2014 APTA Expo – Learning Zone

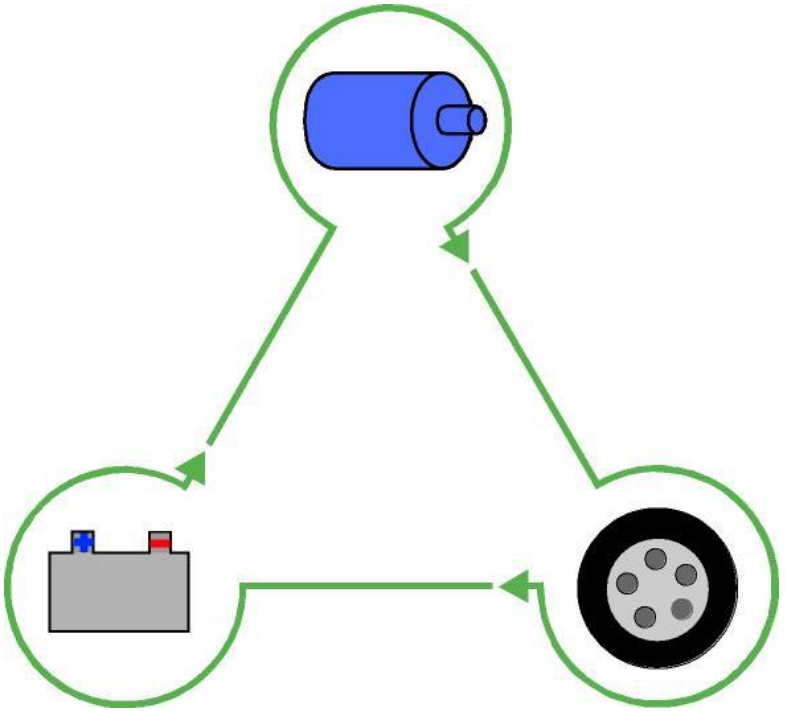
Case Studies of Hybrid Electric Performance in Transit Applications

By Lawrence Zepp
Chief Technologist

Crosspoint Kinetics
A Cummins Crosspoint Company

Hybrid Energy Recycling Triangle

- Hybrid provides braking (Regen) torque and stores the energy
- During launch, hybrid torque reduces engine load and fuel use
- Many routes **increase MPG and reduce CO2 emissions by 20-30%**



Crosspoint Kinetics
A Cummins Crosspoint Company

Selecting Optimum Routes for Hybrids

- Best routes have 4-8 stops/ mi. and 0-35 mph. typical speed range
- Note – this is total stops- not just bus stops
- More than 20,000 mi/year
- Limited highway driving
- Discussion -

Crosspoint Kinetics
A Cummins Crosspoint Company

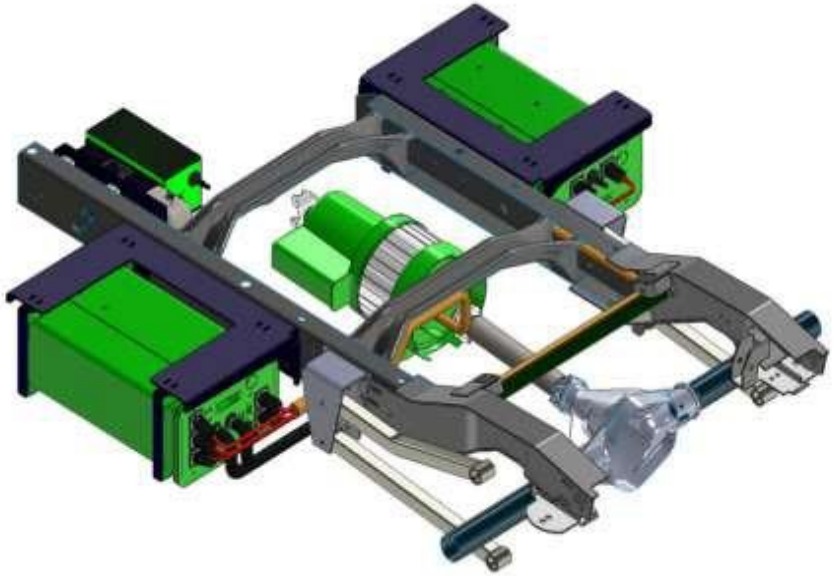
Using Fleet Data for Hybrid Route Evaluation

- Use annual miles and MPG to evaluate routes
- A Class 4 shuttle bus route with 6-7 MPG may be a good candidate to investigate further
- Class 4 shuttle with 10-11 MPG average is spending way too much time on the highway for good hybrid payback
- The same shuttle with 5 MPG usually has an aggressive driver or too much idling!

Factors to Consider in Hybrid Perf. Eval.

- Avoid using a “MPG Fleet Average” for any comparison – better to compare each route
- Avoid excessive idling
- Identify A/C use periods – has a big effect
- On-Demand para-transit routes are very hard to estimate – use GPS tracking if possible

Kinetics Hybrid Technology



Post transmission variable speed hybrid system in the driveline.

Patented variable torque / speed technology.

Uses ultra-capacitors, not batteries.

Modular integration; Easily installed and transferable.

No effect on vehicle powertrain warranty.

Reduces fuel use, emissions and brake wear by 20-30% in start / stop routes.

Simple and very low maintenance.

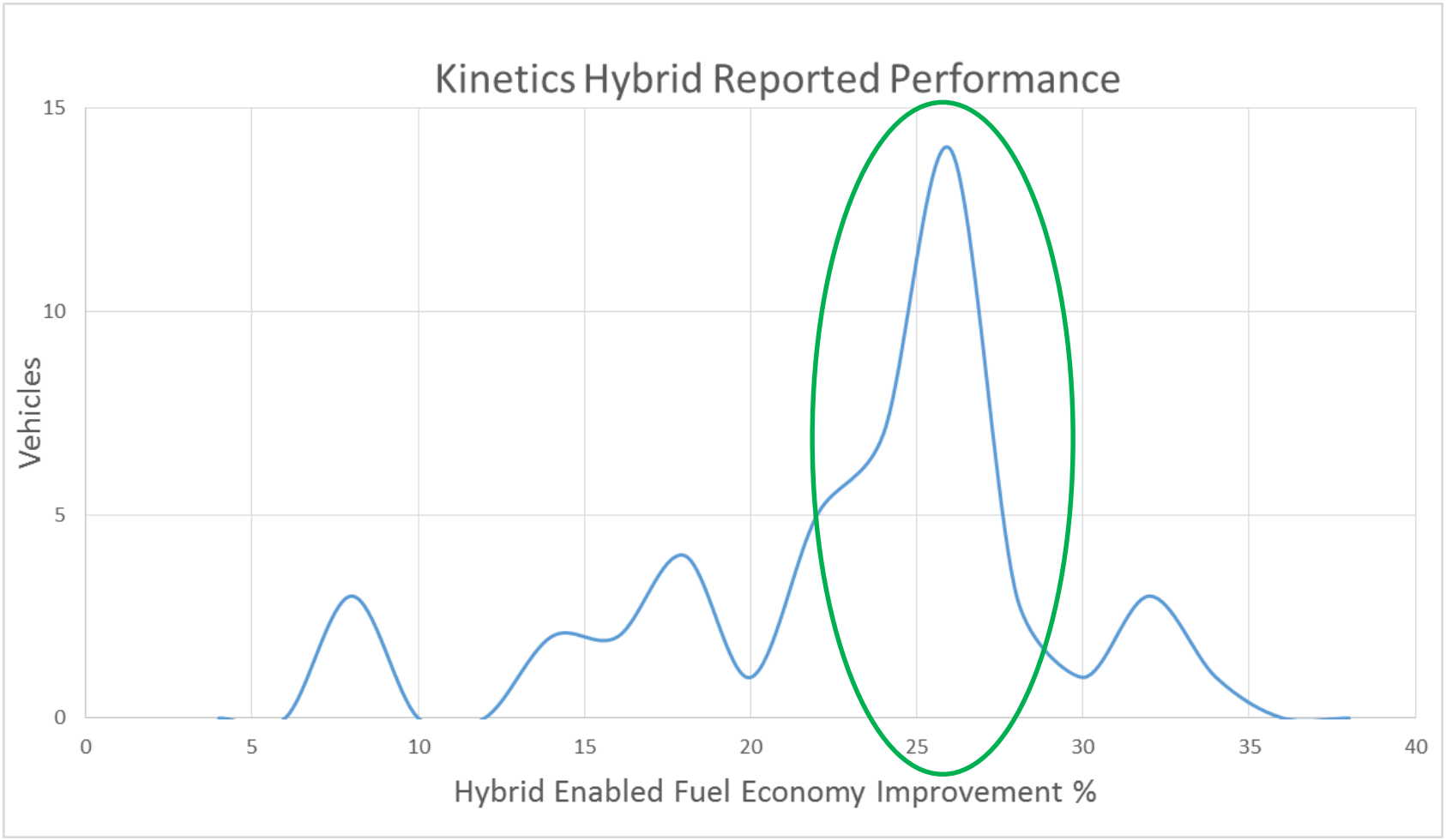
Over 150 Installations

Non Attainment Areas

Over 7 Million Fleet Miles to date

Crosspoint Kinetics
A Cummins Crosspoint Company

Case Study Performance Range



Crosspoint Kinetics
A Cummins Crosspoint Company

Hybrid Performance Case Studies -

- ***Small city fixed route CK hybrid*** *–Cl. 4 Chevy; 4 stops/mi., 0-22 mph, 16% idle time =* ***+19% MPG***
- ***Regional transit on-demand route CK hybrid*** *– Cl. 4 Chevy, 6 stops / mi., 0-35 mph, =* ***+25% MPG***
- ***School bus fixed route CK hybrid-*** *Cl. 6 Intl., 6 stop/mi., 0-35 mph, =* ***+ 26% MPG***
- ***Small city fixed route driver test CK Hybrid –*** *Cl. 4 Ford, 5 stop/mi., 0-25 mph =* ***+19% MPG***
- Note – All comparisons were hybrid ON vs Hybrid OFF

CALSTART / FTA Long Term Case Study

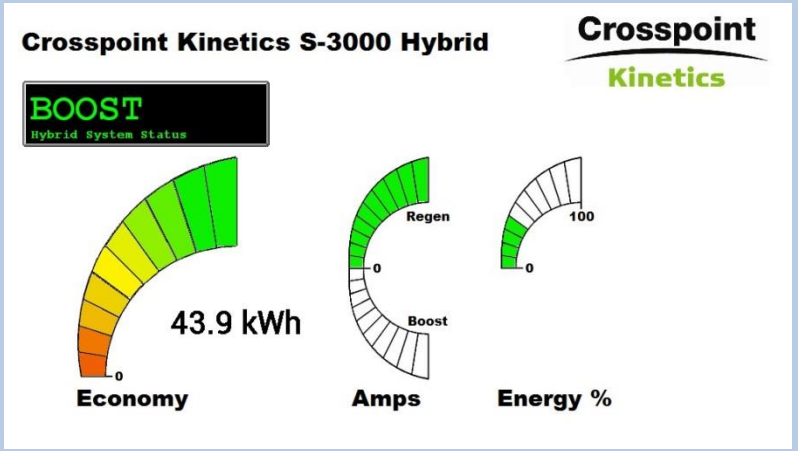
- Six month long term performance comparison of the Kinetics Hybrid in Tracy, CA
- Hybrid MPG increase from **28% to 13%**
- Gasoline engine hybrid ON vs. hybrid OFF
- Over **14,000 lbs. of CO2 saved** per vehicle / yr.
- **NOx reduced 18% and 12%** on two routes
- Drivers found that hybrid made bus easier to drive

Crosspoint Kinetics
A Cummins Crosspoint Company

Hybrid Driver Training Is Important!

- Hybrid driver training will provide substantial and lasting benefits
- Use the hybrid system “Best Driving Practices”
- Your fleet trainer should become the hybrid expert and lead the driver training
- Training should include both classroom and driving with hybrid perf. feedback to driver
- Use the hybrid car owners as experts

New Trends in Driver Awareness -

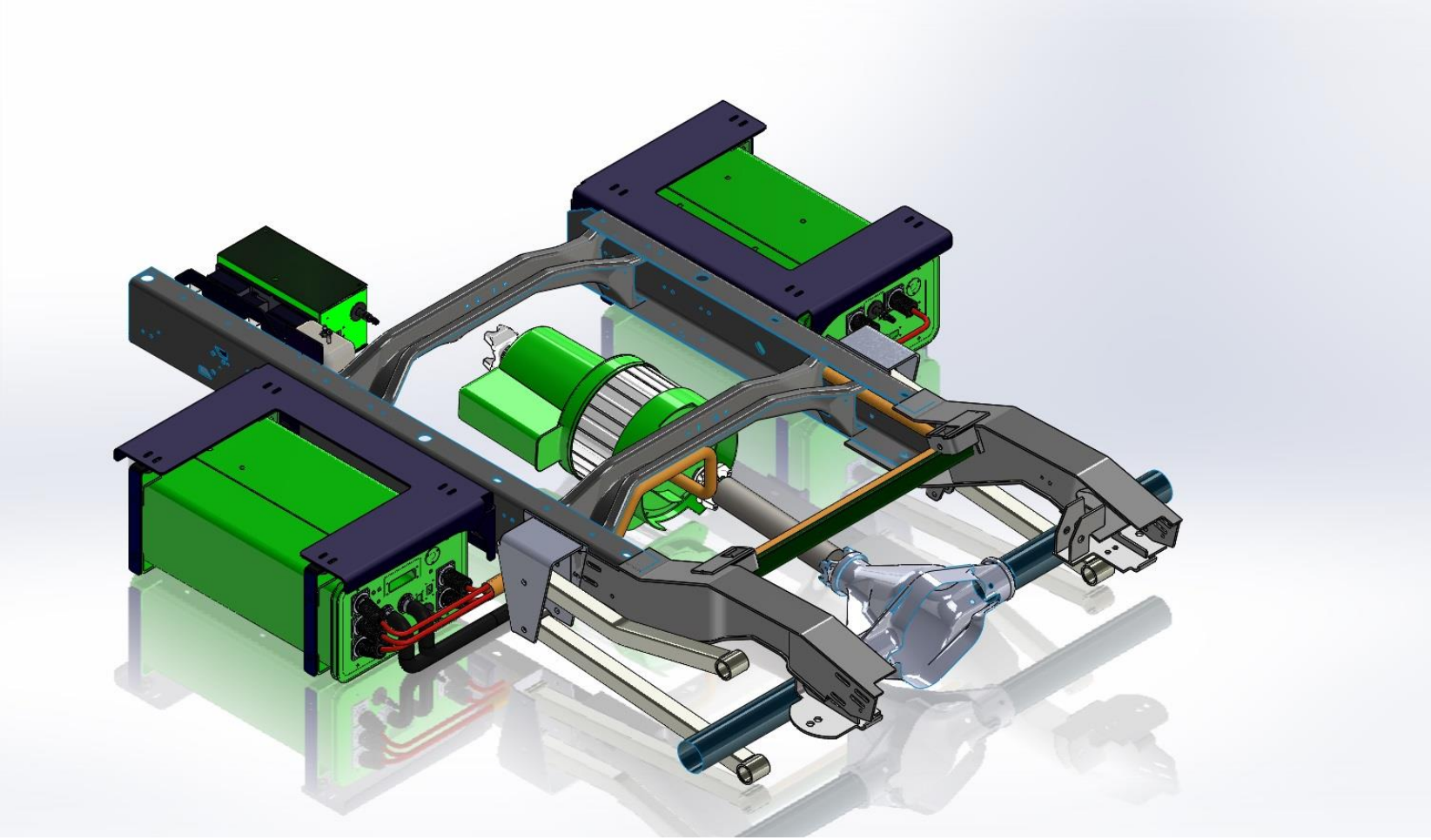


- Hybrid status display to assist driver
- Tells the driver how they are driving
- Helps explain hybrid operation
- Assists with competitive MPG performance and awareness
- Complements driver incentive programs if they are available

Hybrid Driver Training Recap -

- SMOOTH driving = GREAT hybrid performance
- **Gradual acceleration** lets the hybrid launch the bus – **Use light pressure on the accel. in 1 st gear. Then apply more throttle to increase your speed**
- If possible, plan for a long coast to a stop – then the hybrid will save all that energy as regen
- The hybrid makes driving easier by doing most of the braking
- **If Safe** – ***use light braking – to get max. regen.***

Example – The Kinetics Hybrid is a very modular system for front engine buses



Keep it Simple!

Crosspoint Kinetics
A Cummins Crosspoint Company

Thank you for your attention!

- Questions?

Larry Zepp

Chief Technologist

Advanced Technology Center

Crosspoint Kinetics

lzepp@crosspointkinetics.com

A Cummins Crosspoint Company

Crosspoint Kinetics
A Cummins Crosspoint Company