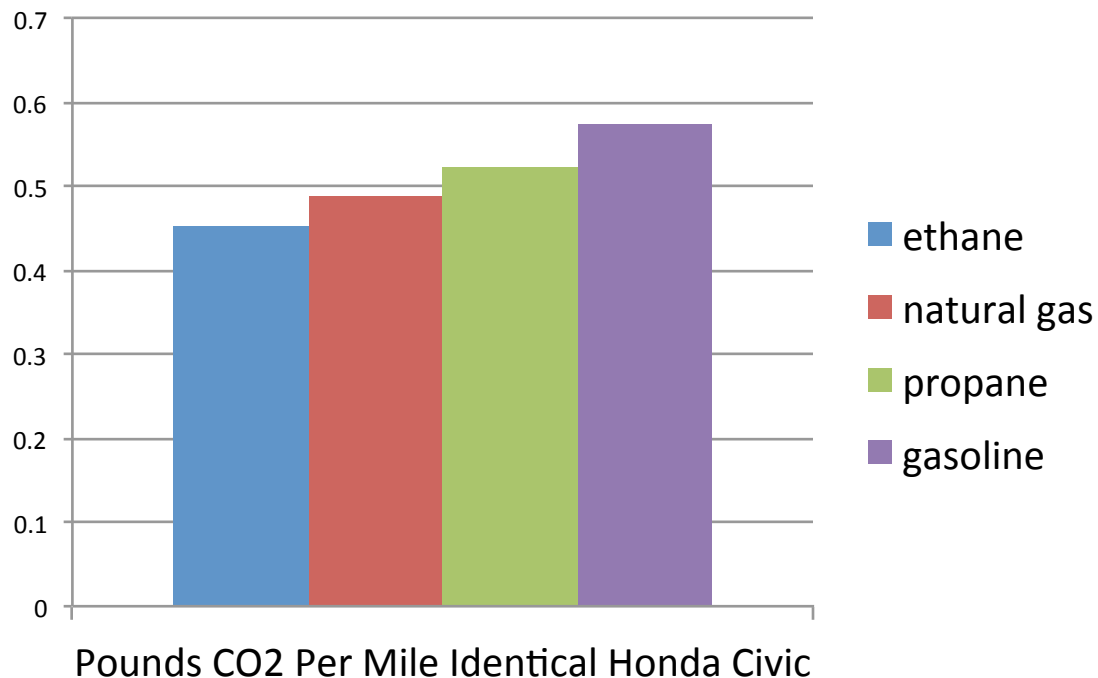
- More MPGs/GGE (Gasoline Gallon Equivalent)
- Vehicle modeled: Honda Civic (Gasoline or CNG)





# ethane is the greenest fuel 17

- More MPGs/GGE
- Less CO<sub>2</sub>/MMBTUs than Gasoline or Propane
- Vehicle modelled: Honda Civic Gasoline or CNG



**Note:** Data is burning of the fuel only. There is even more pronounced improvement when the upstream carbon footprint is included.

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# ethane is the low CO<sub>2</sub>/mi fuel

# 18

## Ethane (C<sub>2</sub>H<sub>6</sub>):

- Is more H<sub>2</sub> rich than Propane (C<sub>3</sub>H<sub>8</sub>) and Gasoline
- Emits lowest CO<sub>2</sub>/mile for the same vehicle, beating:
  - CNG
  - Propane
  - Gasoline
- Nucor Steel Ford F150 On-road Test, Jewett, TX:
  - 31% lower than gasoline in CO<sub>2</sub>/mile
  - 1.1 lbs/mile vs 1.6 lbs/mile in the same vehicle, same route, same traffic, same speed, same driver

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# ethane well-2-wheels CO<sub>2</sub> 19

## is low

- Not needed:
  - Refining and chemical processing (unlike Gasoline)
  - Massive energy input for storing (unlike CNG)
    - Ethane @ 600 psi
    - CNG @ 3,500 psi
  - Massive energy to liquefy (unlike LNG)
    - Ethane is a liquid at room temperature and 600 psi
    - LNG is cryogenic
- Simply needs:
  - Fractionation from NG (like Propane)

**Upstream carbon footprint is similar to Propane, and lower than Gasoline, CNG, and LNG**

# low carbon footprint

Table 2. Upstream Emissions Factors (grams per million Btu)\*

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	TOTAL CO <sub>2</sub> EQUIVALENT
ETHANOL (E85)	-14,409	113	41.0	-387
NATURAL GAS	6,995	317	1.34	16,228
PROPANE	12,867	188	0.26	18,204
GASOLINE	16,010	118	3.95	20,368
COMPRESSED NATURAL GAS	10,985	324	1.40	20,429
DIESEL	18,727	118	0.31	22,104
FUEL OIL	18,727	118	0.31	22,104
ELECTRICITY	182,897	317	2.84	192,523

Annotations: A blue arrow points to the PROPANE row. A red arrow points to the GASOLINE row. A yellow arrow points to the COMPRESSED NATURAL GAS row. A blue box labeled "Ethane" with an arrow points to the NATURAL GAS row.

\*End-use emissions are based on the lower heating value, density, and weight ratio of carbon atoms per unit volume of each fuel provided in the GREET model software. All carbon is assumed to be released as CO<sub>2</sub>.

## Ethane emissions testing showed:

- Complete combustion of hydrocarbons (HCs)—No methane slip like CNG or LNG
- Very low NO<sub>x</sub>
- 86 mg/mile of non-methane HC plus NO<sub>x</sub> as required in vehicles (easily achievable)
- No large, nasty organic compounds formed in the Ethane engine—Ethane and other HCs react out in the catalytic converter
- Lowest emissions of all transportation fuels
  - Exception: Hydrogen made from PV energy or wind energy

## On-road testing in California and other states

- Honda CNG Civics running on Ethane to prove improvement over CNG
- Side-by-side test of UPS 'Bread Truck' on Ethane against Gasoline
- Dual fuel with diesel in:
  - Large trucks
  - Locomotives
  - Ferries

Gain with Ethane.

(1) Handbook of Atmospheric Science: Principles and Applications, pp.93-97, [Online] - [Cited: 12 October 2015] <http://www.scribd.com/doc/23585958/Handbook-of-Atmospheric-sciences>.

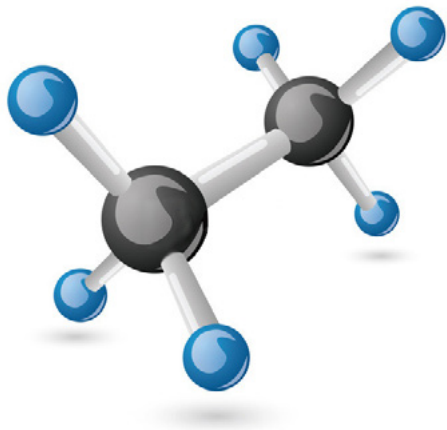
The logo for GOETHANE features the word in a bold, 3D-style font. The letters are filled with a gradient from red at the bottom to blue at the top, with a white starburst pattern overlaid on the blue portion.

# a parting thought

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Gain with Ethane.

*Ethane (C<sub>2</sub>H<sub>6</sub>) is a GREAT transportation fuel!*



**GOETHANE**