CALIFORNIA AIR RESOURCES BOARD

Clean TRU Technology Webinar

August 31st, 2016
9:00 am – 11:30 am PST

PARTICIPATING MANUFACTURERS

AIR LIQUIDE · ELECTRIC · CleanFuture · BOREAS · Carrier · SHORepower · THERMO KING

Overview

- Current TRU Airborne Toxic Control Measure
  - eTRUs - Alternative Technology compliance option
- Going Forward
  - The Governor's Air Quality Goals
  - Sustainable Freight Action Plan
- Draft Concepts – Cold Storage Control Measure

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Governor's Executive Order B-32-15 Sustainable Freight Action Plan

- Governor's Executive Order B-32-15 link:
  - **www.gov.ca.gov/news.php?id=19046**
- Sustainable Freight Action Plan - adopted July 2016
  - www.arb.ca.gov/gmp/sfti/sfti.htm
  - Includes Cold Storage Control Measure for TRUs **www.arb.ca.gov/cc/cold-storage/cold-storage.htm**

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What Is the Focus of the New Control Measure for TRUs?

- Reduce GHG and criteria pollutant emissions (including diesel PM) by reducing stationary internal combustion engine operating time
- Types of activities to consider
  - Cold storage TRU operations at grocery stores
  - Over-weekend staging for Monday dispatch
  - Cargo box pre-chill operations
  - Time waiting for loading dock/labor (inbound loads)
  - Time waiting for driver and dispatch (outbound loads)
  - Rest periods (HOS)

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How Can Stationary TRU Engine Operating Time Be Reduced?

- Use effective logistics, scheduling, tracking, and dispatch procedures
- Plug into electric power grid while stationary
  - Hybrid-electric TRUs (or electric standby)
  - All-electric refrigerated shipping containers
  - All-electric stationary transport refrigerators

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How Can TRU Engine Operating Time Be Reduced? (cont'd)

- Use cryogenic transport refrigerators (liquid nitrogen, air, or CO_2)

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When Is the Implementation Time Frame?

- Start implementation in 2020
- Phases going out to 2030
  - Stationary Operating Time Limit - shorter over time
  - Time to turn over fleet
  - Time to install infrastructure

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Proposition 1B: Goods Movement Emission Reduction Program

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Proposition 1B: Goods Movement Emission Reduction Program

- Infrastructure
  - Electric power plugs for eTRUs - $30k for 10 plugs
  - Cryogenic infrastructure– up to $100k
- Diesel TRU replacement with zero-emission TRs
  - All-electric or fuel cell TRs – up to $50k
  - Cryogenic TRs – up to $100k to replace 5 TRUs

www.arb.ca.gov/gmbond

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Current 1B Funding Status

Local Agency	TRU Funds Awarded	Potential Funds Remaining
San Joaquin	$5 Million	$2 Million
Bay Area	$3 Million	$3 Million
South Coast	$1.5 Million	-
San Diego	$600,000	$600,000
Sacramento	$300,000	$200,000

Interested? Email gmbond@arb.ca.gov

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electric REEFER SOLUTIONS

Zero Emissions Reefer Solutions

ER 230 & 460

electricreefersolutions.com

electric REEFER SOLUTIONS

Zero Emissions Reefer Solutions

Electric TRU's :

- ER - 230
- ER - 460
- ER - 230/460

-20F to +90F Set Points
Bolt-in to any reefer trailer
Power via any 3 phase supply

electricreefersolutions.com

electric REEFER SOLUTIONS — Zero Emissions Reefer Solutions

Concept:

Recover / Repurpose existing diesel based TRU's

- Recycle "old" components

New Electric Copeland Scroll Technology

- No diesel engine
- No 12V DC components

Very High Value

- Quality & Performance
- Reliability (One PM Part)
- Low Cost to acquire
- Low Cost to run and maintain

electricreefersolutions.com

electric REEFER SOLUTIONS — Zero Emissions Reefer Solutions

Differentiators:

Voltage range & variants
Pure AC voltage
Phase detection
Overload protection
Cycling & defrost

electricreefersolutions.com

electric REEFER SOLUTIONS — Zero Emissions Reefer Solutions

Practicality / Support:

Manuals
Schematics
Parts Lists
Dealer Support
Website
Leading vendors – supply side

electricreefersolutions.com

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What you get:

Drastic Cost Savings

Green(est) - emissions

Immediate and practical

electricreefersolutions.com

electric REEFER SOLUTIONS — Zero Emissions Reefer Solutions

Who we are:

Electric Reefer Solutions (dba)
Thermo King dealer organization (since 1963)
Growth Increase (fuel cost & emissions)

Michigan / North American Reach

electricreefersolutions.com

electric REEFER SOLUTIONS — Zero Emissions Reefer Solutions

Just "call us"!

Thank You!

electricreefersolutions.com

THERMO KING

CryoTech

TIME TO CHANGE

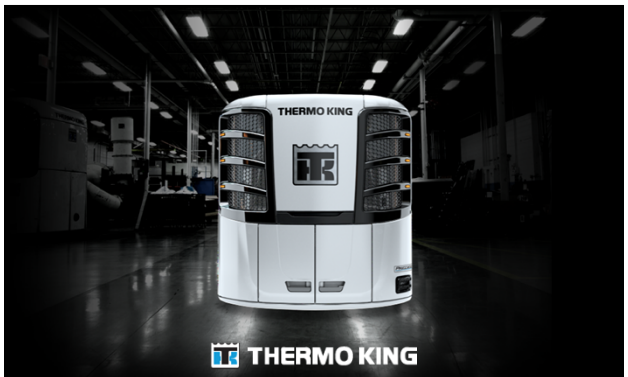
CryoTech

Single and Multi Temperature Refrigeration System for Truck &Trailer

PRECEDENT

SMART POWER

Ingersoll Rand



THERMO KING

PRECEDENT SMART POWER
Every Model Every Day

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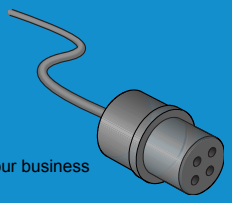
THERMO KING

SMARTPOWER™ ELECTRIC STANDBY PACKAGES



Plug into shore power options designed for your business

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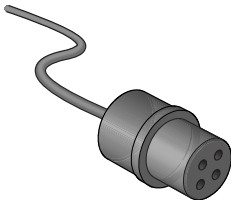
THERMO KING

SMARTPOWER™ ELECTRIC STANDBY PACKAGES

Extend your ability to run offshore power with three SmartPower options for Precedent. Simply select the voltage and capacity option that best fits your needs — then rest easy knowing all components are included in our major component warranty coverage.



- Standard SmartPower system maintains setpoint within the trailer and can be ordered in either 230V 3-phase or 460V 3-phase.
- High Output (HO) SmartPower option provides the capacity to pull the trailer to temperature on shore power and is available in 460V 3-phase.
- Multiple receptacle options are available for Precedent — chose to have the receptacle placed on the trailer nose, below the unit (standard location) or remotely located toward the rear of the trailer in either a Pin and Sleeve or Twistlok configuration.

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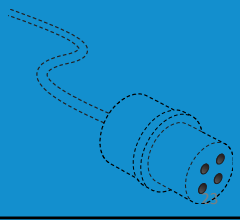
THERMO KING

SMARTPOWER™ PREP PACKAGES

Adapt for the future in less than 24 hours



SMARTPOWER™ PREP PACKAGE

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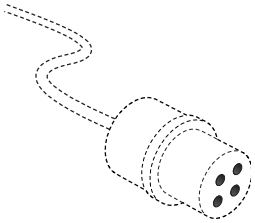
THERMO KING

When we built Precedent, we considered every option. That also means providing customers the ability to upgrade their units with our SmartPower Prep Package. Simply choose this option and when the time is right, a Thermo King dealer can convert your unit from non-shore power equipped to shore power equipped in less than a day.



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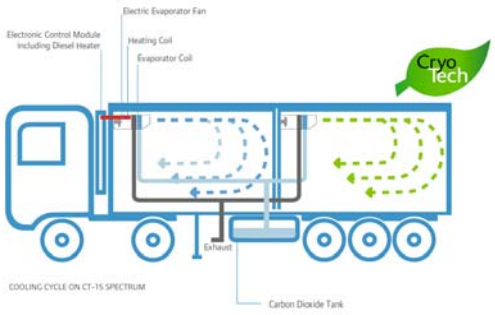
How does the system work?

THERMO KING



PLAY MOVIE

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Available models

THERMO KING

Models available for truck and trailer ranges, and single-temperature and multi-temperature applications (up to three temperature zones):

- CT-10 Truck
- CT-10 Spectrum Truck
- CT-15 Trailer
- CT-15 Spectrum Trailer
- All units available with S-2 and S-3 evaporators

CT-10 for Truck

CT-15 for Trailer

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Infrastructures Installations Types

THERMO KING

CryoTech advantages

THERMO KING

FEATURES	OPERATIONAL BENEFITS	ENVIRONMENTAL BENEFITS
EFFECTIVELY SILENT	• Access to inner-city zones for night-time deliveries - increased fleet utilization, reduced fuel consumption • Compliance with noise and truck engine idling regulations	• Driver and residents comfort • Reduced noise pollution • Less time spent in traffic - lower vehicle emissions
RAPID PULL-DOWN	• Increased vehicle usage • Increased distribution centre Productivity	• Lower emissions from vehicle engine
PRECISE TEMPERATURE CONTROL	• Enhanced temperature control and increased product shelf life • Reduced load loss under extreme conditions • Suitable for sensitive loads due to anti top-freezing control	• Reduced waste from spoilage
INNOVATIVE TECHNOLOGY	• Complements an environmentally responsible corporate identity • Life costs compare favourably with conventional technology	• No cumulative global warming effect from refrigeration • Powered by recycled natural refrigerant

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CryoTech advantages

THERMO KING

FEATURES	OPERATIONAL BENEFITS	ENVIRONMENTAL BENEFITS
ZERO DIESEL EMISSIONS FROM REFRIGERATION	• Fuel cost largely independent of oil price fluctuation • Compliance with current and future regulations	• Significantly lower carbon footprint
NO FLUORINATED REFRIGERANT	• Compliance with current and future regulations	• No refrigerants to dispose of • No ozone depletion or increase in green house • gas emissions
FEWER MOVING PARTS	• High reliability • Lower downtime and maintenance costs • Long life	• No lubricants or other hazardous waste to dispose of • Reduced noise pollution
FLEET MANAGEMENT	• Reduces operating costs • Increases security and reduces insurance risk • Increases truck/trailer asset utilization	• Reduces vehicle emissions

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Transport Refrigeration Unit Electrification *(eTRU)*

Carrier TRANSICOLD turn to the experts

August 31st, 2016

David Brondum

Director of Product Management and Sustainability

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United Technologies (UTC)

United Technologies

Fortune 50 company	197,200 employees	$56.5 billion in adjusted net sales

Source: 2015 UTC Annual Report (Amounts presented for 2015 have been restated to reflect results from continuing operations.)

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Our Brands

Iconic brands delivering the smart, sustainable solutions the world needs

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Carrier Transicold & Refrigeration Systems

Truck, Trailer and Rail	ISO Container	Food Retail	Food Service	Value Added

REFRIGERATE · MONITOR · TRACK · DISPLAY · PREPARE

ACROSS THE ENTIRE COLD CHAIN

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Carrier Transicold Applications

ISO Container

Trailer

Straight Truck

Domestic Container and Intermodal Trailer

Rail

Small Truck or Van

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Electric Standby: Greenhouse Gas Reduction

Infrastructure Availability	Established Technology	Common Use Worldwide

- Electricity everywhere
- Need correct form
- Renewable

- Commercially available
- Quantifiable benefits
- Simple technology

- Diesel fuel expensive
- More sustainable
- Lower noise

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Electric Standby Introduction

VECTOR eDRIVE

8500 · 8600MT · 8100

Single Temperature

Multi-Temperature

Stationary Cold Storage

SUPRA

560, 660, 760, 860, 960

Single and Multi-Temperature

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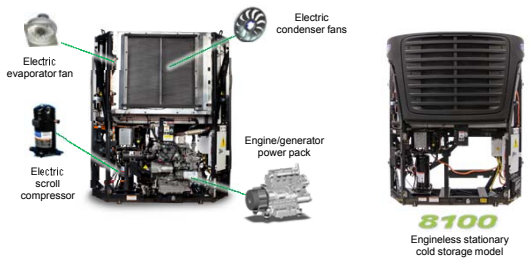
Vector Unit With Electric Standby

VECTOR

Integrated electric standby standard



Turns components on independently when they're needed. And off when they're not.

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Electric Standby Plug Configurations

Plug At Front

- ~20% of configurations
- Must handle long cord
- Concerns of cord damage
- Near glad hands
- Driver sees, disconnects before driving off

Plug At Rear

- ~80% of configurations
- Supported by trailer OEMs at additional cost
- Less cord handling and cord damage potential
- Less visible
- Employ strategies to prevent driver from pulling out cord

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Benefits

Estimated cost/hour at an average operating load

$2.10*

$1.15 per hour, or 55% savings

$0.95**

**Diesel: $2.85 per gallon* ***Power: $0.10 per kW*

- Typical savings: 40-75% per hour
- Diesel prices fluctuate
- Electricity traditionally stable

Diesel Fuel vs. Electricity Historical Price Fluctuations

Source: EIA

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Benefits

Maintenance Savings

- Most maintenance engine-hour based
- Reduces costs ~30% per run hour

Quieter Operation

- 5 to 6 dBA quieter
- "Significantly or noticeably" quieter
- Better sound quality

Lower Emissions

- Zero emissions locally
- In general, lower grid emissions than engine
- CA power: natural gas

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Benefits Noted In The Media

New England Produce Center (NEPC) Chelsea, MA

- 98 Vectors
- Save 268K gallons of diesel per year
- $590K annual fuel savings

Mile Hi Foods Denver, CO

- 37 outlets
- 21% reduction in engine hours
- $85K annual fuel savings

Witte Bros. Troy, MO

- 225 Vector units
- 20% reduction in annual fuel use

Maines Paper & Food Service Conklin, NY

- 33 Vector units
- $300K annual fuel savings
- Significantly less maintenance

Source: Press reports

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Multiple Compliance Benefits

Regulation *Compliant*

Airborne Toxic Control
(California >7 years)

Sustainable Freight
(GHG <40%)

Food Safety (FSMA)
Record Keeping Assistance)

Electric Standby
Telematics

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Summary

- Proven demonstrated technology
- Readily available infrastructure
- Stability vs. fuel prices
- Lower operating and maintenance costs
- Power company participation
- Regulatory compliance (GHG, noise, etc.)

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TRU Electric Power Plug Infrastructure:
Electrified Parking Spaces (EPS)

Clean TRU Technologies Webinar
August 31, 2016
John Thornton
Principal Consultant, CleanFuture, Inc.

About CleanFuture

Who
- Founded 2010
- Sustainable energy consulting firm
- Refrigerated fleet assessment & analysis
- Fleet fuel efficiency

What
- Refrigerated Fleet Operations Consulting
- Refrigerated Fleet Fuel Efficiency
- Idle Reduction Management Systems
- Project development for grants / incentives
- Training and support

About Shorepower Technologies

Who
- Founded 2004
- Leader in Truck Stop Electrification (TSE)
- 2,000+ connections, millions in infrastructure
- Deep industry experience

What
- Lead organizer – system integrator
- Design-build / turnkey solutions
- Equipment provider
- Technology provider
- Training and support
- SmartWay® Verified

Two companies providing TRU electrification solutions

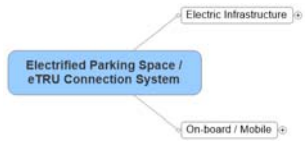
Shorepower Technologies
- Equipment
- Systems
- Design
- Technology
- Turnkey Solution
- Training & Support
- Financing

CleanFuture Consulting
- Consulting
- Fleet Operations Analysis & Assessment
- Electrification Assessments
- Project Development
- Grants & Incentives

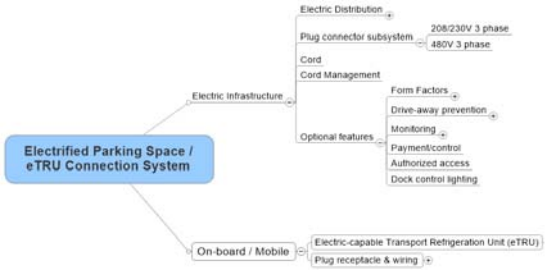
TRU Electric Infrastructure Example

TRU Electric Infrastructure Description

Electrified Parking Spaces
- Idle reduction technology
  - Dual-system electrification

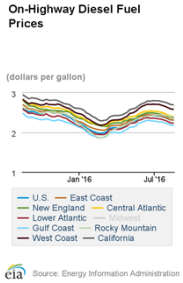


TRU Electric Infrastructure Description
Shore Connection System



What are the economics of electric standby with low diesel prices?

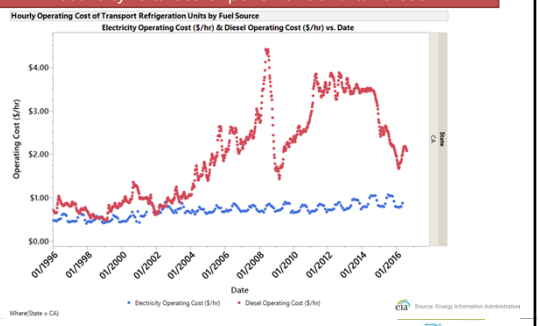
Short-term Diesel Prices



Long Term Outlook
- Diesel fuel prices are volatile and rising
- Electricity pricing is more stable
- Electricity is less expensive than diesel

Operating Cost per hour
Diesel vs. Electricity

Electricity is a less expensive fuel than diesel

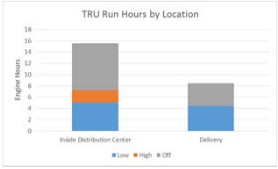


http://CleanFuture.us/eTRU_$perHour

eTRU Operating Cost Savings: 40-70%

Recognizing Fuel Savings Opportunities

- Stationary run during normal operation
  - Pre-cooling
  - Waiting to unload
  - Loading / unloading
  - Pre-delivery staging
- Pre-cooling too long
- Doors open too long while running
- Other



eTRU Summary

- Electrified Parking Spaces reduce costs by 40-70%
- Under-recognized opportunity to reduce fuel use
- Benefits
  - Cheaper
  - Cleaner
  - Quieter
- Commercially available

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Shorepower Technologies
jkim@shorepower.com
503-686-8844

CARB Clean TRU Technologies Webinar
August 31, 2016

- Who we are / What we do - JFE
- System Benefits
  - A Zero emissions system in use
- System Architecture
- Infrastructure
- Cost / Savings
- Contact Us

BOREAS
Nitrogen Cooling Systems

Who we are

JFE Industries LLC
Troy Michigan

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What we do

- Design, Develop, & Manufacture Products and Systems
- Market, Sell and Support

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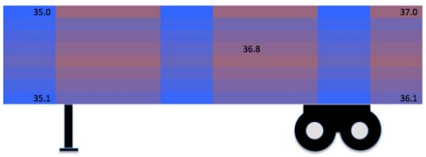
Boreas System

- Temperature Control Quality



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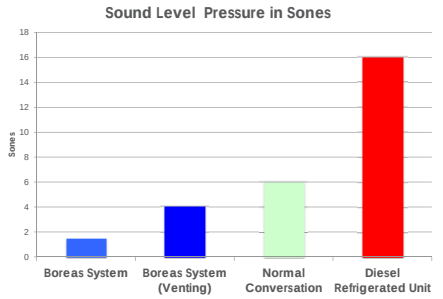
Boreas System

- **Noise Pollution**
  - **Boreas system is Virtually Silent**



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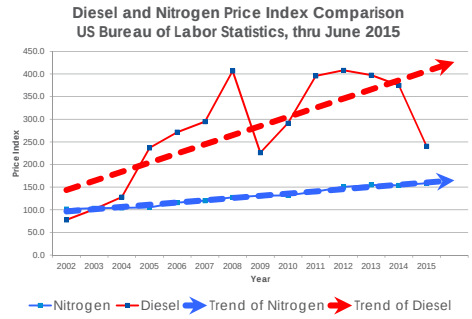
Boreas System

- **Stability of Fuel Prices**



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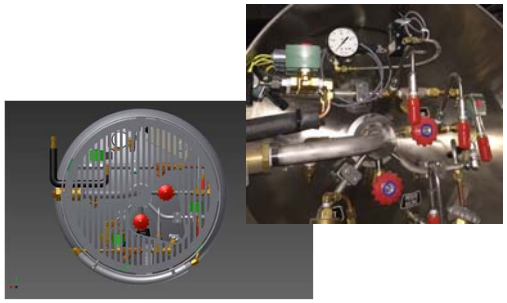
Boreas System

- **Reliability / Maintenance**



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Boreas System

- **Air Pollution**
  - Boreas System TRUs Emit ZERO CO2 During Operation
  - Boreas System TRUs Emit ZERO Criteria Pollutants Emissions During Operation

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Other Customer's Frequently Asked Questions

- **Safety**
  - Our track record – Zero incidents
    - 20,000 dock bumps
    - 8,000 routes
    - 42 systems in operation
    - Long term effects – None

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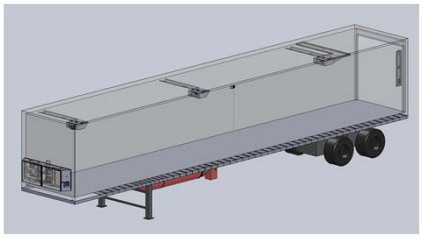
System Architecture



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System Architecture

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Other Frequently Asked Questions

- **Scalable Fueling Infrastructure**

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System Cost / Savings

- Price
  - Competitively priced with existing technology
    - Price based on quantity & trailer specification package
    - Typical payback 1-2 years
    - Payback of less than 1 year based on use model
- Performance
  - Tighter temperature control
  - Virtually no maintenance
  - Virtually silent
  - Fuel savings
  - Zero emissions in operation

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Contact Information

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Troy Mi 48083
586-940-1600
http://www.boreassystems.com/

Paul Scheil - Sales
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307 Robbins Dr.
Troy Mi 48083
248-256-6400
C. 248-978-8790
http://www.boreassystems.com/

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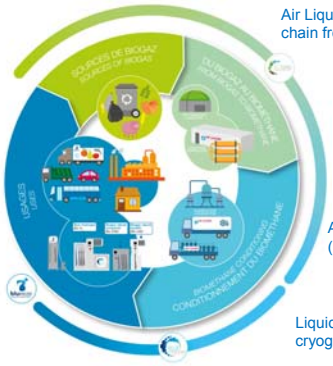
Air Liquide Advanced Business clean mobility offer



Air Liquide: present throughout the value chain from production to retail

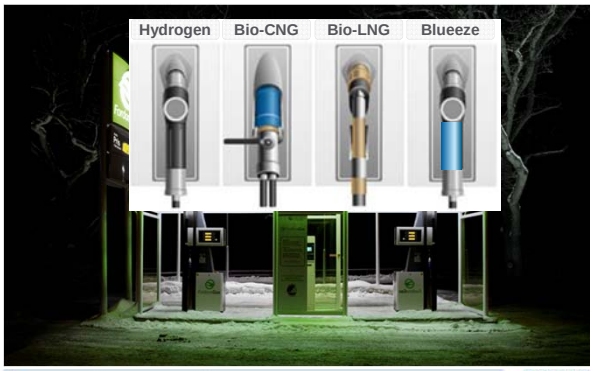
Bio-methane

Material handling (forklifts)

Alternative fuel retail: (Bio)GNV & H2

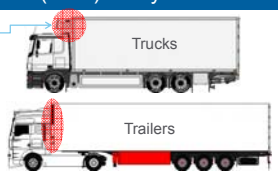
Liquid Nitrogen cryogenic Blueeze

Our vision : zero petrol & one-stop shop

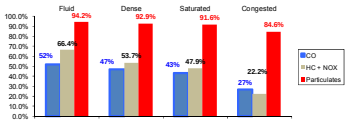


Transportation Refrigeration Unit (TRU) today

- **Today : autonomous diesel refrigeration unit**
  - Paradox = much higher local pollution than trucks & engines in urban deliveries
  - High carbon footprint (diesel + HFC)
  - Noisy especially during night deliveries or driver pause
  - Limited cold chain performance for urban deliveries (several doors opening) & when ΔT increases
  - Limited performance over the years



% of total local emissions of a refrigerated Euro VI truck coming from its diesel refrigeration unit only (Chilled +2°C temperature) - urban delivery



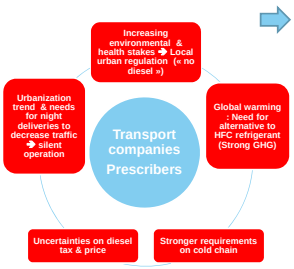
Euro VI : comparable in stringency to the US 2010 standards

Urban traffic (Max 50 Km/h)

Emissions of Euro VI truck with diesel TRU = Emissions of **17 to 20 Euro VI dry van trucks (up to 40 if frozen food)** !!

Cryogenics : Making sense in refrigerated transport

- **Today & tomorrow**

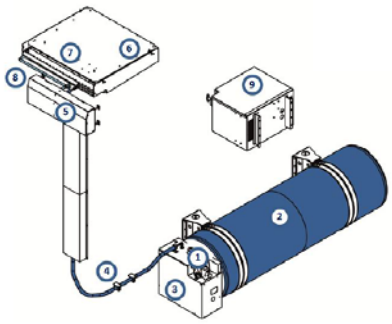


Nitrogen cryogenic value proposition

- No noise : ideal for night deliveries (higher productivity, lower pollution & higher truck usage rate)
- Nitrogen is natural, inexhaustible & harmless to the environment : NO pollution in operation (No particulates, Nox, No2, HFC…)
- Cryogenic performance (-196°C) : secure the cold chain especially with frozen food
- No combustion engine : little maintenance / higher availability & lifetime, consistent cold chain over the years.
- Nitrogen is locally produced
- Best combination with NGV

blueeze™ a breakthrough in refrigerated transport

Blueeze™ cryogenic cooling unit

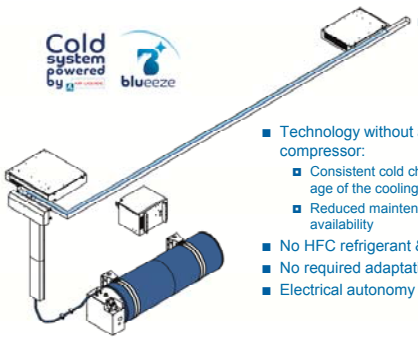


Cold system powered by blueeze

1. Filling connector
2. LIN tank
3. Valve box
4. Vac. Jacketed piping
5. Front side
6. Cold exchanger
7. Oxygen sensor
8. Nitrogen exhaust
9. Battery box

Mono-Temp version

Blueeze™ cryogenic cooling unit



- Simple and modular equipment without any wear parts
- Technology without a thermal engine and a compressor:
  - Consistent cold chain quality whatever the age of the cooling unit
  - Reduced maintenance & maximum availability
- No HFC refrigerant & related requirements
- No required adaptation to vehicle engine.
- Electrical autonomy with its own batteries

Multi-Temp version

Straight truck equipped with Blueeze

Liquid Nitrogen Tank capacity from ~ 114 to 246 gal
Overall length from ~ 87 to 117 in
Diameter from ~ 26 to 30 in
(shown here fitted on a truck fueled with Natural Gas)

Blueeze trailer

Nearly the same Blueeze system for Trailers vs. trucks :
- Usually 172 gal tank for truck & 246 gal for trailer
- User Interface in the cabin (truck), on the front face (Trailer)

Blueeze trailer

blueeze™ Nitrogen Filling Station

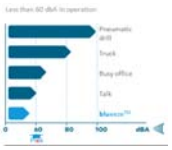
- blueeze™ Station :
  - Air Liquide investment
  - 24/7 service
  - Depending on country or location, usually does not require any specific authorization
  - From ~ 2 650 to 13 210 gal
  - Small surface area (160 x 160 in) with one dispenser
  - Possible extension with several dispensers & tanks as a stand-alone liquid nitrogen filling station or within a Natural Gas filling station.

blueeze™ within Air Liquide multi energy filling station

- Air Liquide multi-energy filling station :
  - (Bio) Compressed Natural Gas / (Bio) Liquid Natural Gas / Liquid Nitrogen
  - Simultaneous filling
  - A strong synergy in change management

Multi-energy filling station *(Example shown here in Europe)*

Local and GHG emissions



- No particulates, Nox & NO2 & No HFC refrigerant
- Carbon footprint decrease by at least 50% vs. Diesel Refrigeration unit (USA)
- Zero petrol solution when combined with Natural Gas Vehicle (NGV)
- Noise level ≤ 57dB in all conditions without compromise on cold chain.

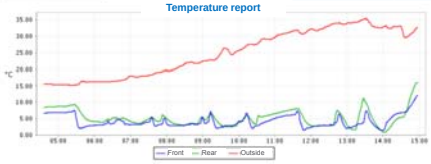
Cold chain at its best

- Up to 3x more powerful than a diesel cooling unit
- Maximum power available even if the engine is idle or switched off (anticipated loading, waiting periods before unloading, driver legal break, engine breakdown)
- Consistent cold chain whatever the age of the cooling unit
- Outside temperature has nearly no effect on cooling power
- Management of power according to needs

Evaporator	Cooling power (W) @ 32°F / 86°C outside	Cooling power (W) @ -4°F / 86°C outside
S	4 800	4 500
M	9 500	9 000
L = M+S	14 050	13 300

Chilled – 18 pallets truck – 10 deliveries

Temperature report



Safety

- Indirect injection of Nitrogen
- Gaseous nitrogen exhaust at the top of the cargo van front side
- < 3 bars operating pressure
- One oxygen sensor per evaporator
- Immediate stop, light & buzzer when O2 > 19%
- Automatic micro-leak testing.

Economics

- There could be some significant differences from one customer to another (climate, hours of operation, loading & unloading processes, chilled or frozen, type of goods, cargo van thermal efficiency & accessories…)
- Depending on customer operations, Blueeze may impact by few % on cost on delivery i.e. total cost of driver, Truck & TRU ownership and fuels when compared to diesel technology (North Europe situation).
- This additional cost will be quickly offset through usage rate increase thanks to night operations & market share gain.
- There is a much lower cost of maintenance & higher lifetime than conventional TRUs
- There is no doubt that higher volumes of cryogenic TRU sales will result in significant cost decrease.

Blueeze offer within a clean transportation offer

Natural Gas Vehicle (NGV) + Blueeze : Close to a Zero particulates solution !

Blueeze : best & logical add-on to Natural Gas for refrigerated transportation's market It solves conflict with diesel cooling unit's very high pollution & It Strenghtens Natural Gas advantages :

- Lower noise, (biogas) lower Carbon footprint & local emissions reduction
- Similar change management than with Blueeze (driver, maintenance…) especially with LNG (Liquid Natural Gas).
- Blueeze can combine with both Compressed CNG trucks and Liquid LNG trailers
- No impact on vehicle operating range.
- Better management of cold chain
- Liquid Nitrogen can be available within multi-energy filling stations Natural Gas / Nitrogen

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End of presentation
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