

Green Power Solutions



A **PACCAR** COMPANY

EPA Clean Air Excellence



Hybrid-Electric Vehicle



Liquefied Natural Gas



Clean Power System



KENWORTH

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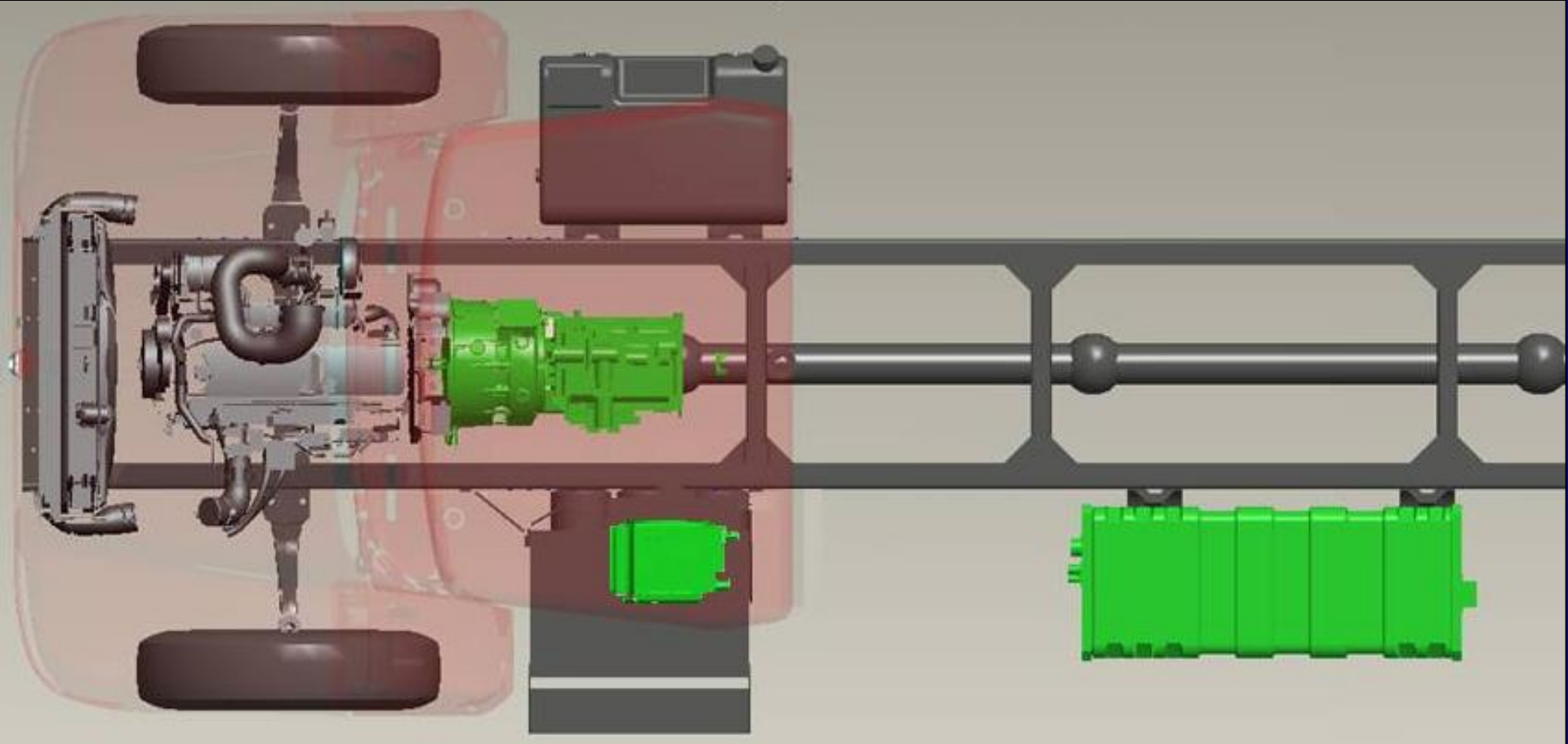


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Hybrid Technology



Straight Truck and Tractor



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Configurations

- Pick Up And Delivery or Beverage
 - Up to 33,000 lb GVW
- Utility W/ Engine Off ePTO
 - Up to 33,000 lb GVW
- Tractor
 - 55,000 lb GCW



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Environmental

- Vehicle Test Fuel Economy Improvement Of 30% to 50%
 - IRS Tax Credit Eligibility Obtained
- Corresponding Reduction Of Carbon Emissions



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Coca-Cola

Did You Know This
Hybrid Electric Truck
Helps Reduce Emissions
In Our City?



HYBRID
ELECTRIC
POWERED BY



07U410456

Coca-Cola Enterprises, Inc.

Hybrid
Electric
Truck
USDOT 152970

08B610850

Future Objectives

- Higher Capacity Energy Storage
- Higher Output Electric Motor
- Application Expansion
 - Medium-Duty
 - Heavy-Duty



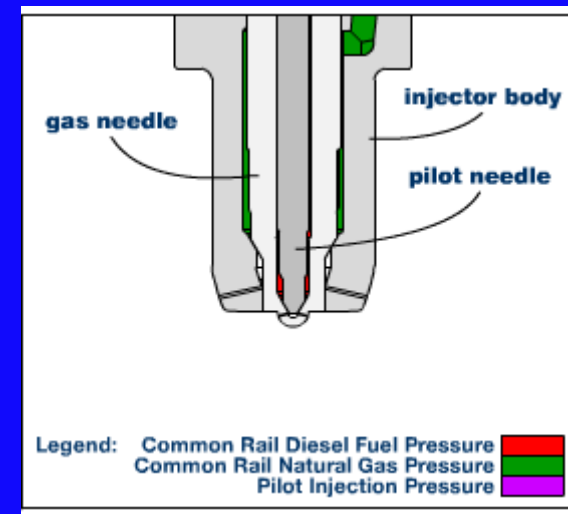
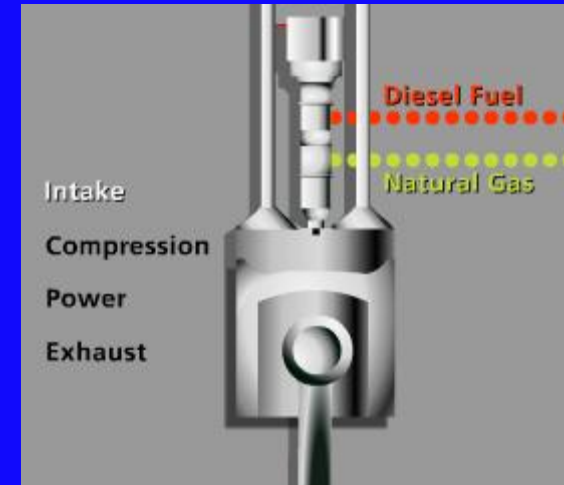
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Kenworth T800 LNG

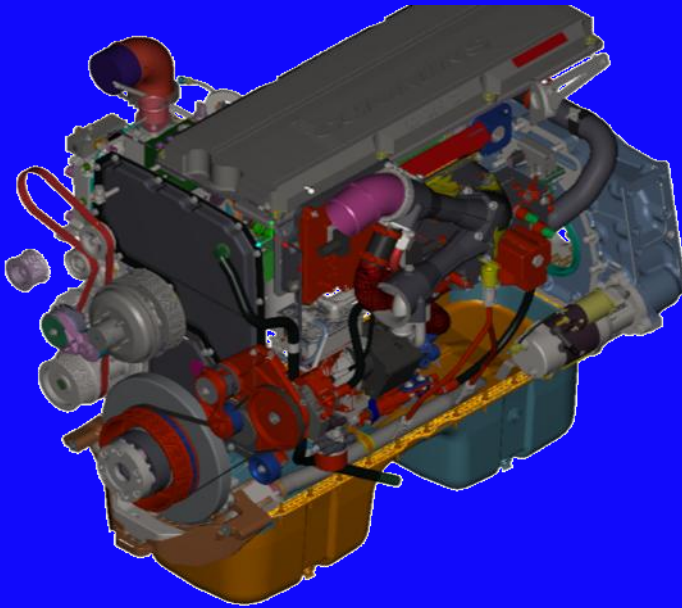


High Pressure Direct Injection Injector Technology

- Pilot Diesel Injected Just Prior To Natural Gas To Provide Ignition
- Natural Gas Injected At High Pressure At End Of Compression Stroke
- Low Diesel Usage Under All Conditions
- Diesel Engine Performance Remains
- Low Gaseous and PM Emissions
- Not Sensitive To Fuel Composition
- High EGR Tolerance



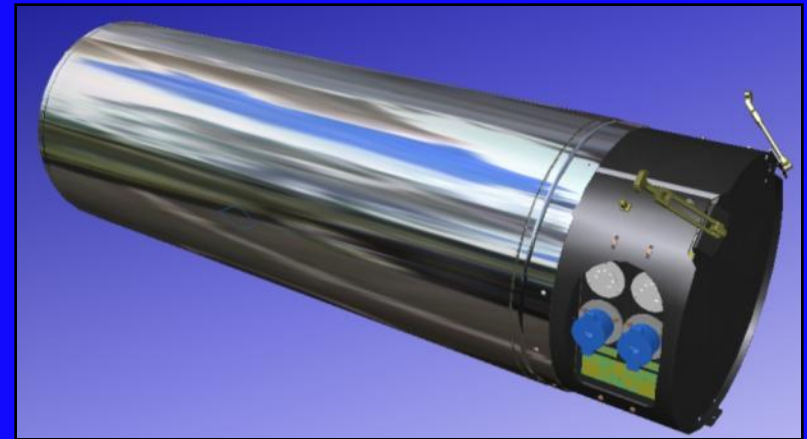
Primary LNG Components



Westport GX
Engine



Driver Display



Dual Walled LNG
Tank

Kenworth T800 LNG Configurations

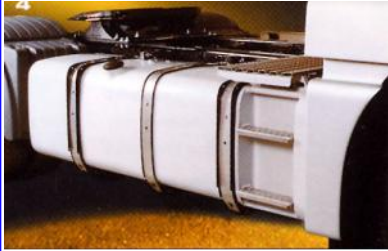
- 4 Different Configurations Are Offered
 - 2 Configurations With A Single LNG Tank
 - Equivalent to Approximately 52 Diesel Gallon Capacity
 - 2 Configurations With Dual LNG Tanks
 - Equivalent To Approximately 104 Diesel Gallon Capacity
 - A Small Diesel Tank Is Still Required



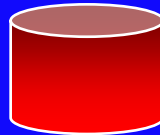
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Comparison of Volume

Diesel



Volume Per
100 mi



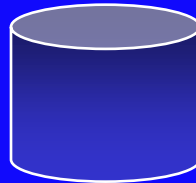
15 Gal.

Range Per
100 Gallons



650 mi

LNG



26 Gal.



380 mi

CNG



58 Gal.



170 mi

* Estimate based on 6.5 mpg diesel, and same efficiency for NG vehicle

LNG Filling



Environment

- The Westport GX Is CARB And EPA Certified
- Certified Emission Levels Are:
 - NOx = 0.8 g/bhp-hr
 - PM = 0.01 g/bhp-hr
- The Westport GX Offers An Emission Benefit Over Equivalent Diesel Engines
 - NOx benefit ~33%
 - Current Diesel Engines Certified To 1.2g/bhp-hr NOx
 - PM Consists Of Less Diesel Particulate
 - Green House Gas Benefit ~20%



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Customer Considerations

- Ideal Customers
 - Return To Base Or Fixed Route Fleets
 - Have Refueling Available On Route, Or
 - Have Space To Place A Temporary Or Permanent Fueling Station On-Site
- Training Required
 - Fueling And Servicing



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Target Applications

- Ideal Applications
 - Municipalities (Dump Trucks, Roll-offs, Crane Trucks, Water Trucks, Etc.)
 - Local Distribution
 - Food, Beverage (Regional Store Delivery), Chemical, Cryogenics, Tankers, Green waste, Etc.
 - Port Drayage
 - Line and Regional Haul
 - Trash Transfer
 - Bulk Haulage Operations



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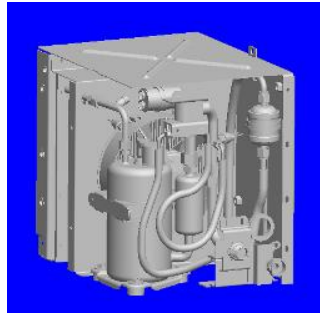
Why LNG?

- Why change to natural gas?
 - More Abundant Domestic Fuel
 - Energy security
 - Lower Cost Fuel
 - Operating cost saving
 - Lower NOx
 - Improved Air Quality
 - Low Carbon Fuel
 - Lower Greenhouse Gases



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Kenworth Clean Power System



Compact A/C Charge Unit



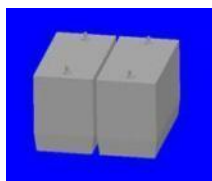
Efficient LED Interior Lighting



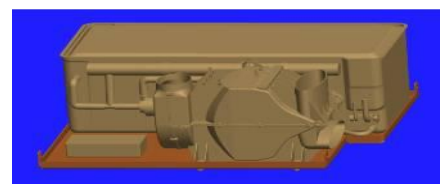
Enhanced Insulation Package



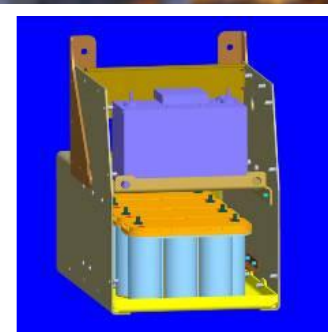
High Power Alternator



Starting Batteries



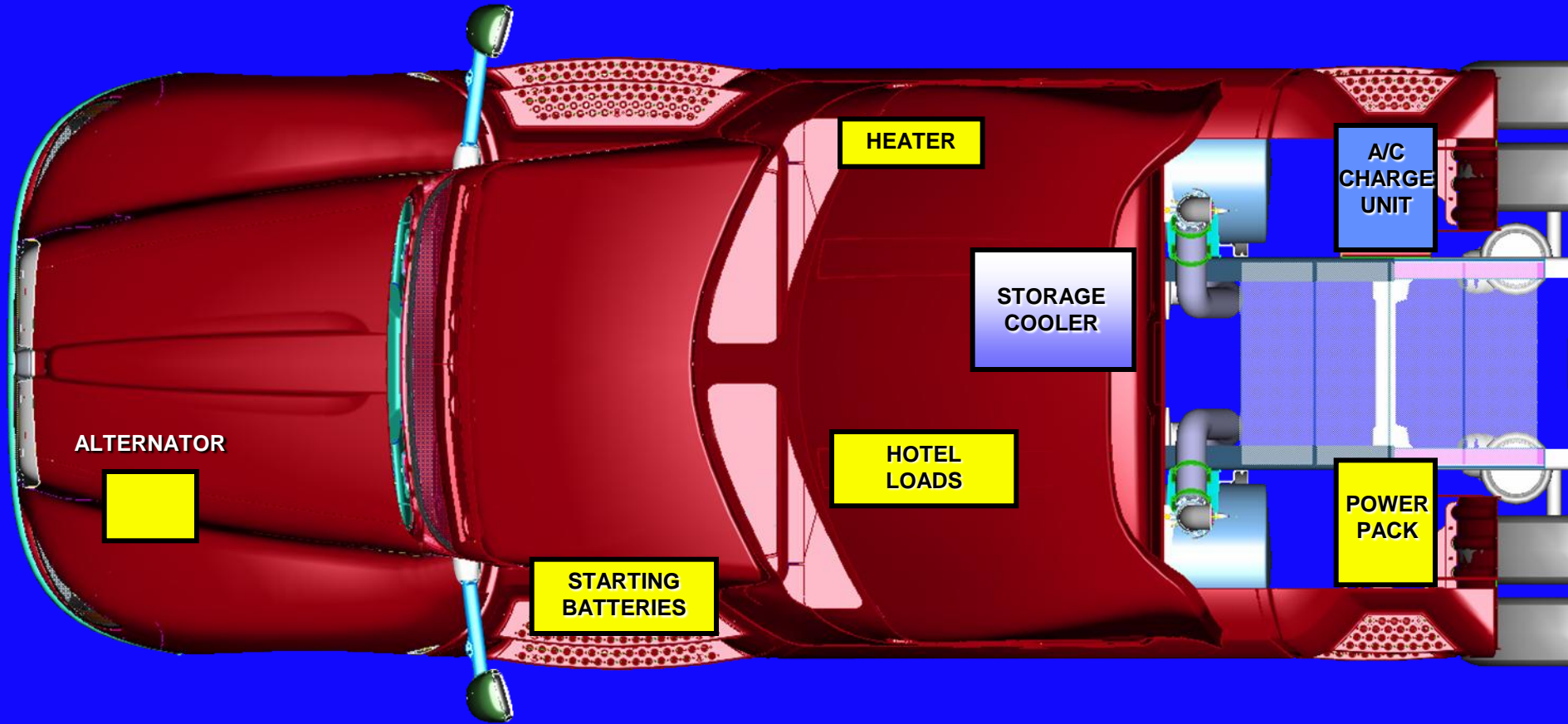
A/C Parking Cooler



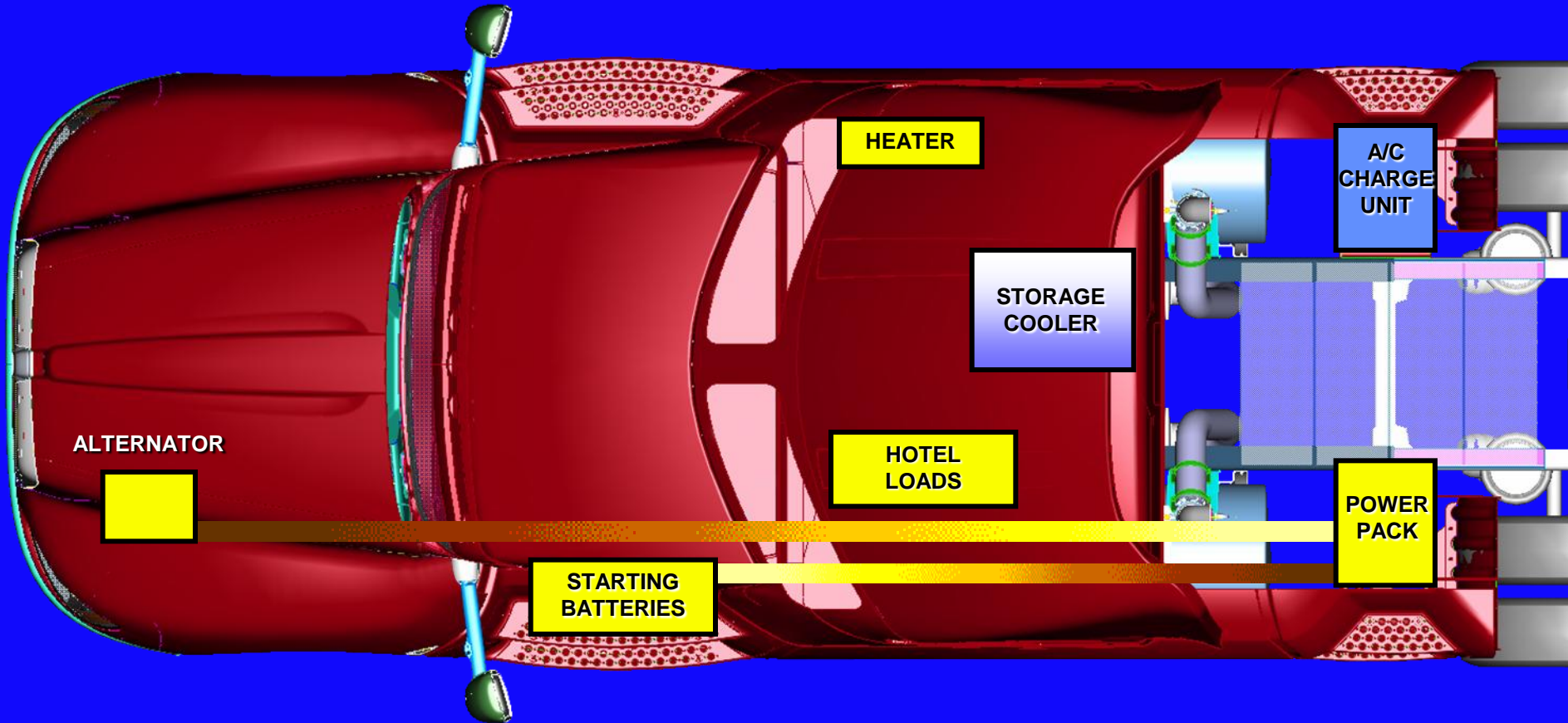
Energy Efficient Power Pack



Kenworth Clean Power

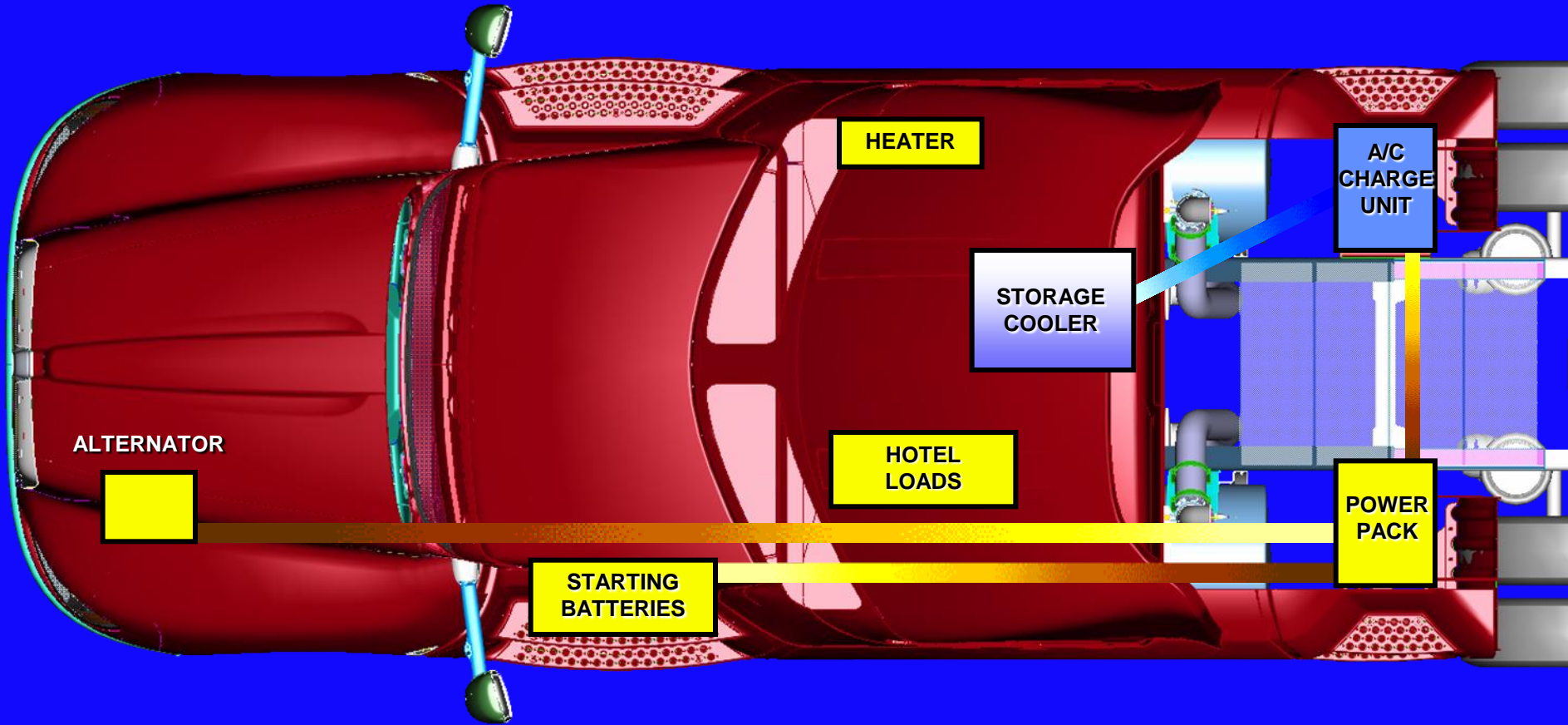


Kenworth Clean Power



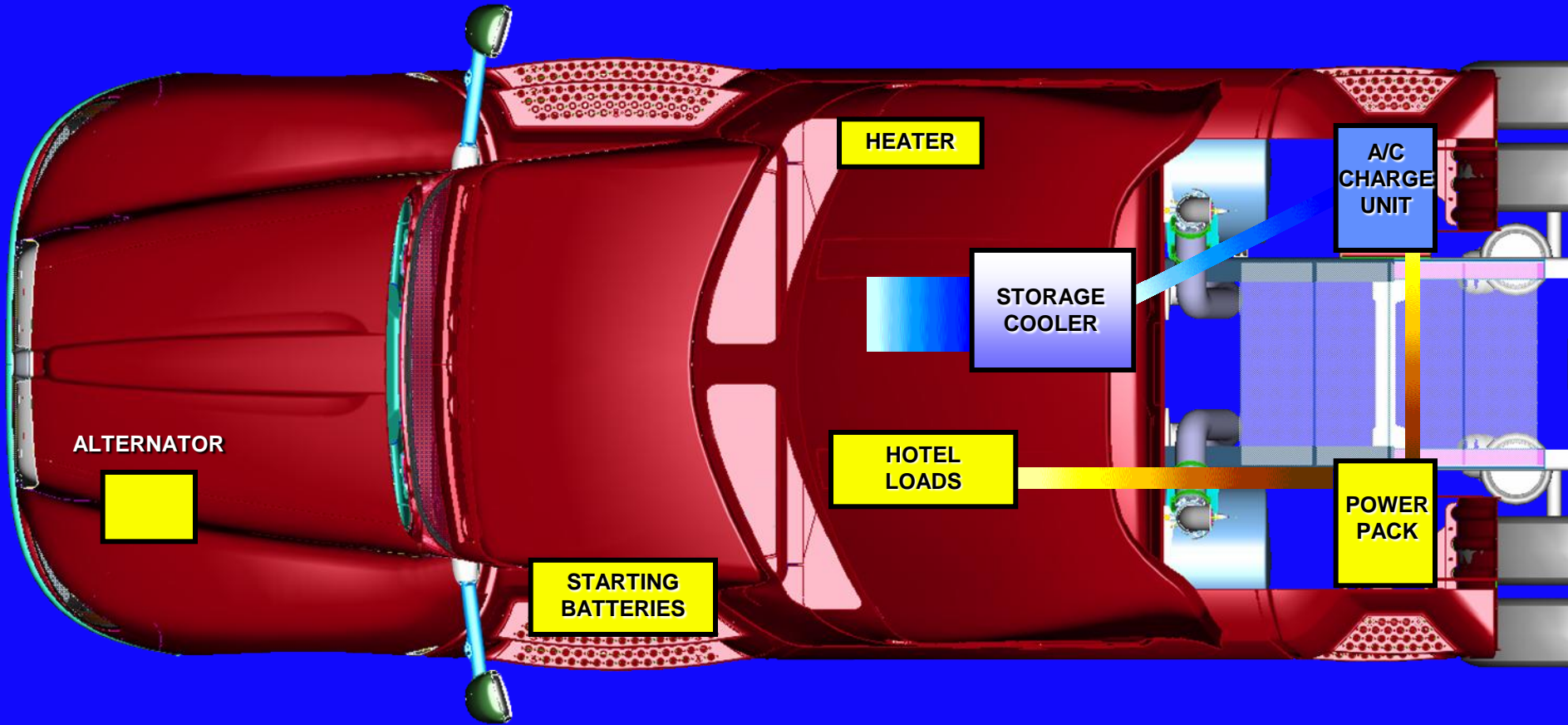
TRUCK RUNNING – STORAGE COOLER CHARGING

Kenworth Clean Power



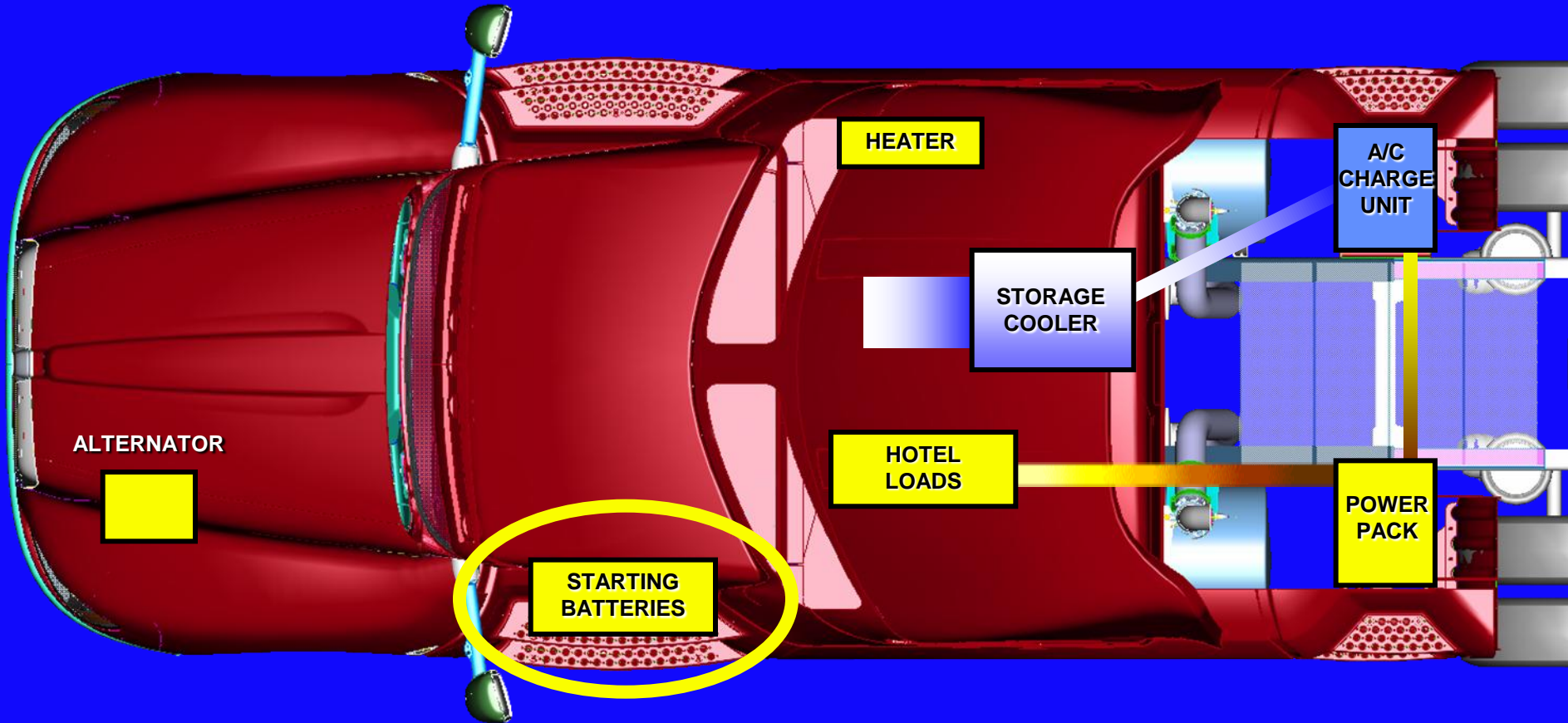
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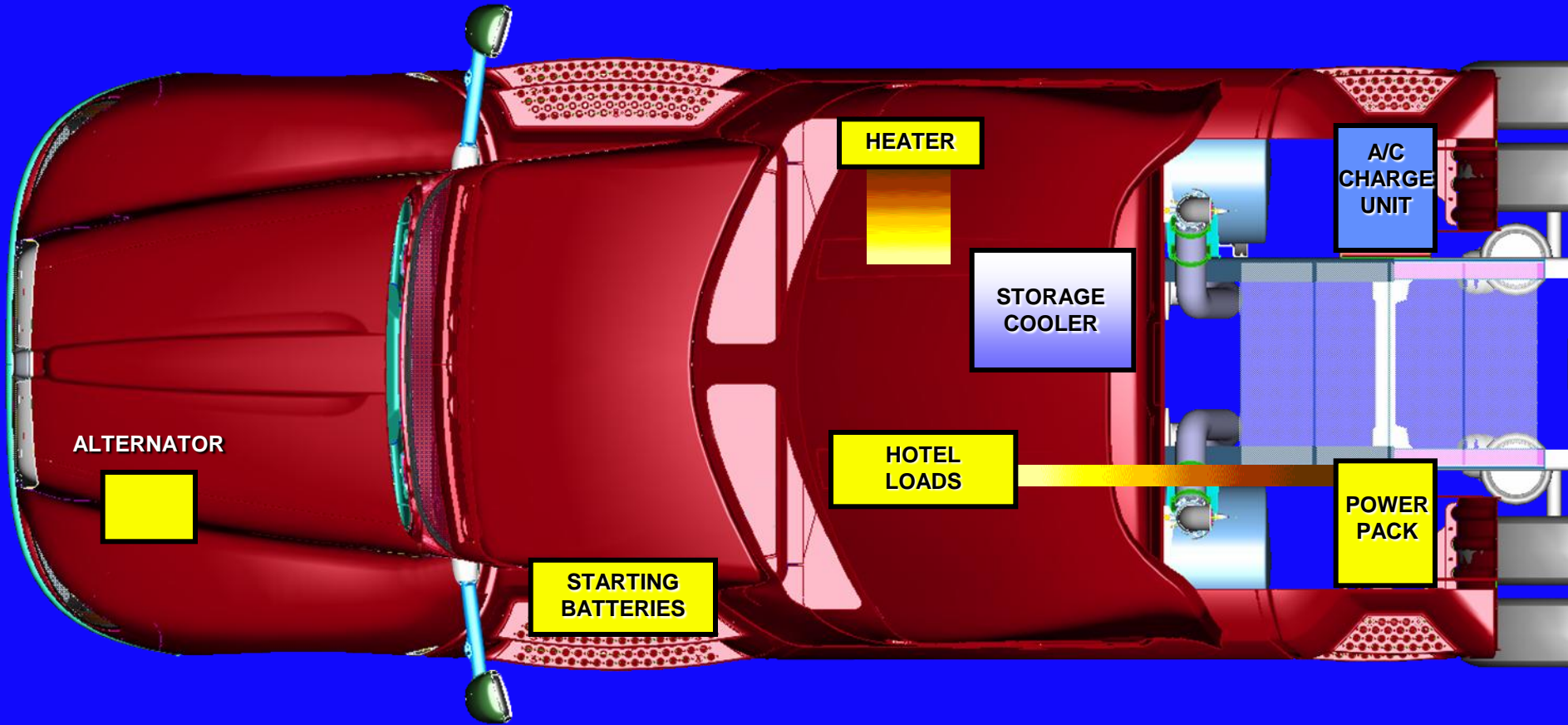
TRUCK STOPPED – STORAGE COOLER OPERATING

Kenworth Clean Power



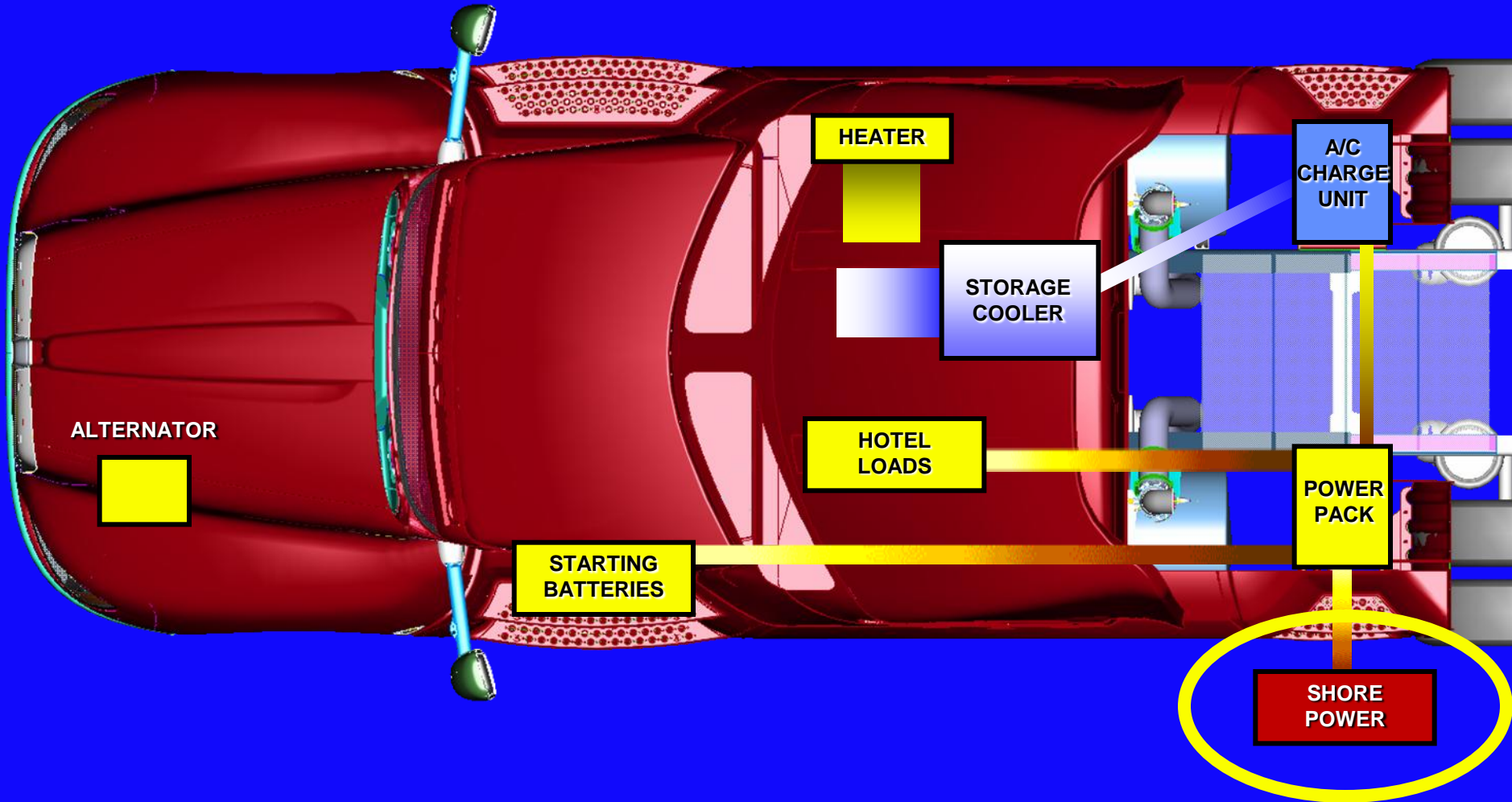
TRUCK STOPPED – STORAGE COOLER OPERATING

Kenworth Clean Power



TRUCK STOPPED – HEATER OPERATING

Kenworth Clean Power



TRUCK STOPPED – SHORE POWER ENGAGED

No-Idle System Performance Comparison

	Kenworth Clean Power System	Diesel APU
A/C & Hotel Load Performance	10+ Hours	Unlimited
Shore Power	Yes	Varies By Model
Enhanced Insulation	Yes	No
Efficient LED Lighting	Yes	No
Emissions Compliance	Fully Compliant	DPF Required for CARB 2008
Diesel Used	0	Yes



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Moving Forward

Research is the transformation of money to knowledge



Innovation is the transformation of knowledge to money

Consequences:

- Research is a necessary but not a sufficient condition for innovation
- Economic value is only created by successful innovations
- Business strategy drives R&D strategy

Source: Siemens



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Application of Technologies



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Technology Implementation

- Optimize
- Performance
 - Work Done, Fuel Used, Time Required
- Cost
 - Initial, Operating, Resale
- Operation
 - Driver Interaction, Weight, Support
- Regulations
- Company Image
- Profit



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Eco-nomics

- Spec'ing A New Truck To Run Efficiently Is A Balance Between Performance And Economy

Fuel Economy

Performance



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Spec'ing

- Know Customer Needs And Expectations
- Appropriate Aerodynamic Components
- Efficient Drivetrain
- Efficient Trailer/Body Configuration
- Driver Involvement
- Maintenance



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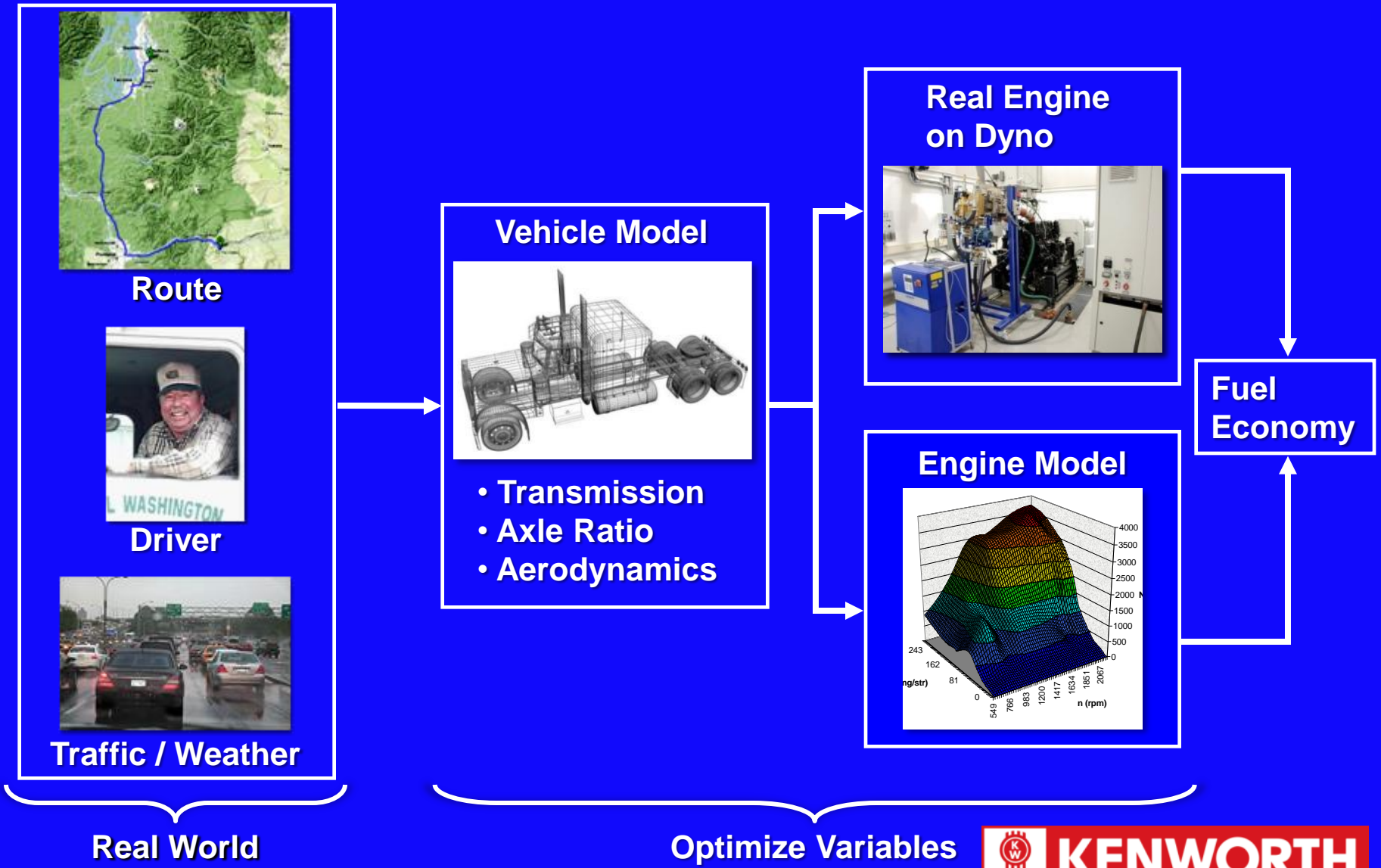
Applying The Right Tool

- Hybrids – Duty Cycle Dependent
- Waste Heat Recovery – High Heat Loads
- Low Rolling Resistance Tires – High-Speed Miles
- Aerodynamics – Speed/Frontal Area Relationship
- Impact On:
 - Payload, Frame Space
 - Wheelbase, Trailer Gap, Trailer Type
 - Bodies, Auxiliary Devices and Equipment
- Optimized Cruising Speed, Operating Area



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Vehicle Performance Simulation



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Thank You



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