

# Expanded Features and Benefits with Compound Electric Hybrid (C-E-H)

## NO INFRASTRUCTURE CHANGES - NO PROBLEM!

The ability of a truck to travel through the Midwest and switch solely to electricity when entering small-town America will bring smiles to the residents' faces. These truckers not only deliver the goods for their homes and businesses but also show themselves as friendly emissaries shaping the future dreams of children who admire them while they pass by the schools. Some of those kids will aspire to drive these new high-tech trucks one day. Show and tell for the kids at school when a truck stops by will be very exciting!

The greatly extended range of a Compound Electric Hybrid (C-E-H) capable of over 2,800 miles between fuel-ups and plugging in, makes planning pit stops smarter and more cost-effective. Fleets can now strategically plan to grab the best deals available and use the type of fuel they prefer. And thereby maximize this ultimate PHEV (Plug-in Hybrid Electric Vehicle) fully leveraging electrical co-generation and battery storage.

The C-E-H will encompass any advancement in:

- Fuel types and deliveries
- Electrical advancements in Motors and Batteries
- Engine types for varying Fuels

## POWER OUTAGE – NOT A PROBLEM! (THE CO-GENERATING PARADIGM SHIFT)

*>> You are going to generate power somewhere ...  
Why not generate it with a truck?*

Considering these trucks as a part of the Co-Generating power providing programs in the USA marks a significant shift – from merely viewing them as consumers of power. By upgrading these big rigs to be the C-E-H highly efficient status, their energy conversion and utilization can be compared very favorably to all other sources of energy delivery and consumption by long haul freight Trucks. The C-E-H upgrade also enables very nicely the quest by engine manufacturers aiming to introduce 50% and up to 60% thermally efficient engines. These manufacturers can not only plan that their engines will continually operate at



the Best-Efficiency-Point, but also choose the fuel type from any mix of fuels with renewables available.

These technological advancements tip the scales of carbon grams per mile per ton of freight in their favor - when compared to other long-haul options like BEV's, which rely on US grids that also burn fossil fuels to generate electricity. Naturally, this comparison must encompass a comprehensive Life Cycle Assessment (LCA) of the carbon footprint from every component involved. That includes mechanisms, systems, batteries, and all processes from the energy source to the truck, encompassing delivery and related functions that go over lines or pipes. This thorough LCA is crucial for an accurate comparison of the carbon footprint since it is not solely about what comes out of the tailpipe. This concept is clearly illustrated in the paper available at the link [ATRI](#), and depicted there on pages 18 to 29. Also shown in its summary here on this [link](#). Additionally, these papers show technological advantages that go beyond BEV's.

As a bonus, if coupling the trucks with solar panels on their trailers - you tilt the scale further in their favor. In essence, these trucks have now become an investment step in clean power production!

## CATCHING MORE DRIVERS – ENJOYING THE JOURNEY!



Attracting good people to become excellent drivers and pilot these big rigs is a primary goal for fleets. Besides the High-Tech allure, and Zero Emissions (which is very attractive), there is also no more manual shifting involved. This means operating the truck is easier and safer, as well as more interesting - being on the cutting edge. Also, no more fretting when on steep grades at stops; this truck won't shudder and shake or require fancy dancing with the clutch to start each gear like the old trucks do. These C-E-H upgrades will just smoothly accelerate at the pace desired even in electric-only mode – whether going forward or reverse. And whenever parking for a break – the electric mode keeps all the hotel amenities inside the truck very enjoyable.

So for a variety of potential drivers who might not have considered truck driving as their end game career – this now becomes very interesting. By reducing the physical effort required to operate as well as

aligning with other technologies such as partially autonomous functions and the current high-tech safety features – these all transform driving a truck to be more like other professional pilots and

captains. And the integration creates a sense of camaraderie among drivers who have the same tech at their fingertips. Drivers will boast about how environmentally friendly their work is and enjoy the journey!

## THE OEM ADVANTAGE WITH CORNERSTONE SYSTEMS

Only a few sizes of computer-controlled C-E-H transmissions (the HST) with their infinite ratios, would then suffice for numerous applications. One size alone can replace hundreds of geared or automatic transmissions for trucks, streamlining their configurations and allowing more repetitive manufacturing. Geared transmissions, with their hundreds of variations to adapt to different loads by changing up gear ratios and their controls, highlight the significant advantage of this C-E-H to leverage for manufacturing and sustainability. These transmissions are also sustainable as they can be completely rebuilt and resold.

Similarly, now high-efficiency engines can be used across multiple applications within their power output category, because the Hydrostatic Transmission and final drive gears can cover and accommodate the variety of unique torque and rpm load requirements in each application. This HST eliminates the need for the engines to have a torque curve that accommodates revving up and down between gear shifts. No longer the need to pick up the slack between gear ratios - designing engines free of this shackle means higher efficiency can be obtained.

Just like with electric motors, these refined fuel engines become smaller faster, using less resources, which significantly reduces their carbon footprint and makes them more sustainable.

With the focus on going up to 60% efficiency for ICE engines, adapting to the C-E-H drivetrain is simple and doesn't require a specific engine torque output. Once an engine reaches the desired power size for a particular fuel, the transmission and final gearset adjust for all various application torque needs that will be using this engine.

This significant manufacturing advantage is that it doesn't necessitate engine variations for various applications. Smaller and lighter engines can handle more significant, varied, and tougher tasks. Thanks to Infinitely Variable ratios, the chosen Final Drive gearset suffices for any vocational application. The C-E-H will be paired with a final drive gear selection based on the truck type, load, axle, speed and duty cycle required.



Moreover, retaining the current available configurations of drive train axles and drivelines allows existing manufacturing plants and their equipment to continue with the latest refinements and investments made thereby promoting sustainability.

The corresponding fuel engines will increase their longevity in truck use, and their fuel economy, as a result from less rpm cycling and more consistent high-efficiency operation. The electric motor will more efficiently handle fluctuating power demands from road terrain and traffic, reducing fuel engine cycling and low-speed operation, utilizing battery electric power during low-speed times.

## INTEGRATED FLEXIBILITY – IMAGINATION IS THE LIMIT!

The Compound Electric Hybrid easily serves multi-function uses, including firefighting, cranes, construction equipment, and vocational trucks like concrete mixers and refuse trucks. By implementing more than one HST motor at the different load functions – they can all be working off a common prime mover. Also, for lighter duty implements an electric motor can run those ancillary functions - and the C-E-H will keep the electricity flowing to the batteries. This approach avoids specialty vehicles requiring multiple engines onboard, resulting in tremendous savings and greatly reducing the adverse environmental impact. All these functions of course can be operated separately or simultaneously providing the greatest flexibility - with full power always available. For the greatest sustainability.

Moreover, the fuel engine can be vertically positioned as on the back end of a bus or motor home, or placed sideways like seen in many compact cars. Since there are flexible hose connections between the prime mover and the vehicle final drive - this allows **any orientation** of the prime mover engine to accommodate vehicle characteristics that maximize efficiency and use.

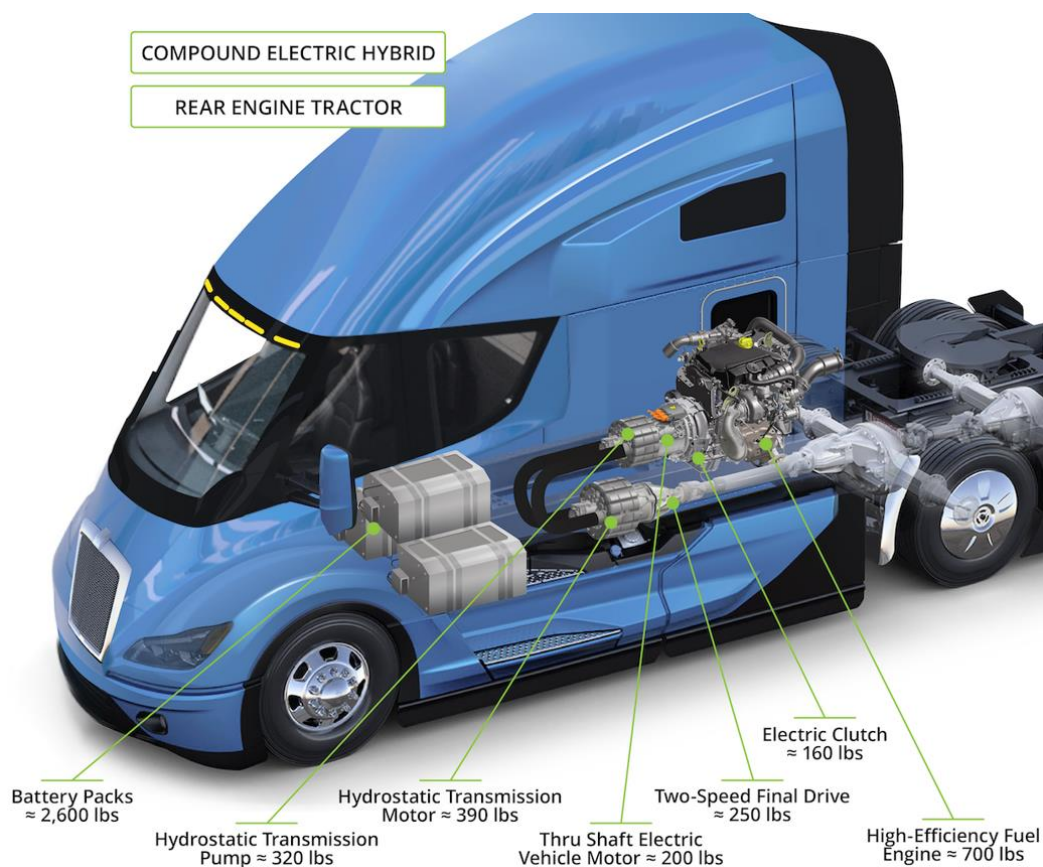


Specialty applications with multiple prime movers and final drives can be adapted to specific designs (such as for mining operations and military). For instance, powering multiple wheels or track drives with separate HST motors to each wheel or track is easily feasible. The ability to control the amount of power to each track-drive is done by sensors deriving torque and rpm using fluid pressure and actuator displacement - and then adjusting those functions as required.

Quieter engine possibilities are viable, utilizing higher rpm and lower torque to work with the C-E-H ensemble. Integration with other energy storage devices, like flywheels and accumulators, can cater to specific application designs as desired.

The combustion engine can be started by the electric motor of the power source for efficiency since they are in-line connected through a clutch. And the HST can accommodate with zero displacement position for the time of this function.

Combining power management with Topography-capable GPS Route Planning Technology will significantly boost long haul fuel efficiency by optimizing use of battery power potential and recharging capability. Electricity from batteries can be fully utilized to help power up a hill, followed by the Hybrid system recharging the batteries on the descent. This cycle repeats for consecutive hills and maximizes fuel efficiency.



## The Big Snooze! - Taking Advantage of Congestion

In a recent paper with analysis by the American Transportation Research Institute ([ATRI link](#)), the staggering loss of 1.27 billion trucker work hours due to congestion in 2021 was exposed. ATRI's estimate also revealed an astounding 6.7 billion gallons of diesel wasted during these idle periods of near standstill traffic. However, if envisioning a solution where drivers, equipped with Compound Electric Hybrid (C-E-H) technology and new autonomous driving features, they could make the most of these congested situations.

By engaging the autonomous electric mode within the C-E-H setup, drivers could leverage this downtime to fulfill their legally required rest breaks while navigating through slow-moving congested traffic, often crawling along at speeds of fewer than 33 miles per hour (regulations may vary by state).

The substantial energy squandered during idle times or in low-power-demand scenarios, such as traffic jams or freight loading and unloading, could be effectively mitigated by seamlessly transitioning to Electric Only Mode. This transition shuts off of the fuel engine, for no tail pipe emissions.

Gone would be the emissions generated during idling or traffic snarls, especially in urban centers and crucial port and harbor areas. The implementation of such technology presents an opportunity not just to work through congestion-related issues but also to curtail environmental impacts, utilizing those periods of stagnation with much more efficiency.