

CNG Infrastructure Cost Webinar



September 16, 2014

- ❖ Overview of CNG Stations - Mark Smith, U.S. Department of Energy and John Gonzales, National Renewable Energy Laboratory
- ❖ Small Station Example - Jeremy Talbot, Phoenix Energy
- ❖ Medium Station Example - Graham Barker, ANGI Energy Systems
- ❖ Question and Answer Session



Photo from Margaret Smith, DOE

Overview of CNG Stations

- Key Components
- Types of Stations
- Factors that Affect the Station Cost
- Station and Equipment Costs
- Operational Costs



Photo from Jeremy Talbot,
Phoenix Energy Corp



Photo from Trillium CNG

Key Components and Costs



Equipment	Purpose	Cost Range
Compressor	Compress gas from the inlet gas pressure to the pressure necessary for filling a vehicle to 3,600 psi	\$5K-\$500K
Dispenser	Quickly transfers CNG to the vehicle tank at a fast-fill station	\$25K-\$60K
Dual hose time-fill post	Fuels vehicles at a time-fill station	\$4K-\$7K
Storage tank	Stores compressed gas	\$70K-\$130K
Card reader	Allow the driver to access fuel using a fleet card or credit card	\$10K-\$30K
Gas dryer	Removes moisture from the gas prior to compression	\$10K-\$150K

- Fast-Fill – similar fill times to a gasoline station
- Time Fill – vehicles may take several minutes to many hours to fill
- Combination Fill – has the ability to both fast fill and time-fill vehicles



Photo from Kaye Evans, PR Newswire



Photo from Greater Long Island Clean Cities

Fast Fill Systems – Provide immediate dispensing of CNG to vehicles ranging from passenger cars and fleet trucks to transit buses

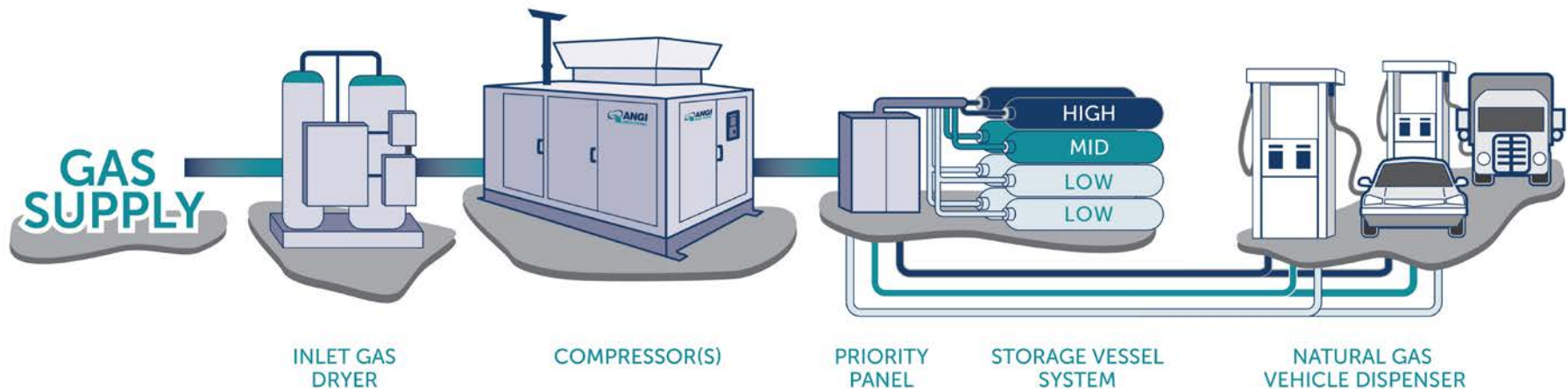


Image from ANGI Energy Systems

Time Fill Systems – Are a cost effective fueling option that allow vehicles to conveniently refuel overnight or when the vehicles are parked and not in use.

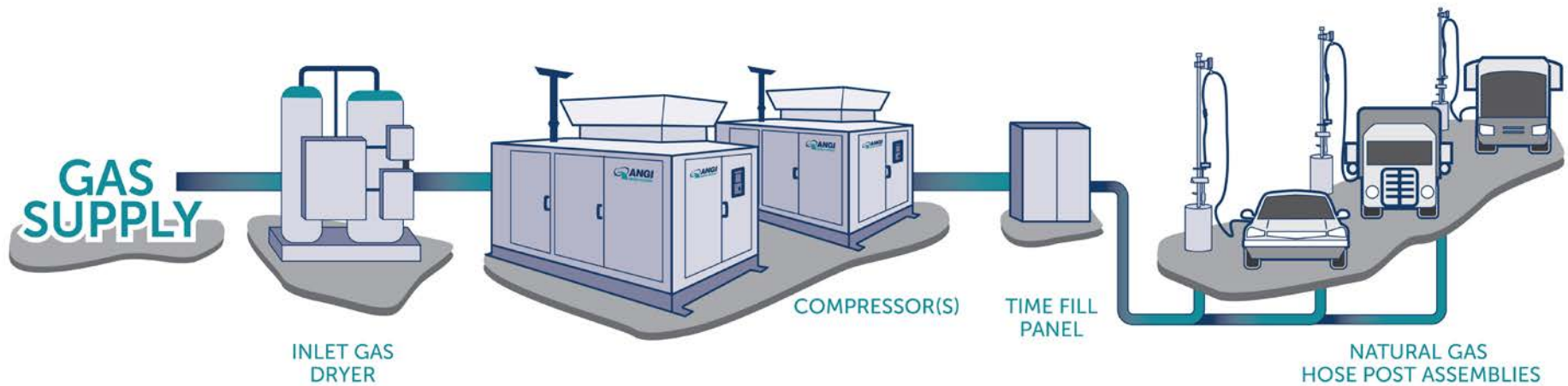


Image from ANGI Energy Systems

Combination Systems – Feature both a fast fill and time fill system allowing high utilization of the compression capacity both day and night

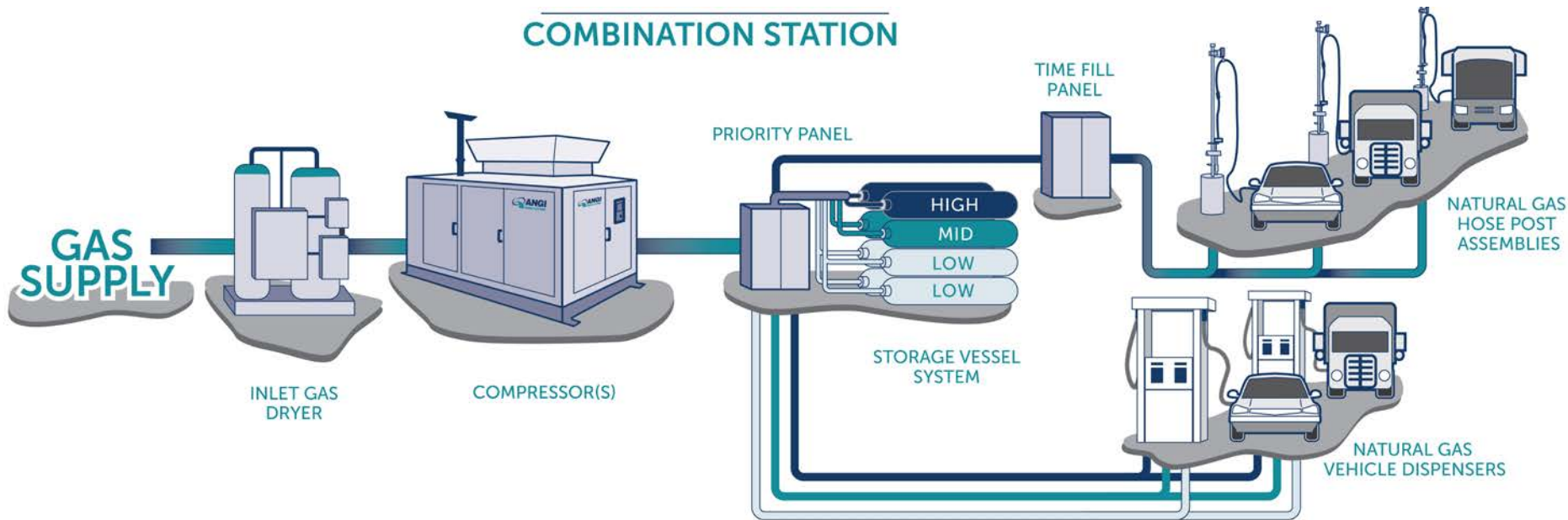


Image from ANGI Energy Systems

- Public Stations – open access to fleets and retail consumers
- Private Stations – only available for use by fleet or with a contract
- Public/Private Stations – fueling available to the private fleet as well as a publicly available fast-fill dispenser



Photo from Margaret Smith, DOE



Photo from Tulsa Gas Technologies

- Every station is different and costs vary substantially
- Station design and location are necessary for a cost estimate
- We'll provide a general overview of some cost factors



Photo from Robert Gordon, DeKalb County

Costs are Affected by User Needs and Access

- Vehicle quantity
- Vehicle drive cycle and duty cycle
- Fuel usage
- Fueling window
- Private, Public, Public/Private



Photo from Kaye Evans, PR Newswire



Photo from Warren Gretz, NREL



Photo from Margaret Smith, DOE



Photo from United Parcel Service

Costs are Affected by Site Constraints and Installation

- Inlet gas pressure
- Site layout
- Available power supply
- Space constraints
- Site proximity to gas pipeline



Photo from Tulsa Gas Technologies



Photo from Marathon Technical Services

Costs are Affected by Station Design

- Compressor redundancy
- Designing for future growth
- Backup generator



Photo from Marathon Technical Services

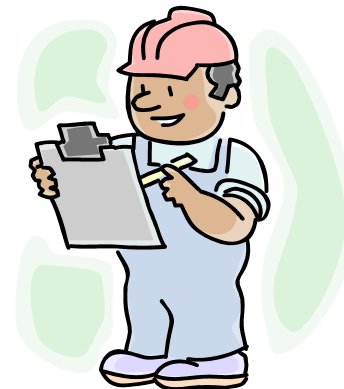


Photo from Marathon Technical Services



Photo from Marathon Technical Services

- Engage the authority having jurisdiction early and often
- Americans with Disabilities Act



- Operational costs included in fuel cost
- Billing and accounting systems
- Maintenance
- Liability insurance



Photo from Marathon Technical Services



Photo from Greater Long Island Clean Cities

- ARRA funded through Greater New Haven Clean Cities
- End users provided construction services to keep costs low
- Used refurbished components
- Duplex 20 SCFM compressors
- Dispenses ~170 gge/month for 6 sedans and 1 cargo van
- Estimated total installed cost is \$350K-\$400K



Town of Glastonbury, CT Municipal CNG Station



- ARRA funded through Greater New Haven Clean Cities
- End users provided construction services to keep costs low
- Single 20 SCFM compressor
- Dispenses ~680 gge/month for 3 shuttles, 2 trucks, and 15 sedans
- Estimated total installed cost is \$450K-\$550K



Costs Associated with CNG Vehicle Fueling Infrastructure Report

http://www.afdc.energy.gov/uploads/publication/cng_infrastructure_costs.pdf

- Ballpark station cost ranges provided for very specific situations
- Costs include
 - Engineering
 - Equipment
 - Installation
- Assumes no installation complications, permitting issues, or compressor redundancy
- Stations with similar fuel throughputs but different designs or sites may have quite different costs

Example Station	Assumptions	Cost Range
1 personal vehicle fueling 5 gge/night inside a residential garage	<ul style="list-style-type: none">• One 1-scfm (0.5 gge/hr) compressor• ¼-2 psi inlet gas pressure	\$5,500- \$6,500
Private fleet station serving 2 passenger sedans/pickups fueling 5 gge/night outdoors	<ul style="list-style-type: none">• One 2-scfm (1 gge/hr) compressor• ¼-2psi inlet gas pressure• One dual-hose post	\$9K-\$10K

Example Station	Assumptions	Cost Range
Fast-fill private fleet station serving up to 4 sedans/pickups fueling 10 gge/day	<ul style="list-style-type: none">• One 8-scfm (4 gge/hr) compressor• 5 psi inlet gas pressure• 3,780 scf storage (30 gge)• One single-hose dispenser	\$45K-\$75K
Time-fill private fleet station serving <ul style="list-style-type: none">• 2 utility service trucks fueling 20 gge/night or• 4 delivery vehicles fueling 10 gge/night	<ul style="list-style-type: none">• One 8-scfm (4 gge/hr) compressor• 5 psi inlet gas pressure• Two dual-hose posts	\$35K-50K

Example Station	Assumptions	Cost Range
<p>Fast-fill private station serving</p> <ul style="list-style-type: none"> • 15-25 pickups/delivery vans fueling 7 gge/day or • 9-16 taxis/work trucks fueling 12 gge/day 	<ul style="list-style-type: none"> • <i>One 40-75 scfm (19-24 gge/hr) compressor</i> • <i>5-15 psi inlet gas pressure</i> • <i>16,250 scf storage (129 gge)</i> • <i>One single-hose metered dispenser</i> 	<p>\$450K-\$600K</p>
<p>Time-fill private station serving</p> <ul style="list-style-type: none"> • 10-20 school buses fueling 10 gge/night, • 5-10 refuse vehicles fueling 20 gge/night, or • 15-20 city sedans fueling 7 gge/night 	<ul style="list-style-type: none"> • <i>One 20-50 scfm (10-24 gge/hr) compressor</i> • <i>5-10 psi inlet gas pressure</i> • <i>Ten dual-hose posts</i> • <i>One time-fill panel; 10-hour fueling window</i> 	<p>\$250K-\$500K</p>

Included installation costs are estimated @ 65% of equipment costs

Example Station	Assumptions	Cost Range
<ul style="list-style-type: none"> Fast-fill public retail station serving 50-80 light/medium-duty vehicles fueling 10 gge/day or Fast-fill private fleet station serving 45-65 taxis fueling 12 gge/day 	<ul style="list-style-type: none"> One 180-300 scfm (86-143 gge/hr) compressor 30 psi inlet gas pressure 34,000 scf storage (270 gge) One dual-hose metered dispenser 	\$750K-\$900K
<p>Time-fill private station serving:</p> <ul style="list-style-type: none"> 50-80 school buses fueling 10 gge/night, 25-40 refuse trucks fueling 20 gge/night, or 75-80 city sedans/pick-ups fueling 7 gge/night 	<ul style="list-style-type: none"> One 100-175 scfm (48-83 gge/hr) compressor 30 psi inlet gas pressure Ten to forty dual-hose posts One time-fill panel; 10-hour fueling window 	\$550K-\$850K

Included installation costs are estimated @ 65% of equipment costs

Example Station	Assumptions	Cost Range
<ul style="list-style-type: none">• Fast-fill large retail station serving light- to heavy-duty vehicles such as delivery vans, work trucks, refuse trucks, class 8 tractors, and local fleets or• Airport station serving light- and medium-duty vehicles such as taxis, shuttle buses, and local fleets	<ul style="list-style-type: none">• <i>Two 300-400 scfm (143-190 gge/hr) compressors</i>• <i>30 psi inlet gas pressure</i>• <i>55,000 scf storage (437 gge)</i>• <i>Two dual-hose metered dispensers</i>	\$1.2M-\$1.5M

Included installation costs are estimated @ 65% of equipment costs



**PHOENIX
ENERGY**



Presented by: Jeremy Talbot

Introducing:

**Phoenix Energy Corp, LLC
on Compressed Natural Gas (CNG)**





Phoenix Energy Corp

Phoenix Energy Corp, LLC



Phoenix Energy Corp, LLC Company Profile



President: Ken Hyde

Vice President: Matt Hyde

CNG Conversion, Refueling Equipment & Installation

With over 60 years of combined experience, the team at Phoenix Energy is uniquely equipped to offer you the latest and most comprehensive alternative fuel solutions. We are a leader in the alternative fuels industry in Alabama and the surrounding states—applying our years of hands-on fleet management into practice at every level, from customer service to training new generations of technicians.

PHOENIX ENERGY is a Registered Contractor For the Federal Government, Such as ARMY, NAVY, AIR FORCE, MARINE CORP or any federal entity.

Phoenix Energy Corp, LLC Technician Certifications

-ASE Certified

-CSA Certified

-Swagelok Certified

-IMPCO Automotive Certified

-Landi Renzo Certified

-FuelMaker Certified

-Ingersoll Rand Certified

-Bauer Certified

-ASPRO Certified

-ANGI Certified





Planning For A CNG Station

Phoenix Energy Corp, LLC



CNG Fill Station Considerations

- Station Size and Design Considerations
 - Number of vehicles per day
 - Fueling pattern of vehicles
 - Maximum daily flow
 - Maximum hourly flow
 - Available back-up fueling, redundancy?
 - Metering/Data/Payment needs
 - Amount of space available
 - Funding available



CNG Fill Station Considerations

- Land purchase or lease cost
 - Location, size of property, available utility services
- Site development, permitting and construction cost
 - Existing fuel site remediation, traffic/ improvements/changes, local codes & regulations, fencing, lighting, setbacks, labor availability/cost.
- Fueling equipment
 - Compression: Hp and sizing, required peak flow rates, inlet gas volumes/psi, electric drive or gas engine drive, amount of storage space available, controls
 - Gas dryers: projected volume and flow rates, inlet gas pressure and moisture content, manual vs automated regeneration
 - Storage: is it needed, if so what is balance between compression capacity and storage needs, peak reqs, cascade vs buffer, type of storage containers, space
 - Dispensers: number and type, flow rates, traffic flow,
 - Fuel metering/data capture, payment: is it needed, CCs/pmt cards, training reqs such as video (e.g. in CA)?

CNG Fill Station Cost Estimates

- Home Refueling (1 -2 Vehicles)
 - \$6,000 - \$9,000
- Small Fleet (3 – 5 Vehicles)
 - \$30,000 - \$40,000 (NO STORAGE)
 - \$45,000 - \$60,000 (WITH STORAGE)
- Medium Fleet (5 – 10 Vehicles)
 - \$80,000 - \$100,000 (NO STORAGE)
 - \$110,000 - \$160,000 (WITH STORAGE)

Cost Vary Based On Number Of Vehicles, Site Work, Engineering, and Code Requirements.



FuelMaker Refueling

Phoenix Energy Corp, LLC

FuelMaker Refueling

Phill Home Refueling Unit (1 Vehicle)

- 3600 P.S.I. Slow Fill Unit
- Can Be Installed Indoors
- Single Phase 240V Power
- Only 3 P.S.I. Of Inlet Pressure Required
- Produces ½ G.G.E. / Hr.
- Automatically Stops When The Vehicle Is Full



FuelMaker Refueling

FMQ-2 Refueling Unit (2 Vehicles)

- 3600 P.S.I. Slow Fill Unit
- Single Phase 240V Power
- Only 5 P.S.I. Of Inlet Pressure Required
- Produces 1 G.G.E. / Hr.
- Fill Up To 2 Vehicles At The Same Time
- Automatically Stops When The Vehicle Is Full



FuelMaker Refueling

FMQ-8 Refueling Unit (3-4 Vehicles)

- 3600 P.S.I. Slow Fill Unit But Can Be Utilized In A Fast Fill Refueling Station
- Single Phase 240V Power
- Only 5 P.S.I. Of Inlet Pressure Required
- Produces 4 G.G.E. / Hr.
- Fill Multiple Vehicles At The Same Time
- Automatically Stops When The Vehicle Is Full
- Ideal For Small Fleets




FuelMaker Refueling



FuelMaker Refueling





**For More Info,
Visit Us On The Web at
www.Phoenixenergycorp.net**



**Thank You For
Your Time Today!**





Medium & Large CNG Station Examples

Presented at:

DOE CNG Infrastructure Webinar

September 16th, 2014

Presented by:

Graham Barker

Eastern Regional Sales Manager

Corporate Background and History

- 1983 – Incorporated as Automotive Natural Gas Inc. (ANGI)
 - Over 30 Years in the Natural Gas Vehicle Business
- 1991 – 1st to package Ariel compressors for CNG
- 1997 – Purchased by Grimmer Industries, Franklin, IN. Name changed to ANGI International
- 2002 – ANGI Moves to New Factory in Milton, Wisconsin
- 2008 – Name changed to ANGI Energy Systems
- 2009 – Opened branch Office in Shanghai, China
- 2012 – ANGI Expands again to a New Facility in North America – more than 4 times previous capacity
- 2014 – Became a wholly owned subsidiary of Gilbarco Veeder-Root



Compression Experience

Summary of compression application experience by ANGI Energy Systems

HYDROCARBON GAS COMPRESSION PACKAGES

Typical Brake Horsepower	50 - 400 Bhp
Experience Range	10 - 800 Bhp
Discharge Pressure Range	Up to 5000 psig
Typical Packages	Engine & Electric Drive, Single & Duplex, Portable & Stationary Skids up to 65,000 lbs
Markets Served	Airports, Bio Gas, Convenience/Retail Stores, Delivery Fleets, Gas Producers/Distributors, Government Agencies, Owner/Operators, Refuse, Transit and Research & Development

Note: Data 2002 - 2012



Case Study

PA School Bus Fleet

Medium Size Station



Fleet Information

- 74 School District Owned School Buses in the Philadelphia Area, Typically Operating 180 Days Per Year With Some Reduced Usage In Summer Months
- Fleet Increasing In Age; 35 Buses To Be Replaced Over Next 3 Years So Decision Made To Replace With CNG Buses:
 - Year 1 Replace 14 Buses: $\pm 26,000$ DGE/Year
 - Year 2 Convert 11 Buses: $\pm 25,000$ DGE/Year
 - Year 3 Replace 10 Buses: $\pm 19,000$ DGE/Year
- Base Fuel Load 70,000 DGE/Year (± 390 DGE/Day)
- Expansion Design to 105,000 DGE/Year (± 585 DGE/Day)



Project Information

- The School District Obtained Grants From The State of PA Which Helped Pay the Incremental Costs for Both New CNG Buses and The Conversion of Existing Diesel Buses to CNG.
- Eastern PA Alliance for Clean Transportation (EP-ACT) – Formerly Called Greater Philadelphia Clean Cities – Assisted the District With Their Grant Applications.
- The CNG Station Construction Cost Was Rolled Into An Existing Energy Management Contract Provided To the School District by Johnson Controls.



Station Design - 1

- Fast Fill Design; Redundancy Required; Maximum 8 Hours Compressor Operation Assumed; 30 PSIG Gas Line Pressure Available; Dispenser To Tie Into Existing Diesel Fuel Management System.
- Using 135 SCF as 1 DGE Equivalent, **Minimum** Compressor Sizing Is Determined as Follows:
 - Base Design: $390 \text{ DGE} \times 135 \text{ SCF} \div 8 \text{ Hours} \div 60 \text{ Minutes} = 110 \text{ SCFM}$
 - Expansion: $585 \text{ DGE} \times 135 \text{ SCF} \div 8 \text{ Hours} \div 60 \text{ Minutes} = 165 \text{ SCFM}$
- Based On The Above, Two (2) 75 SCFM @ 13 PSIG Inlet, 50 HP Compressors Were Selected for The Base Design, With Expansion Capability To Add A Third Compressor When Necessary



Station Design - 2

- Major Station Components As Follows, In Order of Gas Flow:
 - One (1) Single Tower Inlet Gas Dryer With Onboard Manual Regeneration Sized for Three (3) Compressors
 - Two (2) 75 SCFM Compressors With Duplex Motor Starter Assembly
 - One (1) ½" Construction (Fleet Size) Priority Panel
 - One (1) Three Pack ASME Assembly - ± 35,000 SCF @ 4500 PSIG
 - One (1) Dual Hose Dispenser
- Major Station Design Requirements:
 - Compact Footprint
 - Low Noise Impact
 - Ease Of Maintenance
 - Aesthetically Pleasing
 - Utilize Existing Fleet Fuel Management System for Reporting



Station Construction Process

- This Project Had Some Unique Qualities And Requirements, as follows:
 - An Ongoing Contentious Relationship Between the School District And Local Residents, Which Added Time To The Process
 - The Need For Station Construction To Be Completed During The School Summer Shutdown, Which Required Extra Planning
 - Prevailing Wages Which Increase Construction Costs and Complicate Administration Process



Project Details

- Project Timeline:
 - May 2013: RFP Issued
 - July 2013: AGT/Oxford Engineering Selected For Design Build
 - August 2013: Conceptual Drawings Produced
 - August – November: Attend Two (2) Public Meetings To Provide Information To Residents
 - August – November: Attend Three (3) Open Planning Board Meetings To Respond To Questions/Comments From Residents
 - November 2013: Permits Obtained, Equipment Ordered and Construction Drawings Commenced
 - June 2014: Construction Commenced Once School Closed
 - August 2014: Station Operational For New School Year
- Project Cost:
 - Approximately \$800,000.00

Site Conditions Pre Construction - 1



Site Conditions Pre Construction - 2



Site Construction - 1



Site Construction - 3



Site Construction - 4



Site Construction - 5



Site Construction - 6



Site Construction - 7





Examples of Larger CNG Fueling Stations And Transit Stations

Retail Refueling Stations



- Kwik Trip Retail Locations
- 25+ Locations with 10 more in process
- Installed 2012 – present
- Up to 1500 SCFM (12 GGE/min) each station

Fleet & Public Fueling Station



- Time Fill of 120 Class 8 Tractors daily
- 10-15 DGE/min Fill Capability on multiple Fast fill hoses
- Installed 2013
- 4700 SCFM (34 DGE/min) Compression

Transit Refueling Stations



- Central Ohio Transit Authority (COTA) – Columbus, Ohio
- Designed for 100+ Buses
- Installed 2013
- 4000 SCFM (29 DGE/min) Electric Drive Compression



THANK YOU

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**MADE WITH PRIDE
IN THE USA**

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