ZERO TAILPIPE EMMISSIONS
BATTERY-ELECTRIC BUSES: EFFCIENCY and TECHNOLOGY

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PROTERRA

DRIVING THE TRANSFORMATION OF TRANSPORTATION

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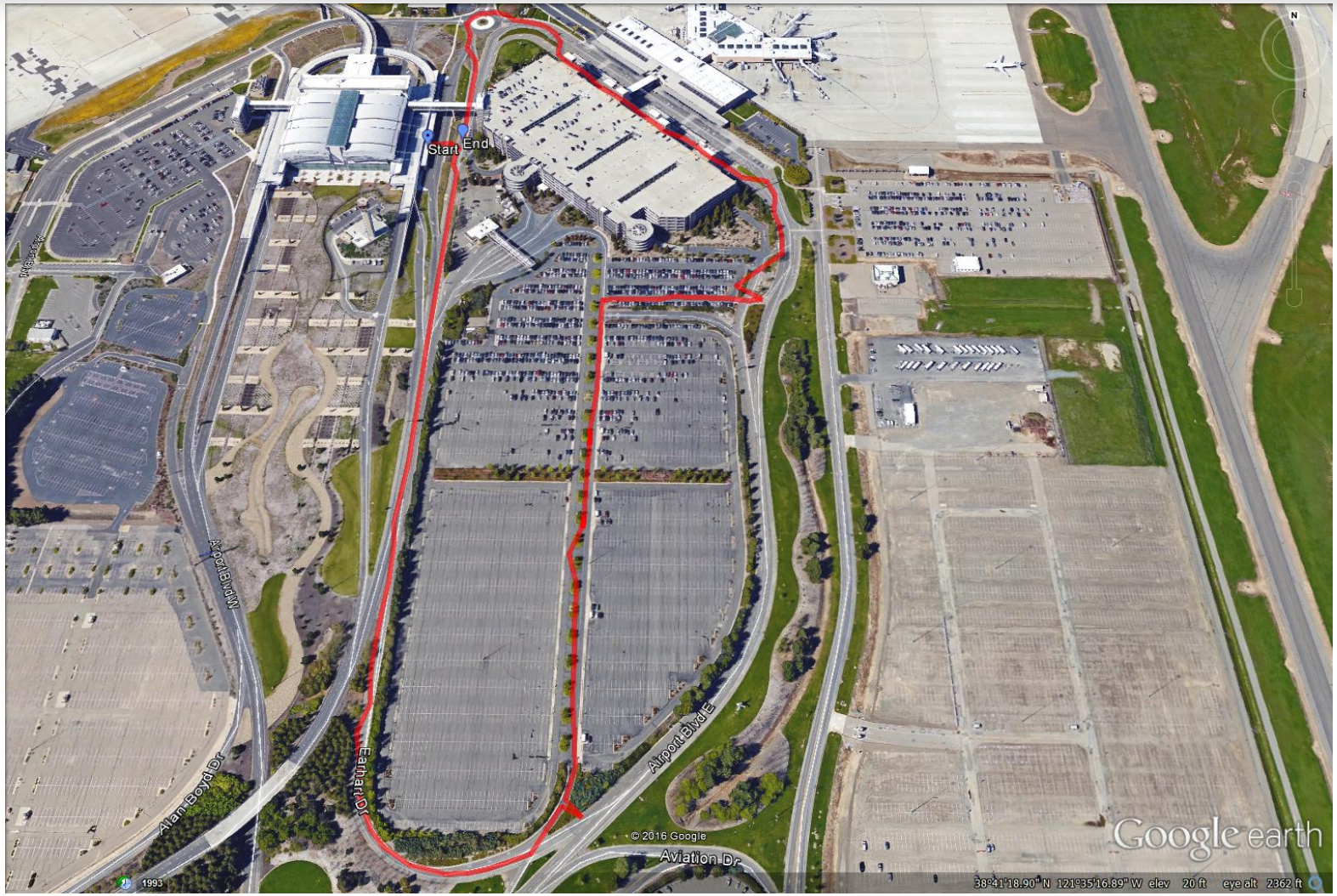
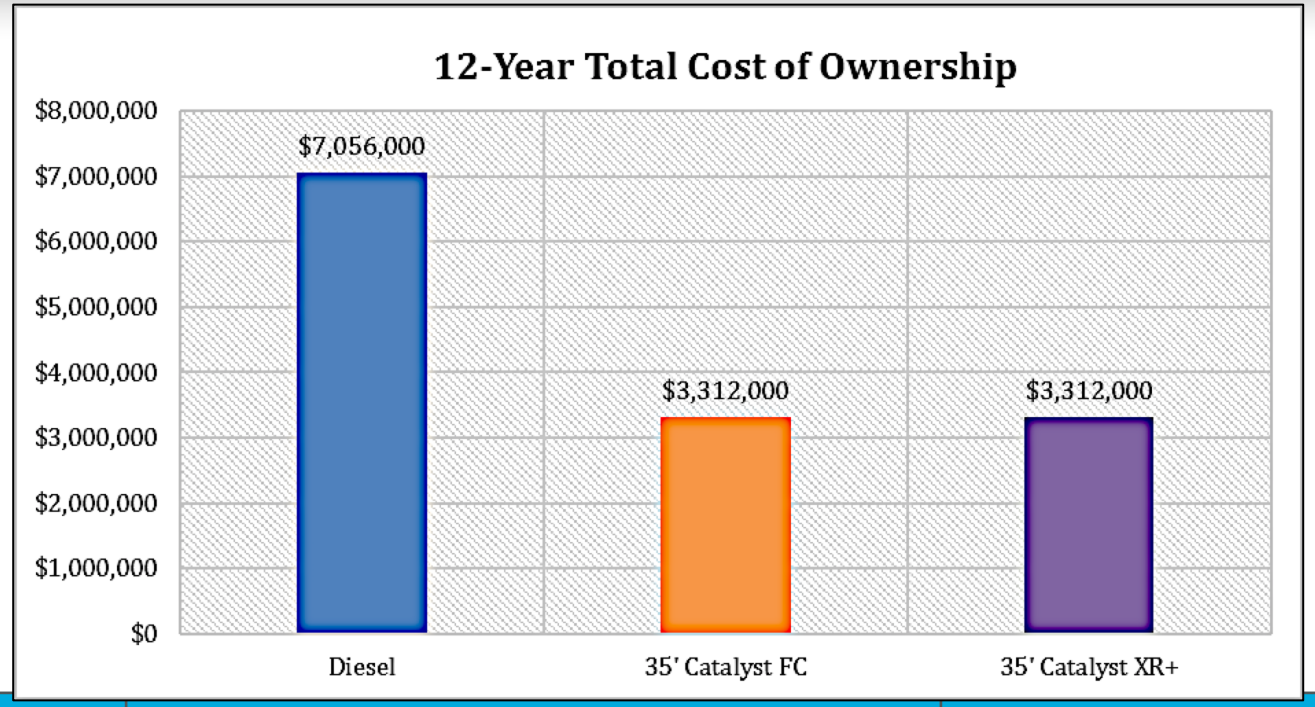
ROUTE SIMULATION RESULTS – **OPEC TERMINAL AIRPORT**



Route Information	E2/FC+
Route Name	**Daily**
Distance	1.3 miles
Duration	10 minutes
Average Speed	8 mph
Maximum Speed	22.5 mph
Maximum Grade	0.4%
Average Day Results	
Passenger Count	29
Ambient Temperature	61.5°F
Efficiency	**1.265 kWh/mi**
MPGe	29.76
Total Energy Consumed	1.65 kWh
Auxiliary Accessories Energy	0.24 kWh
HVAC Energy	0.27 kWh
System Energy Recaptured by Regen	9%
1 Lap Final SOC	96%
Estimated 1 Lap Recharge Time (On-route charger)	01:10 [mm:ss]
Environmental and Operating Impact	
Hot Day	
Passenger Count	66
Ambient Temperature	96°F
Efficiency	**2.072 kWh/mi**
MPGe	18.17
Cold Day	
Passenger Count	66
Ambient Temperature	36°F
Efficiency	**2.082 kWh/mi**
MPGe	18.08

EXAMPLE - TOTAL COST OF OWNERSHIP FLEET OF 10 - 35’ BUS



ELECTRIC vs. Diesel	vs. 35’ ELECTRIC BUS	vs. 35’ ELECTRIC BUS

THE PROTERRA CATALYST PROVIDES AN IMMEDIATE RETURN ON INVESTMENT

This chart takes into account the emission for creating the energy or fuel and then using or BURNING it.

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PER BUS

Emission (lbs/bus/yr)	Proterra	CNG	Hybrid	Diesel	Diesel (metric tons)
CO	22	1,925	47	78	0.04
CH4	149	1,932	318	444	0.20
CH4 in CO2e	3,736	48,292	7,960	11,088	5
CO2	70,013	200,376	166,320	233,640	106
GHG - sum of 2 above, CO2e	73,899	250,600	174,598	245,172	111
NOx	47	179	152	176	0.080
VOC	7	36	18	24	0.011
PM (2.5+10)	13	8	11	13	0.006
BC	3	1	1	1	0.000

THIS DOES NOT REFLECT Delivery AND Distribution VEHICLE EMISSIONS - Above data from GREET US 2016

ORNL study finds best current use of natural gas for cars is efficient production of electricity for EVs

24 September 2014

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Because the use of natural gas for transportation requires compressing, liquefying, or conversion, it is important to determine the best use of natural gas as a transportation fuel. Specifically, to minimize GHG emissions and total energy use, ***is it better to use natural gas in a stationary power application to generate electricity to charge EVs****, to compress natural gas for onboard combustion in vehicles, or to reform natural gas into a denser transportation fuel?*

—Curran *et al.*

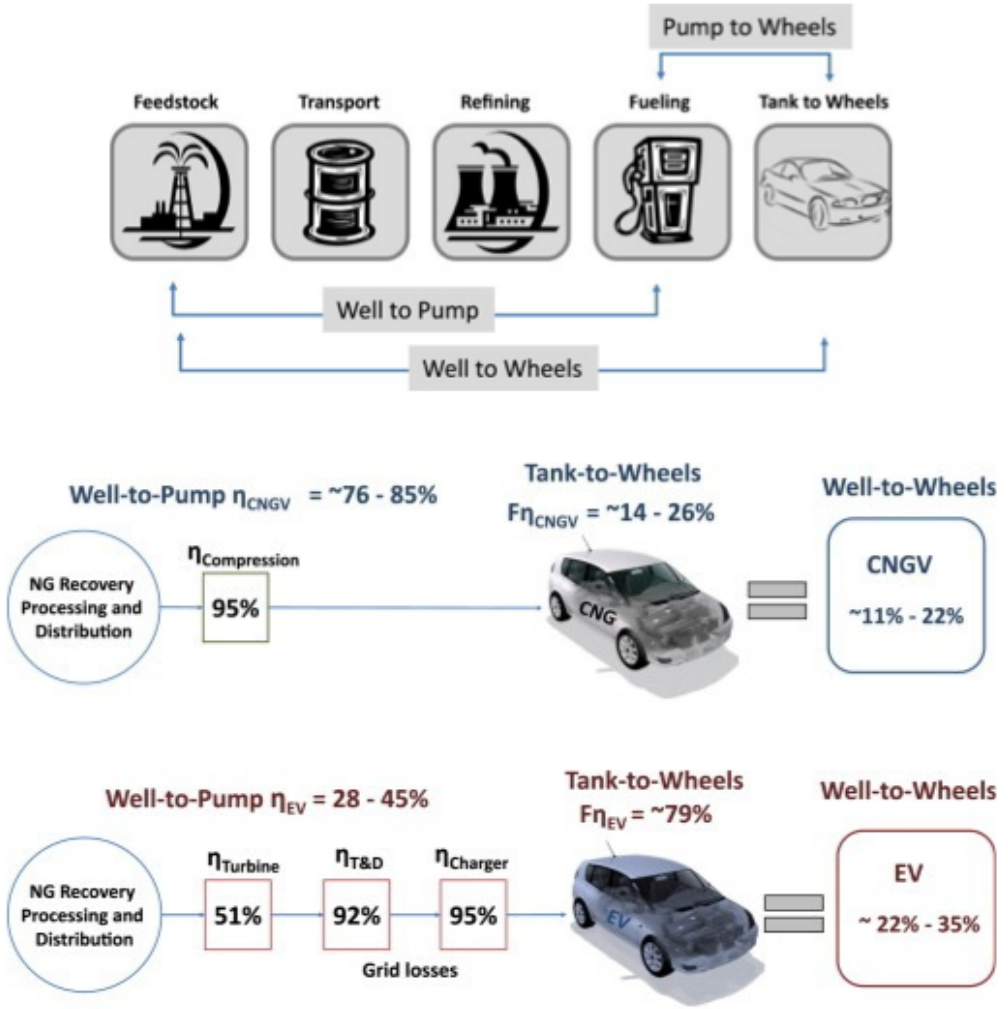
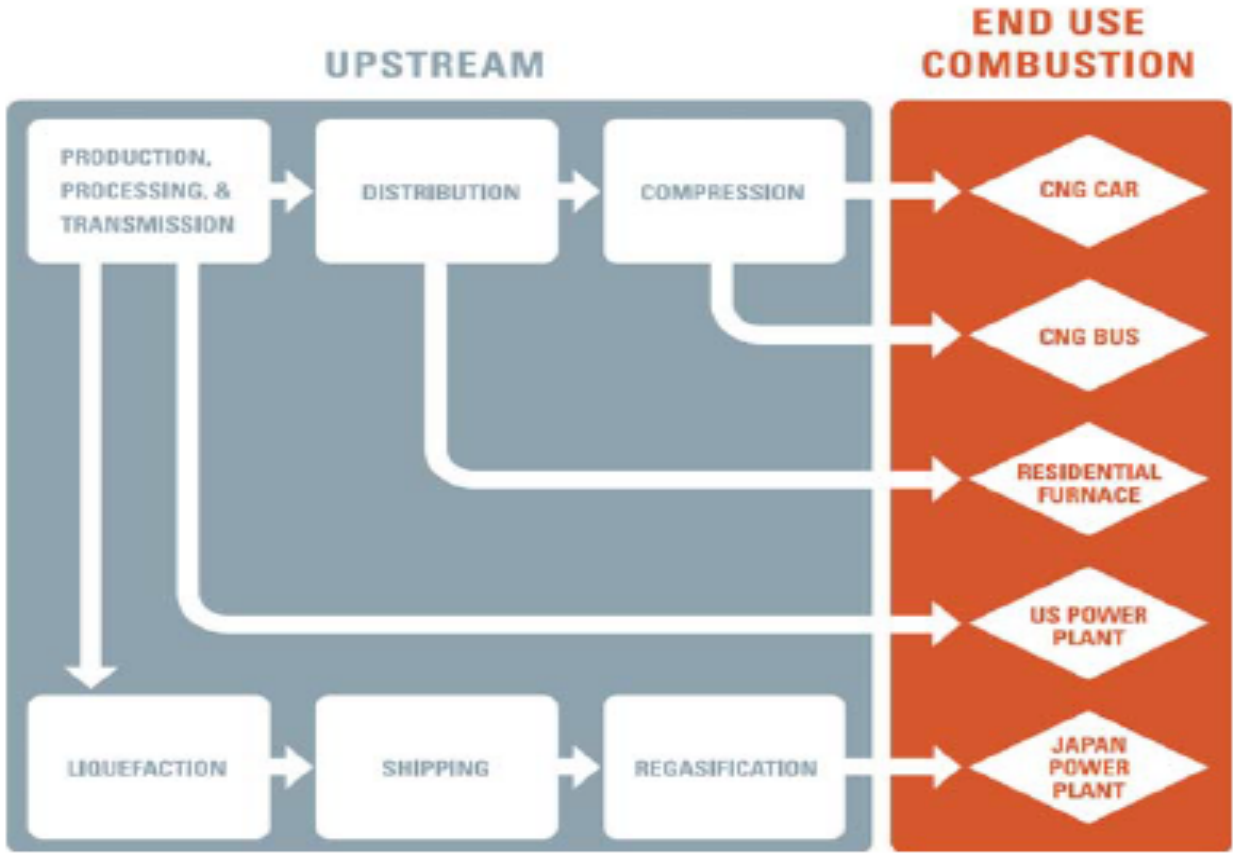


Figure 1 Processes considered in the natural gas fuel cycle (e.g., well-to-wheels or well-to-wire) for emissions analyses (see online version for colours)



The one vehicular use of natural gas that could yield substantial savings of CO_2e emissions would be to power vehicles with electricity generated from natural gas. Based on a 2013 Nissan Leaf electric vehicle, GREET computes emission savings of 41or 52 gCO_2e/MJNG relative to a conventional gasoline Civic if the electricity originates from existing natural gas power plants or new combined cycle facilities, respectively. The emission savings would be far smaller (13 or 20gCO_2e/MJNG, respectively) if the electric Leaf is instead compared to a hybrid gasoline Civic. Greater emissions associated with manufacturing the electric vehicle and its battery would cut these savings by 4 or 3 gCO_2e/MJNG relative to the conventional or hybrid vehicle, respectively, based on GREET2 vehicle cycle model calculations for a 260,000 km lifespan. The limited range and smaller size of the Leaf relative to the Civic make this an inexact substitution in terms of operating characteristics. However, the scenario highlights a more efficient potential path for powering vehicles with natural gas.

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Net greenhouse gas emissions savings from natural gas substitutions in vehicles, furnaces, and power Plants

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THANK YOU.

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