

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549

FORM 8-K

CURRENT REPORT
PURSUANT TO SECTION 13 OR 15(d) OF THE
SECURITIES EXCHANGE ACT OF 1934

Date of report: February 25, 2021



TECOGEN INC. (OTCQX: TGEN)
(Exact Name of Registrant as Specified in Charter)

Delaware
(State or Other Jurisdiction of Incorporation)

001-36103
(Commission File Number)

04-3536131
(IRS Employer Identification No.)

45 First Avenue
Waltham, Massachusetts
(Address of Principal Executive Offices)

02451
(Zip Code)

(781) 466-6400
(Registrant's telephone number, including area code)

Securities registered or to be registered pursuant to Section 12(b) of the Act.

Title of each class	Trading Symbol	Name of exchange on which registered

Check the appropriate box below if the Form 8-K filing is intended to simultaneously satisfy the filing obligation of the registrant under any of the following provisions:

- Written communications pursuant to Rule 425 under the Securities Act (17 CFR 230.425)
- Soliciting material pursuant to Rule 14a-12 under the Exchange Act (17 CFR 240.14a-12)
- Pre-commencement communications pursuant to Rule 14d-2(b) under the Exchange Act (17 CFR 240.14d-2(b))
- Pre-commencement communications pursuant to Rule 13e-4(c) under the Exchange Act (17 CFR 240.13e-4(c))

Indicate by check mark whether the registrant is an emerging growth company as defined in Rule 405 of the Securities Act of 1933 (§230.405 of this chapter) or Rule 12b-2 of the Securities Exchange Act of 1934 (§240.12b-2 of this chapter). Emerging growth company

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.

Item 8.01. Other Events.

On February 25, 2021, Robert Panora, President and Chief Operating Officer of Tecogen Inc. (the "Company") presented an update on the Ultera™ near-zero emission forklift program as part of a Technology Series sponsored by the Propane Education & Research Council (PERC). The presentation, titled "*LPG Near-Zero Emission System for Forklifts - Status Update*" is scheduled for Thursday, February 25, 2021 at 2 p.m. EST. A copy of the presentation is attached hereto as Exhibit 9.01.

Item 9.01. Financial Statements and Exhibits.

(d) Exhibits

The following exhibit relating to Item 8.01 shall be deemed to be furnished, and not filed:

<u>Exhibit</u>	<u>Description</u>
99.01	Presentation titled "LPG Near Zero Emission System for Forklifts - Status Update"

SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, the Company has duly caused this report to be signed on its behalf by the undersigned, hereunto

TECOGEN INC.

duly authorized.

February 25, 2021

By: /s/ Benjamin Locke

Benjamin Locke, Chief Executive Officer

Robert Panora
President & COO



Tecogen:ii[®]

Energy Efficiency Reimagined

OTCQX: TGEN

**LPG Near Zero Emission System for
Forklifts – Status Update**

Topics



- ↳ Tecogen Inc.
- ↳ Technology Background
 - ↳ Ultera® Aftertreatment Process
- ↳ Application to Forklifts
 - ↳ Regulatory issues
 - ↳ MCFA Work
 - ↳ Emissions Performance (modified 2.5 L GCT LPG engine)
 - ↳ Program Status
 - ↳ Origin Engines Agreement
- ↳ Future
- ↳ Final Thoughts & Questions



Tecogen Inc.



- ✓ CHP OEM
- ✓ Installations & Service
- ✓ Technology development - emissions

Tecochill[®]
The Driving Force in Cooling

- ✓ Gas cooling –lower operating costs
- ✓ 50 – 400 Tons
- ✓ “Free” waste heat



InVerdee⁺
Inverter-Based Cogeneration



- ✓ 125 kW
- ✓ Proprietary inverter
- ✓ CERTS certified microgrid system
- ✓ Blackout protection

Tecopower[™]
The pioneer in CHP



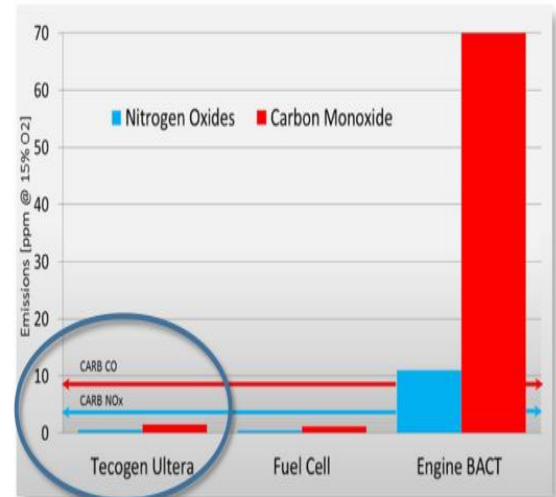
- ✓ 60 -75 KW
- ✓ Cost effective heat and power



Emission Technology Origins



- Stationary NG engine scrutinized
 - Unannounced testing by regulators
 - Exposed widespread non-compliance
 - Regulators enacted harsh countermeasures
 - Lowered compliance levels
- Tecogen awarded research grant (CEC & SoCalGas)
- Achieved groundbreaking process: Ultra®
 - Emissions comparable to fuel cells
 - Patented in 2013 (USA/ Internationally)
 - Widely deployed in Tecogen and non-Tecogen stationary products throughout USA including California
 - Hundreds of engines, thousands of hours



BACT refers to "Best Available Control Technology" and is the regulatory limit in most US regions for stationary natural gas engines

Tecogen Ultra 2-Stage Technology

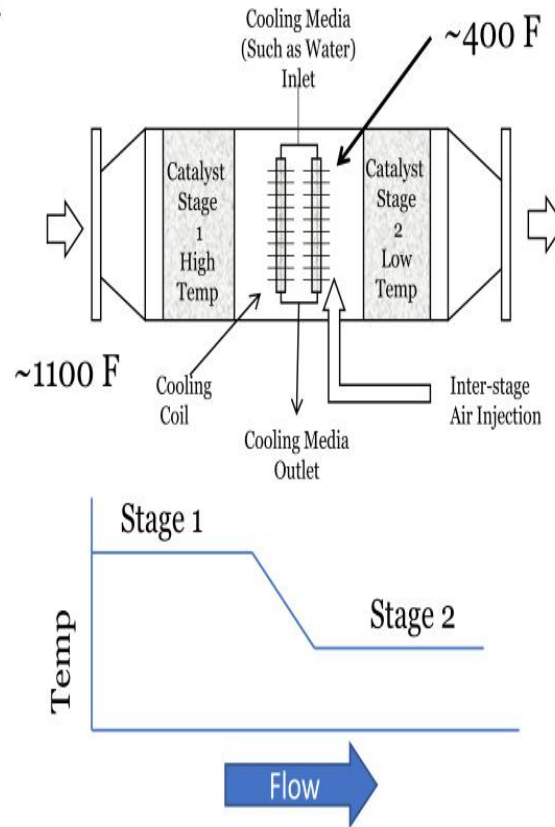


➤ Previously demonstrated two stage process but initial experiment failed

- Stage 1: Operate to Minimize NO_x (Rich)
- Stage 2: Inject Air Upstream to Create Oxidizing Environment
- But NO_x reformed in second stage

➤ Patented Breakthrough: Interstage Cooling

- NO_x reformation eliminated
- Oxidation (favorable) reactions still proceed
- Robust Emission Compliance
- Highly Tolerant of Air/Fuel Deviations



Independent Testing on Various Stationary NG Engine Platforms



Tecogen Ultra Aftertreatment Measurements (g/bhp-hr)					California Heavy-Duty Vehicle Standards (g/bhp-hr)	
Application	CHP	CHP	Water Pumping	Prime Power		
	GM Natural Gas Engine	Ford Natural Gas Engine	Cat Natural Gas Engine	Ford Natural Gas Engine	Otto-Cycle Engine	Optional Otto-Cycle
Hp	108	50	225	189		
NOx	0.008	0.011	0.002	0.004	0.2	0.10, 0.05 or 0.02
CO	0.012	0.002	0.003	0.002	14.4	14.4
NMHC					0.14	0.14
VOC	0.011	0.000	0.013	0.006		

- Performance exceeds California regs by wide margin
- Demonstrates ease of technology transfer
 - Large and small engines
 - Indifferent to manufacturer
- Solves the problem associated with the inherent limits of three-way catalysts
 - Can handle extremely large excursions with small adjustment in engine operating parameters

Note 1: VOC's (volatile organic compounds) and NMHC (non-methane hydrocarbons) are both measurements of organic gases which are harmful pollutants.



Successful Technology Transfer



➤ Repeatability chemistry with carbon-based fuels

➤ NG, LPG, Gasoline, Biogas,

➤ Easily retrofit

LP Gas
Forklift Truck
w/ MCFA



NG Emergency Generator 100-250 kW



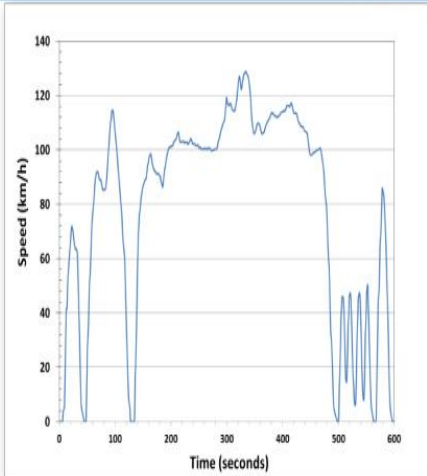
Municipal Water Pumping NG
Engine – 250 HP



Gasoline Passenger Vehicle Chassis
Dyno Testing



AVL Testing of Passenger Vehicle



- 87% CO reduction
- 86% NMOG reduction
- 20% NOx reduction (without AFR adjustments)
- 26% NOx + NMOG reduction

	CO	NMOG	NOx	NMOG + NOx
Pre – Ultera® System				
Grams	9.56	0.042	0.445	0.487
grams/mile	1.18	0.005	0.055	0.060
Post – Ultera® System				
Grams	1.25	0.006	0.356	0.362
grams/mile	0.155	0.001	0.044	0.045
Reduction Efficiency	87%	86%	20%	26%
Total Grams Removed	8.31	0.036	0.088	0.124



Forklift Initiative



- ↳ Ultera process fits well with forklift application
 - ↳ Engine duty cycle exceptionally variable
 - ↳ Ultera emissions performance tolerant of air/fuel ratio excursions
 - ↳ CO elimination highly valued because of indoor air quality consideration
 - ↳ Many low emissions technologies singularly focus on NOx (high concentrations of CO and HC's)
- ↳ Demonstration Program initiated
- ↳ Objective
 - ↳ Demonstrate low emissions on LPG on Ultera-equipped forklift
- ↳ Other participants:
 - ↳ Propane Research and Education Council (PERC) funding
 - ↳ MCFA (Mitsubishi Caterpillar Forklift America Inc.) vehicle donation and tech support

Current Compliance Requirements (CA)



🔄 OEM Certifications

- 🔄 Bare test engine
- 🔄 Optional OLES NOx/HC available (see table)
- 🔄 Pairing of NOx and HC as single pollutant annoying (unpaired in truck regs)

🔄 Fleet operators

- 🔄 Maintain fleet emission averages

🔄 Program goal to meet most stringent OLES value

🔄 New CARB (California Air Reg Board) initiative

- 🔄 Phase out all IC engine forklifts
- 🔄 Workshops underway
- 🔄 Hopeful initiative will be curtailed or eliminated

OEM Compliance Requirements

Model Year	NOx + HC [gm/kW-hr]	CO [gm/kW-hr]
< 2000	16	
2001 - 2006	4.0	49.6
2007 - 2009	2.7	4.4
≥ 2010	0.8	20.6
≥ 2010 (optional)	0.5, 0.3, 0.1	20.6

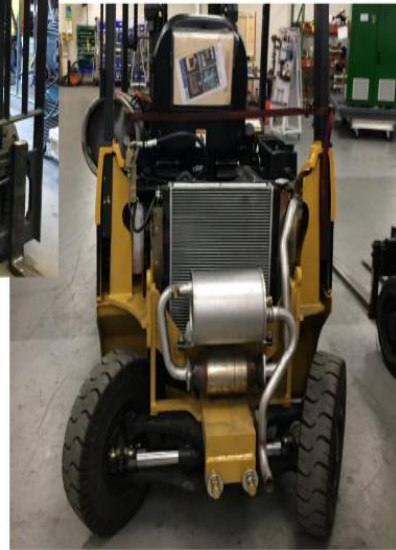


Ultera Forklift Integration



Stock MCFA lift truck features

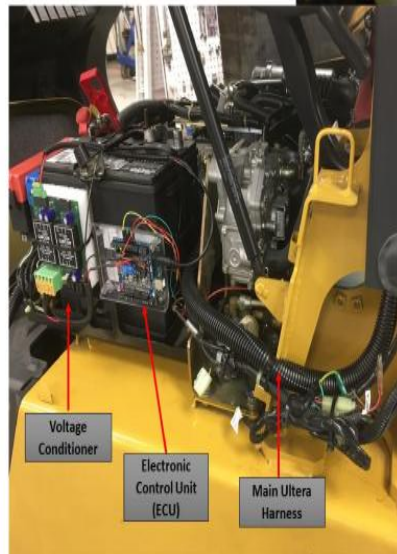
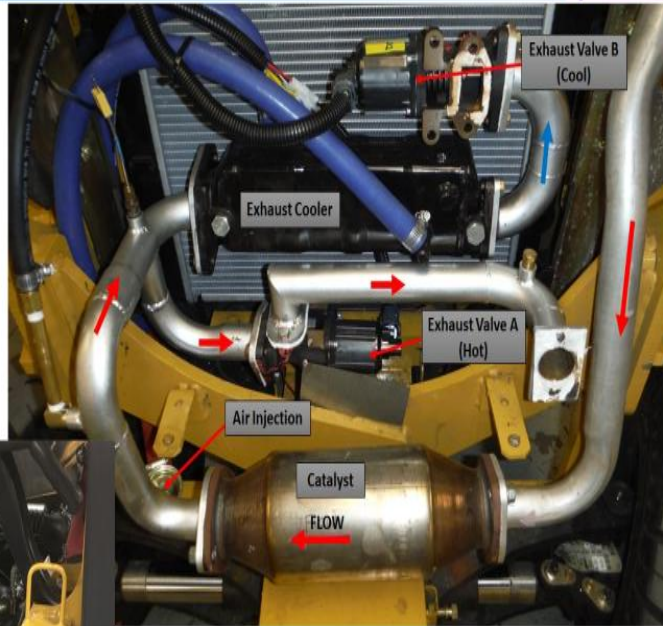
- Model GP25N (2.5L engine)
- 5000 lb capacity
- GCT (Global Component Technology) fuel system
- Three-way catalyst
- Muffler
- Radiator



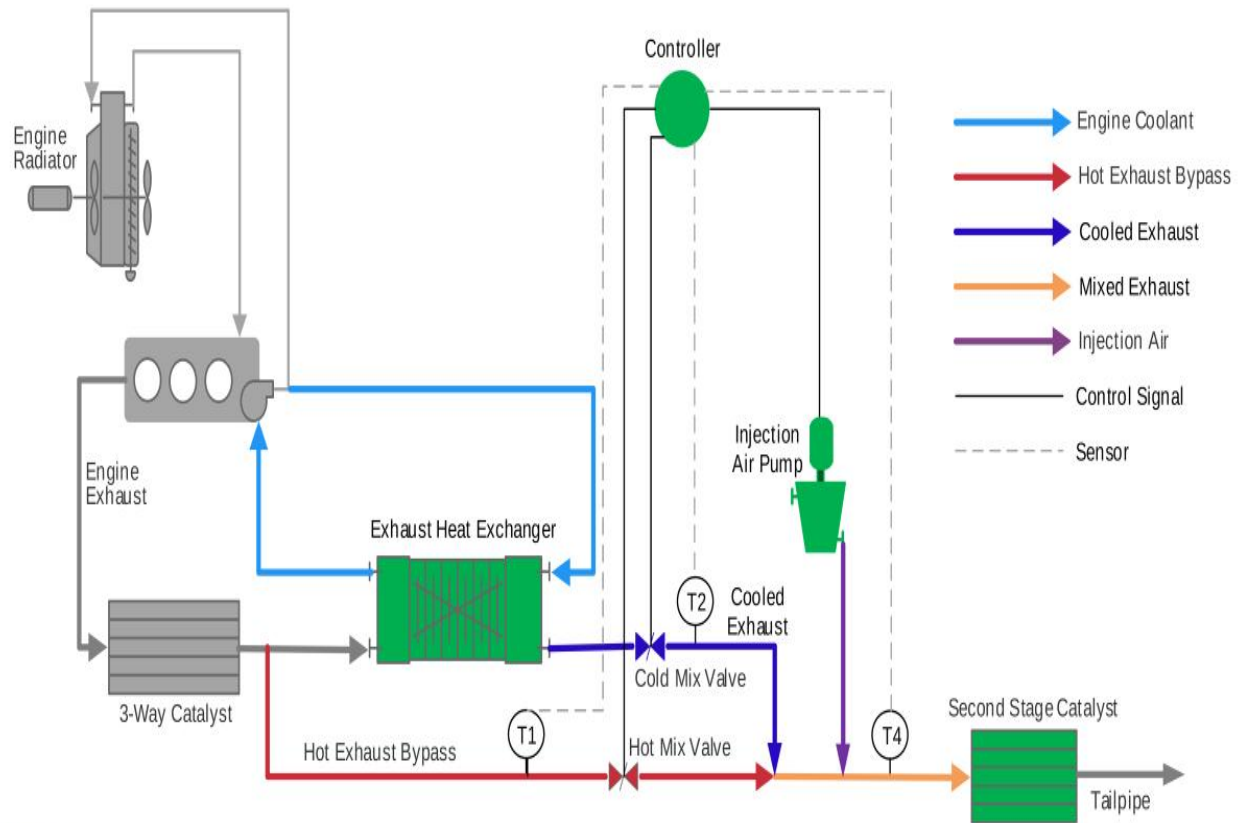
Ultra Forklift Integration



- Fully integrated under counterweight



Process and Instrumentation Diagram



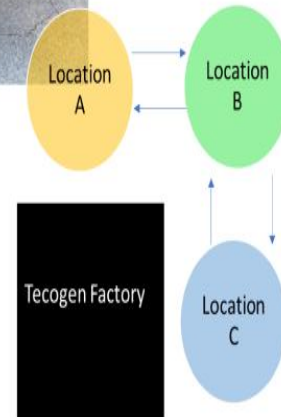
Ultra Performance (pre-engine tuning)



- 4300 lb lift cycle
 - OEM factory AFR calibration
- Third-party validation
 - Confirmed CO and NOx trends
 - THC data
- % Reduction based on pollutant mass



- Test course
 - Two lifts per location
 - Carry block between lifts

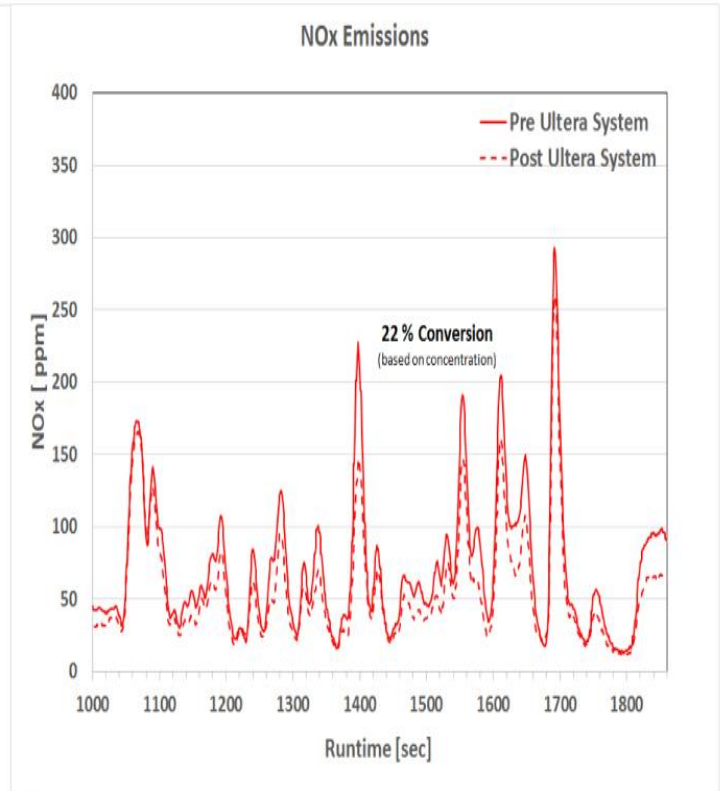
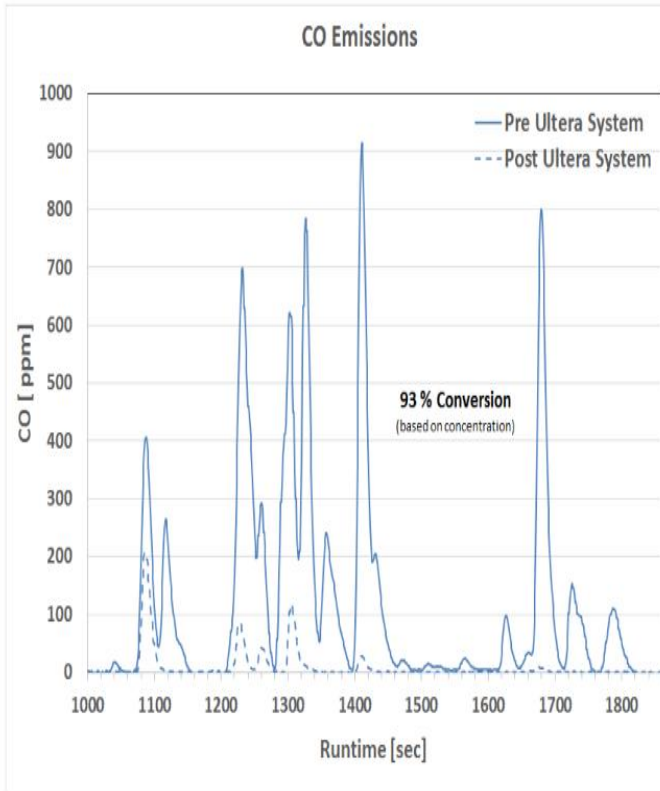


	Tecogen	Third-Party
CO	98.8%	91.0 %
THC	N/A	52.1%
NOx	24.3%	29.2%



* Based on estimated mass flow

Driving/Lift Test (results vs. time)



Engine Retuning (last step)

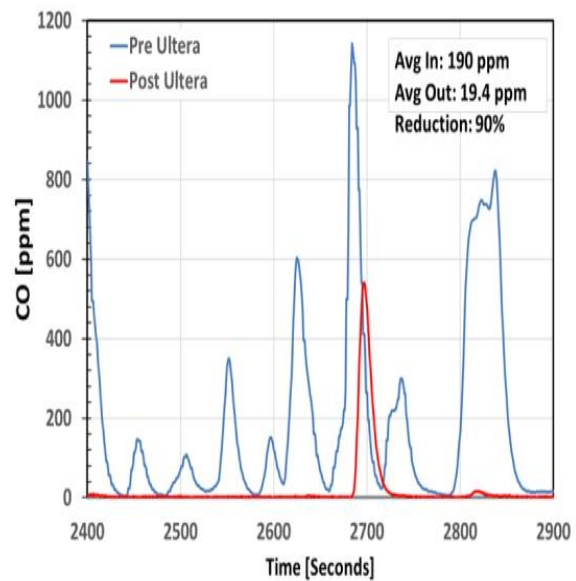
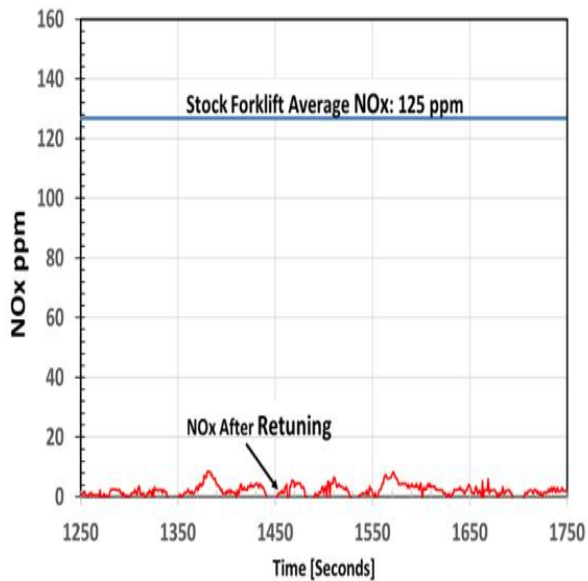


- Optimal Ultra performance required engine retuning
 - Firmware changes in air-fuel ratio needed by programming specialist (Mitsubishi affiliate from Japan)
 - Retuning objective is to bias air/fuel proportion for improved NOx reduction in first stage
- Retuning specialist from Japan and MCFA engineers performed retuning in 2019
- Test results highly impactful
 - CO and NOx levels highly reduced from stock forklift

Final Tests Results (retuned engine)



Retesting on standard test cycle (heavy lifts, etc.)



MCFA Engine Certification Status



With positive test data from retuning, we project successful certification result likely

Notably, test cycle is completed on dyno on bare engine

- Similar but not the identical to our drive cycle
- Additional retuning to test cycle might be needed

We decided to proceed with initial certification testing

- MCFA began scheduling third party test at SwRI (TX) for May 2020
- PERC agreed to fund initial testing
- Objective of initial tests was to prove repeatability of NOx result on the dyno cycle
- Tuning engineer on hand to adjust as needed

COVID-19 upended these plans

Awaiting travel US/Japan travel restrictions to be lifted

	NOx+THC [g/kw-hr]	CO [g/kw-hr]
Near Zero Target Certification	0.1	20.6
Current Regulation	0.8	20.6
GCT 2016 Engine - Dyno Cert Test	0.4	5.6
GCT 2016 Engine - Drive Test	1.67	0.49
GCT 2016 Engine - Drive Test w/Ultera	0.21	0.29
GCT 2016 Engine - Estimated ¹ Dyno Cert Test	0.05	3.3

¹ Extrapolation includes the following:
Drive cycle correction factor of 0.24
Assumed engine efficiency of 28%
THC estimation from previous source test



Origin Engine Ultera Agreement



Origin Engines

- Nebraska-based manufacturer
- Innovative, fast growing supplier in industrial markets
 - Aware of growing value of low emissions to customers
- Tecogen supplier for our CHP products

Tecogen/Origin License Agreement (November 2020)

- Engines 80 to 280 bhp (no conflict with MCFA)
- Propane, Natural gas, others
- Multiple markets covered
 - Oil and gas, power generation,
 - lift trucks, forestry, and distributed energy systems.

See also Feb 2021 article
in Diesel Progress

https://lnkd.in/efzs_B9



Future



🕒 MCFA program

- 🕒 COVID delay unfortunate
- 🕒 MCFA remains enthusiastic about technology

🕒 Origin agreement very positive outlook

- 🕒 Strong potential to expand Ultera
 - 🕒 Other lift manufacturers and other markets
- 🕒 Aggressive schedule for implementation

🕒 Ongoing catalyst research

- 🕒 Third party contracted by Tecogen to investigate improved Stage 2 formulations
- 🕒 Opportunity for innovation because of low temp environment
- 🕒 Laboratory Testing has identified more active, less expensive formulation
- 🕒 Important to pursue

Final Thoughts and Questions



🕒 Possible marketing strategies

- 🕒 Program originally emphasized certification to CA OLES (or near zero)
- 🕒 Certification has value but limited to outdoor air-quality concerns
- 🕒 Alternative would be to emphasize indoor air-quality impact
 - 🕒 Universal appeal (not limited to California)
 - 🕒 Potential to attain low values for all pollutants which is unusual.

🕒 Further reading (SAE International papers)

- 🕒 NOx Reduction Using a Dual-Stage Catalyst System with Intercooling in Vehicle Gasoline Engines under Real Driving Conditions
 - 🕒 <https://www.sae.org/publications/technical-papers/content/2018-01-0335/>
- 🕒 Development and Testing of the Ultera® Dual Stage Catalyst System on Gasoline-Fueled Light Duty Vehicles
 - 🕒 <https://www.sae.org/publications/technical-papers/content/2017-01-0920/>

Thank You!

