



Maximizing Power from the Stock Alternator Using a Practical Constant Speed Drive

Fallbrook Technologies Inc.



- **Small Business**
 - Delaware C Corp.
 - < 60 employees
- **Company Footprint**
 - Headquartered in San Diego, California
 - Engineering center based in Austin, Texas
 - Branch sales office in Detroit, Michigan
 - Manufacturing in Leitchfield, Kentucky
- **Fallbrook is the Company, NuVinci is the Brand**



What Is The Problem With Engine Driven Accessories?

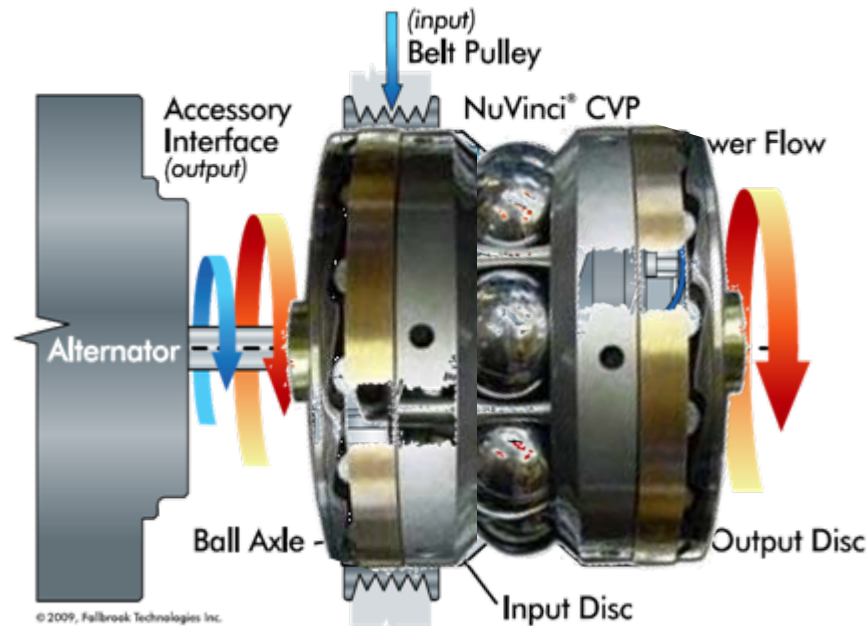
- **Accessory Speed Is Tied To Engine Speed.**
- **The Impact to the Alternator is Measurable.**
 - Lower Power at Idle: Alternators do not make their rated electric power, while idling.



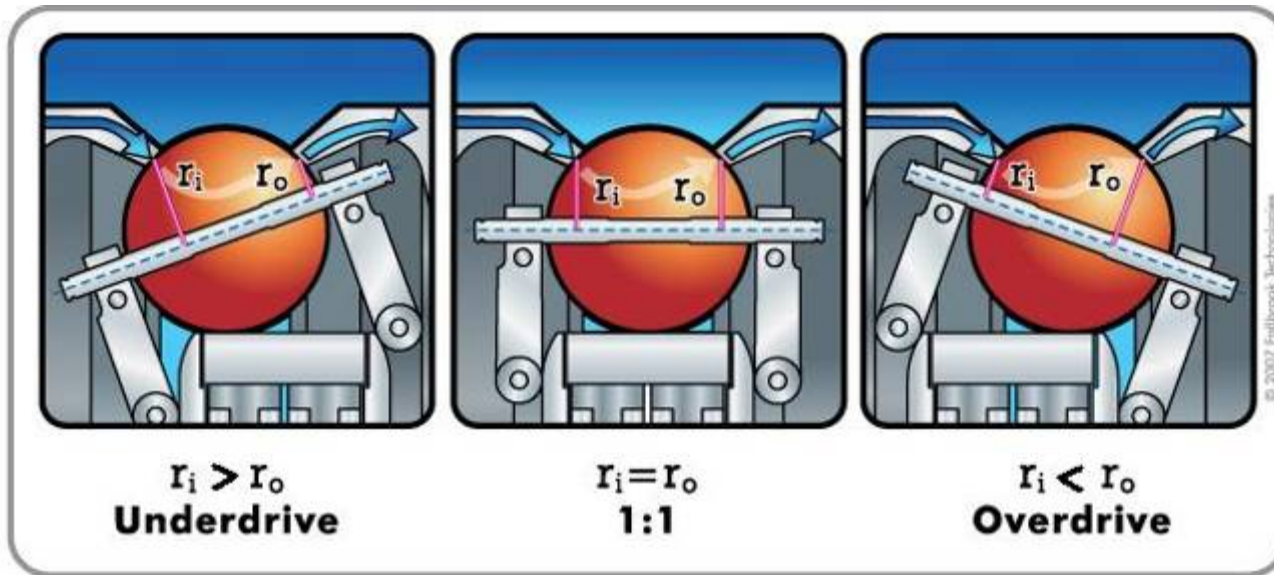
The Application of Fallbrook's *NuVinci* Technology as a Continuously Variable Accessory Drive (CVAD)

The *NuVinci* Code: Principles of Operation

- Employs a set of rotating and tilting balls between input and output discs
- Torque is actually transferred through a thin layer of “traction” fluid (no metal-to-metal contact)
 - Technical term is “elastohydrodynamic lubrication”, or EHL
 - Fluid development partner is Valvoline



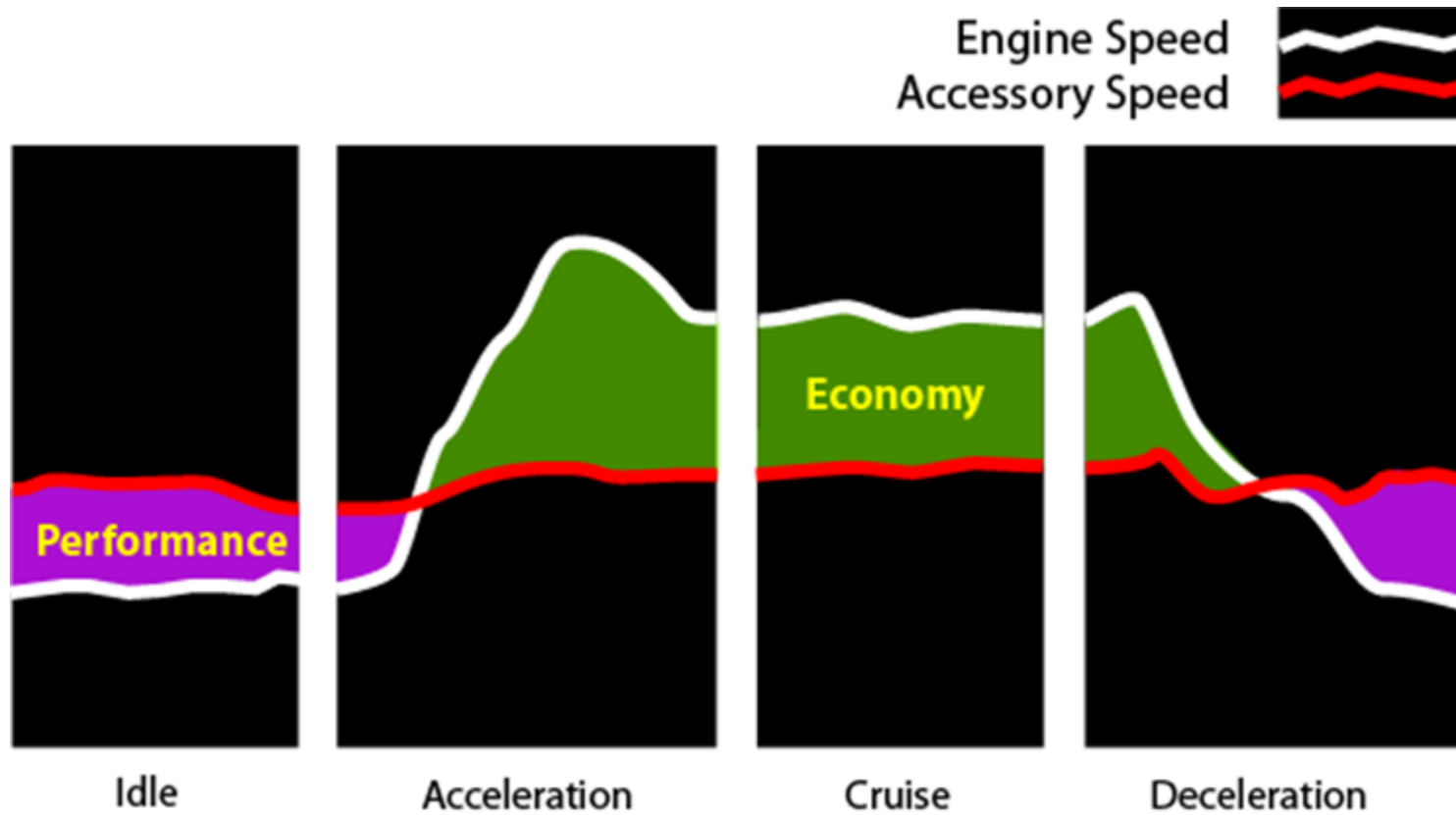
The *NuVinci* Code II: How it Works



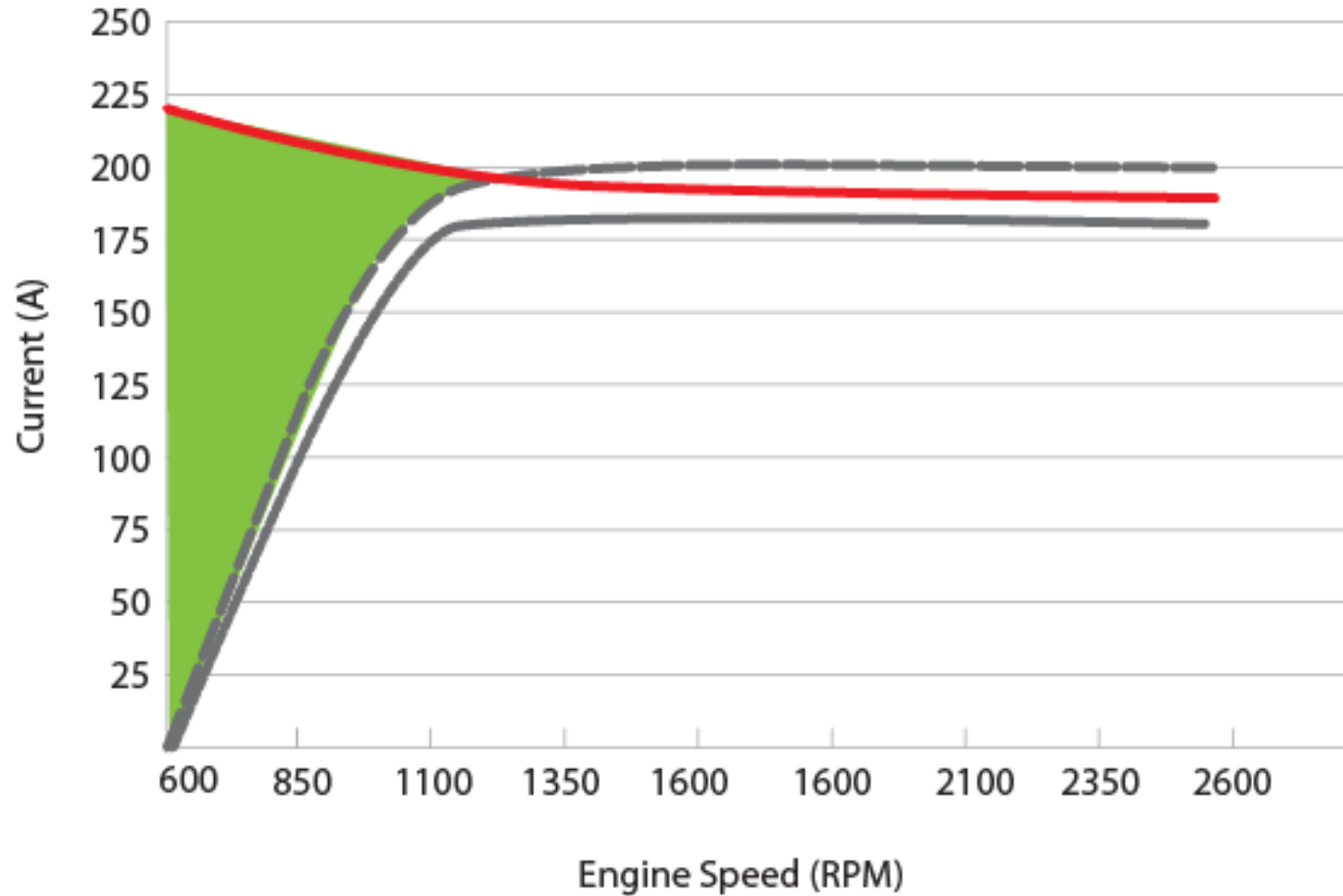
Speed ratio changes with contact radii ratio (r_i/r_o)

- The axis of rotation of the balls is tilted to change its distance from input and output rings, which vary speed ratio

Alternator Speed is Now Free From Engine Speed



Power at Idle. CVAD on the Alternator



Power at Idle: Demonstration of a Continuously Variable Planetary (CVP) Transmission Technology to Drive an Alternator

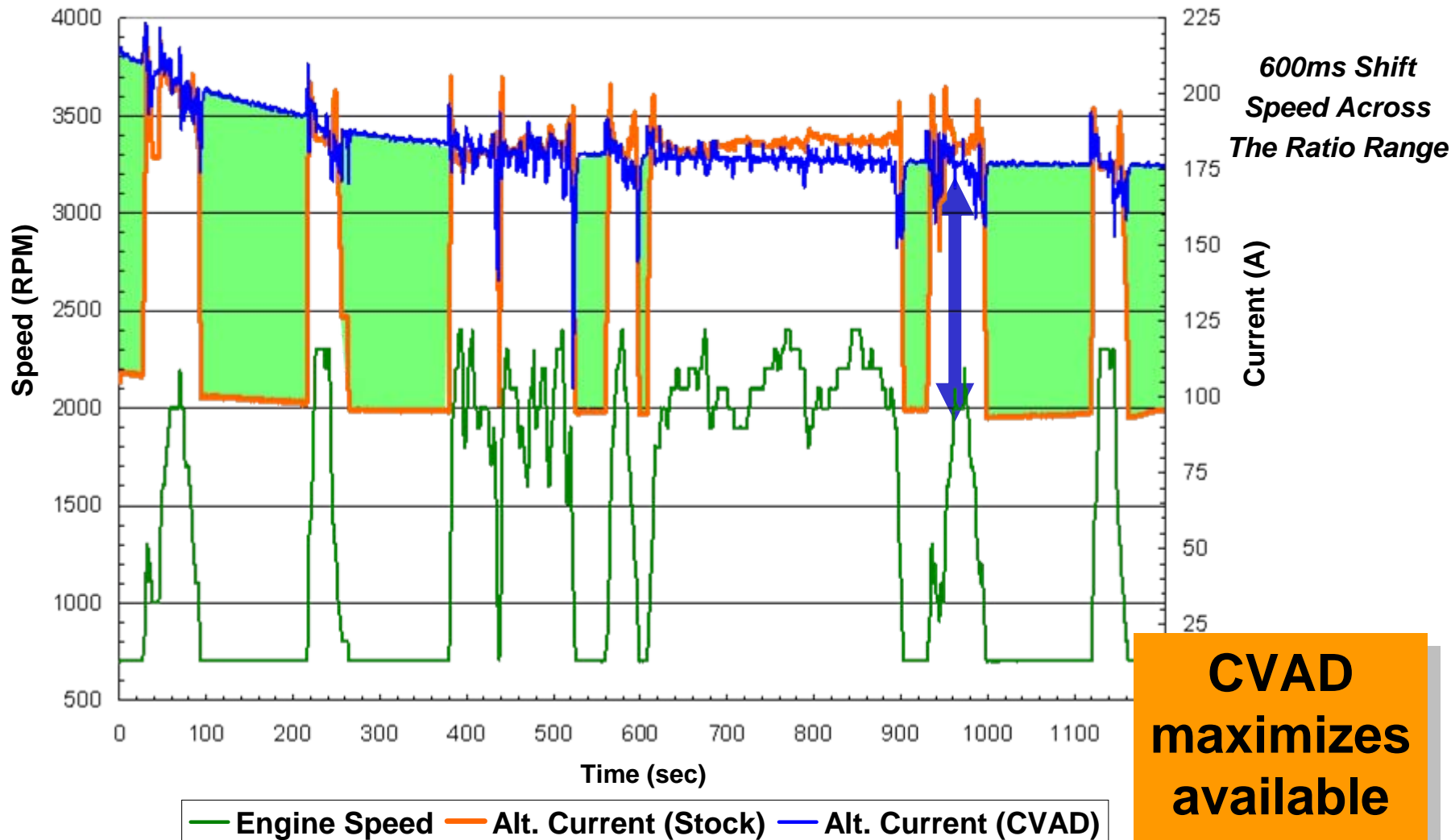
● The Program:

- In 2007, U.S. Army wanted Fallbrook to explore the use of a CVP as a CVAD to address this issue as found in the fleet of Tactical Wheeled Vehicles:
 - Increasing power demand of C4 Systems (Command, Control, Communications and Computers)
 - Vehicle duty cycle inherent with high level of low speed (engine RPM) conditions
 - An alternative to the use of higher amp alternators that are:
 - Higher cost
 - Increase in weight
 - System Economy Considerations (Fuel, Range, Battery Life)
 - Fuel and range affect combat power

● Program Requirements:

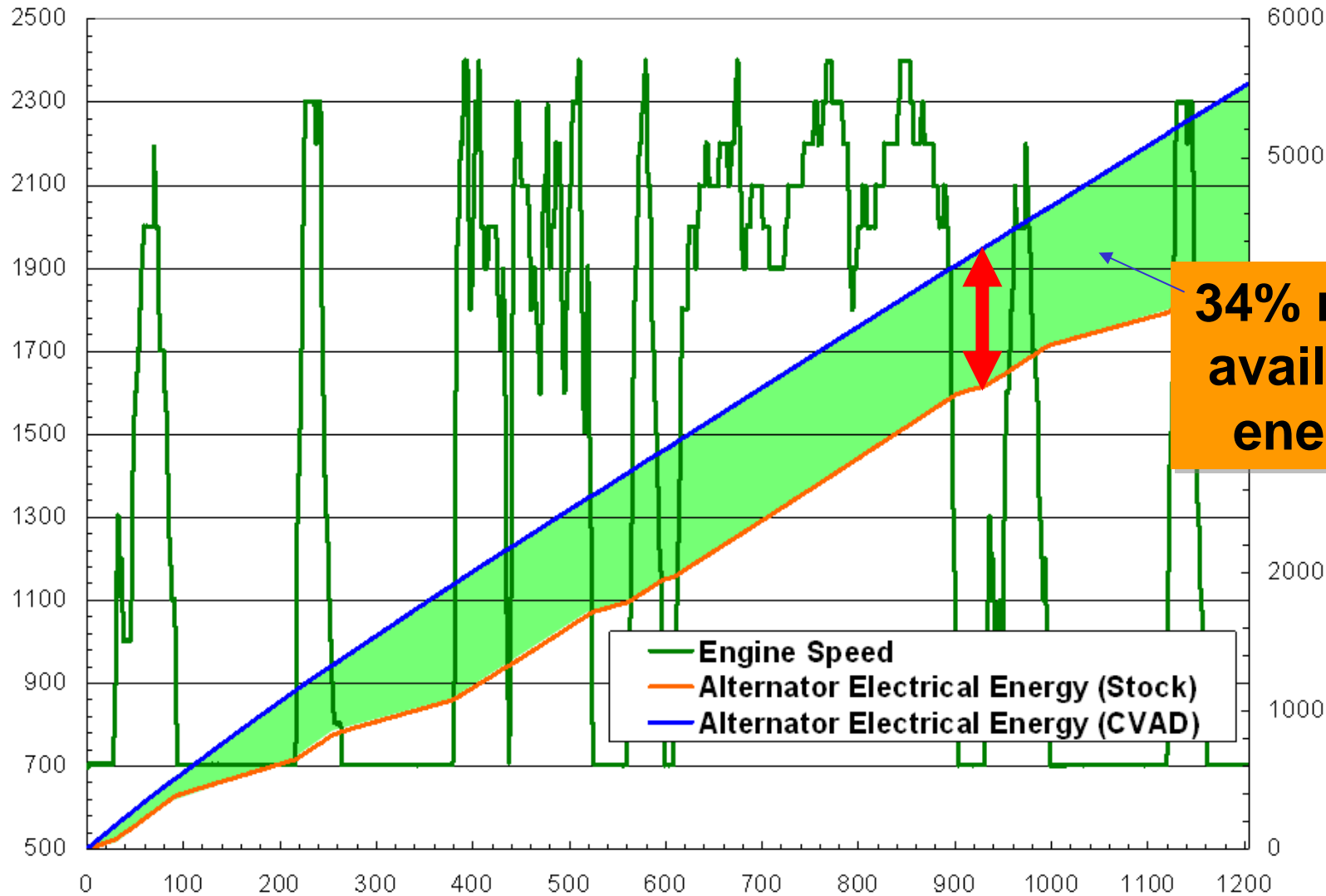
- Output maximum available alternator current at any engine speed
- Maintain alternator output speed of 2400 RPM with dynamic engine RPM input
 - +/- 100 RPM output allowance
- Manage engine compartment temperature levels of 200° F (93° C)
- Package on the beltline with little or no modification to the vehicle.

CVAD Alternator – Improved Performance



**CVAD
maximizes
available
power**

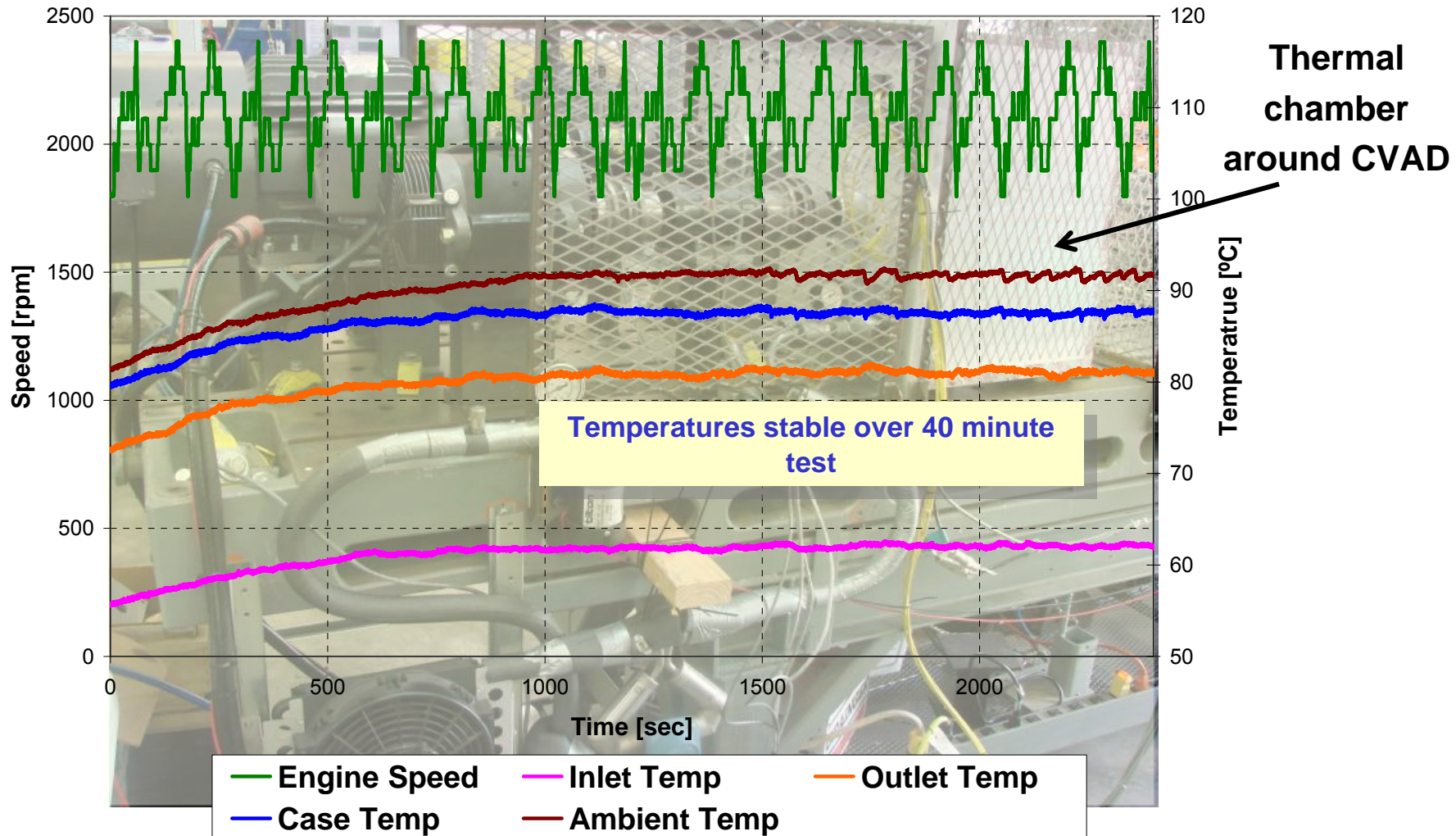
CVAD Alternator – Improved Performance



34% more available energy

The *NuVinci* CVAD Solution on Alternator

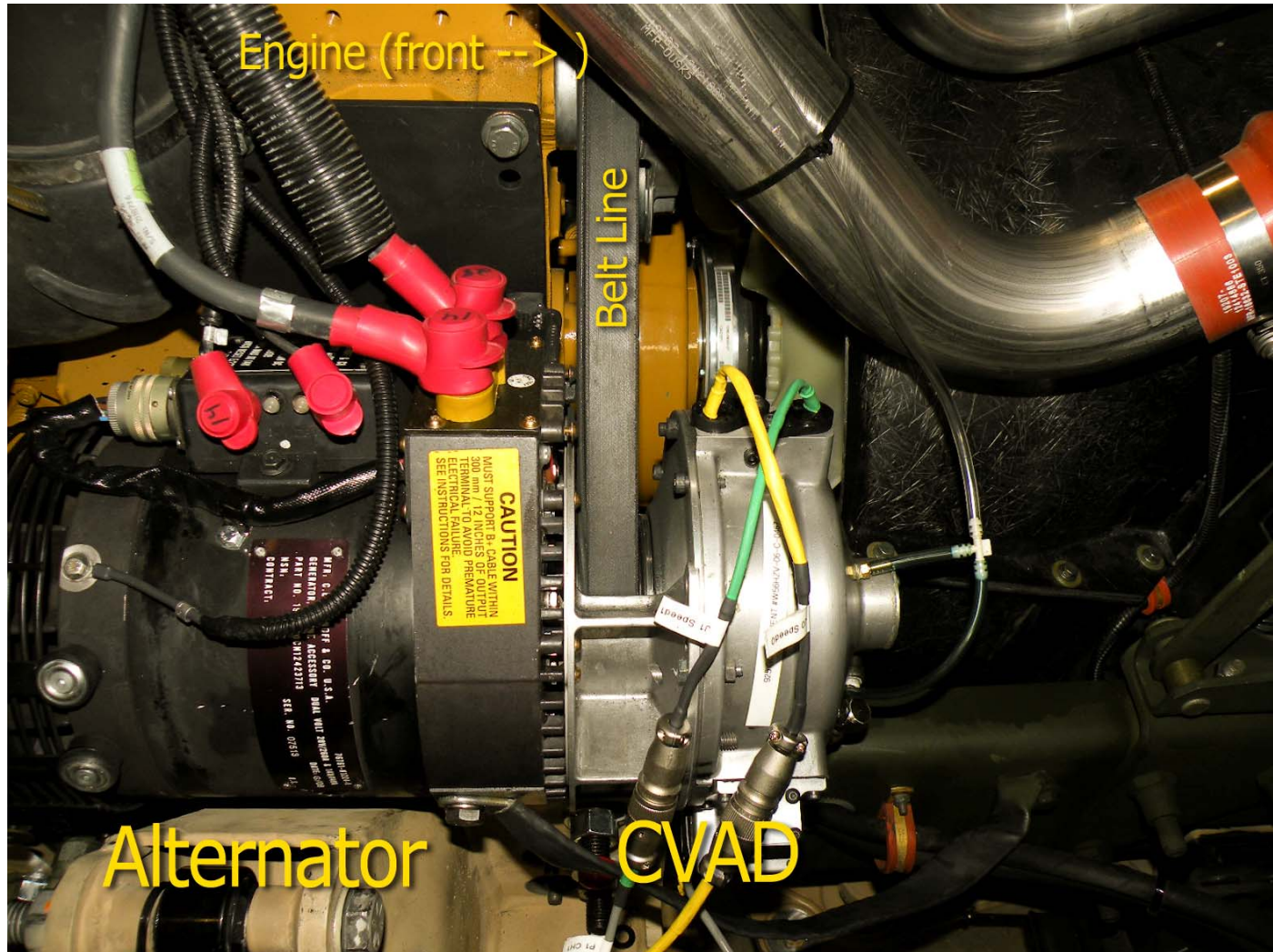
The Results – Thermal Stability



Power at Idle: The *NuVinci* CVAD Solution on the Alternator



Power at Idle. The *NuVinci* CVAD on the Alternator



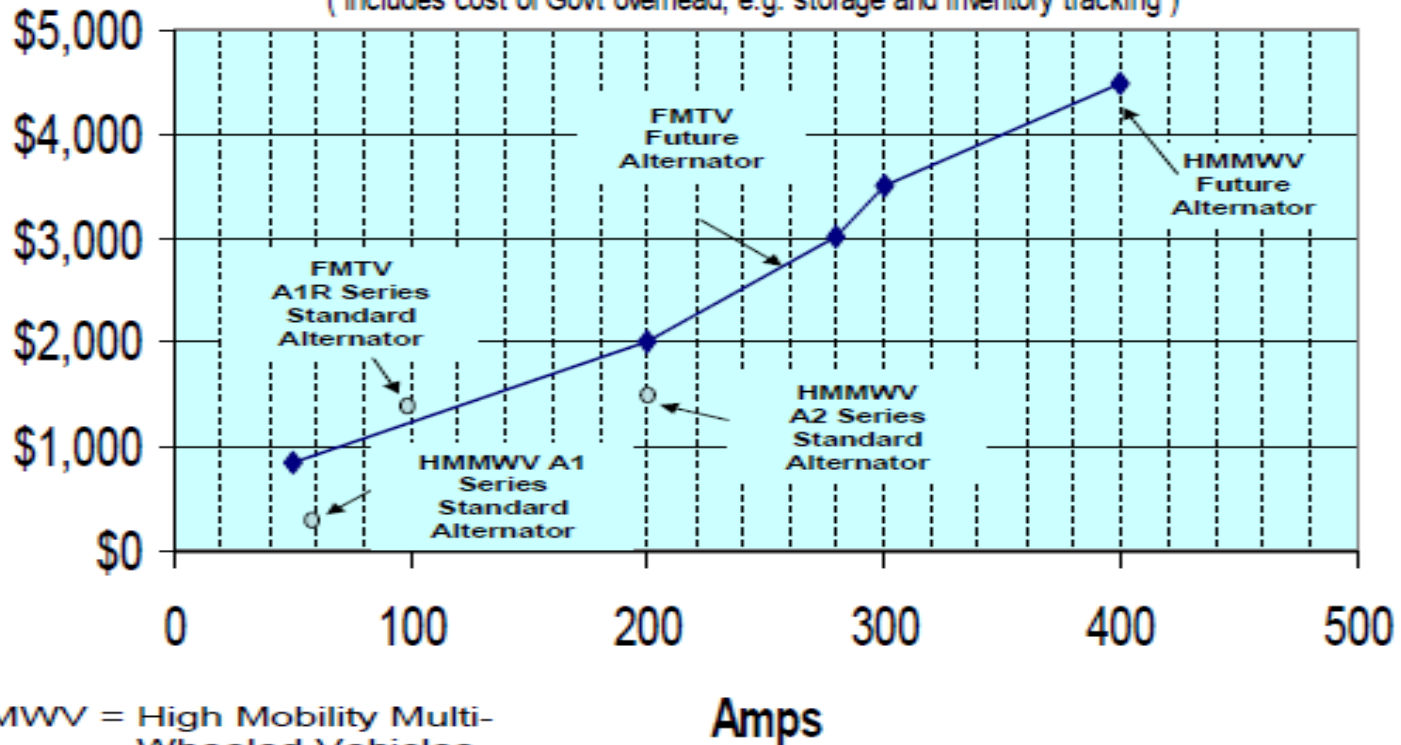
Video



Military Vehicle Alternator Cost Chart

Composite Average of Alternator Costs* as a Function of Amperage

* Source: Web Federal Logistics Information Systems; www.webflis.dlis.dla.mil
(Includes cost of Gov't overhead, e.g. storage and inventory tracking)



HMMWV = High Mobility Multi-Wheeled Vehicles
FMTV = Family of Medium Tactical Vehicles

More Power At Idle With CVAD Costs Less



- **Assuming 175 A is the required “power at idle.”**
 - The current alternator provides 90A
 - Alternatives include...
 - A bigger alternator – for example some 400A alternators can make 175A at idle
 - Cost is roughly \$4,000
 - A different/newer alternator technology
 - Also expensive
 - Hydrostatically Driven Alternator from PTO
 - Not very efficient
 - Noisy
 - Fast Idle
 - Consumes fuel, loud, more exhaust
 - Reduces engine and accessory life
 - CVAD
 - Current alternator (\$2,000) + CVP and controller (\$1,000*) = \$3,000
 - **\$1,000 savings per installation**
- *Estimated cost based on volume production

Additional Benefits

- **Alternator Application**

- Reduce Battery Replacements
- Reduce Battery Size
- Eliminate Belt Hop

- **Crank Shaft Application**

- Reduce the Torque Required to Start the Engine
 - Improve starter life
 - Reduce the Amp draw from the battery
 - Great for engine start/stop systems
- Increase in Accessory Life
- Attenuate Engine Torsionals Imparted on the Belt

- **Easy Integration**

- Co-Axial and Compact U-Drive or Thru-Drive
- Doesn't require special tooling to install on vehicles.

- **Smooth and Quiet**

- Easy to control
- Transparent to the user

In Summary the *NuVinci* CVAD Offers

- A practical, economical and adaptable CVT technology.
- Technical canvas for engineers to create solutions never before thought possible.

CVAD Production Starts in Q1 2010

Beta Units available for evaluation in Sept 2009
(A limited number available to qualified recipients)



Thank You!

For More Info: www.nuvinci.com