Energy - Docket Optical System

From: Dave Cook [dave@energyconversions.com]
Sent: Monday, December 10, 2012 10:46 PM
To: Energy - Docket Optical System; Smith, Charles@Energy
Cc: Allen, Jennifer@Energy; Andrew Burnette
Subject: docket number 12-ALT-02 ; 2013-2014 Investment Plan Update
Attachments: CEC Proposal Near Zero Hybrid CNG Switcher.pdf

Categories: Ready to Docket

I would like to submit a comment for the category of Advanced Medium-and Heavy-Duty Vehicle Technologies Pre-Commercial Demonstrations

I've attached some supporting slides illustrating the technology.

First comment is to keep this category and the 'Pre-Commercial' part of it. Plus make sure that the new solicitation is written to include railroad equipment. Possibly offer a special category for 'near-zero' rail technologies. A bonus for alternative fuels and hybridization at the same time.

We have a technology platform that can achieve 'near zero' emmisions from both Commuter passenger rail and freight switching locomotives. Two applications that typically operate in urban areas.

This is a holistic combination of two technologies, hybridization and conversion to natural gas.

Not only is this a clean technology, but a higher performing technology from the users standpoint.

It is proposed to demonstrate the hybrid energy storage system on a diesel locomotive by itself as an addition. This is essentially a novel packaging and control solution and could be done in half a year.

In parallel it is proposed to build a test stand with two traction motors and develop the high voltage power electronics needed for the commuter rail application.

Natural gas engine system development would also happen in parallel.

Early in this program it would be possible to demonstrate a CNG/Hybrid Switcher using off the shelf components and early stage natural gas engines.

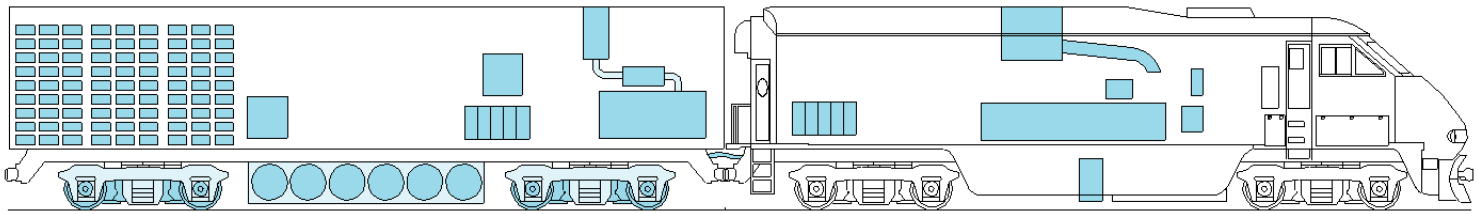
There are more than four small companies working together on the pieces of this system so a solicitation that allows multiple companies to work in parallel would help.

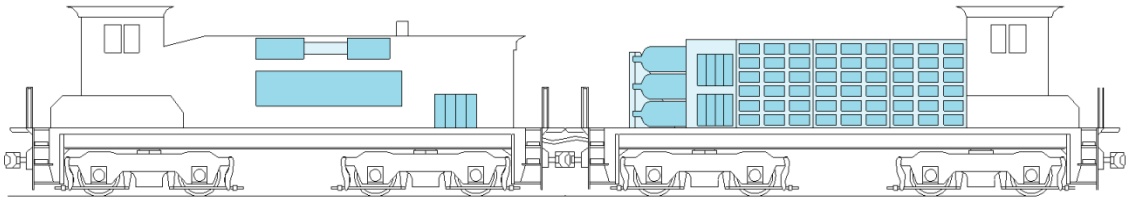
Thank You

Dave Cook

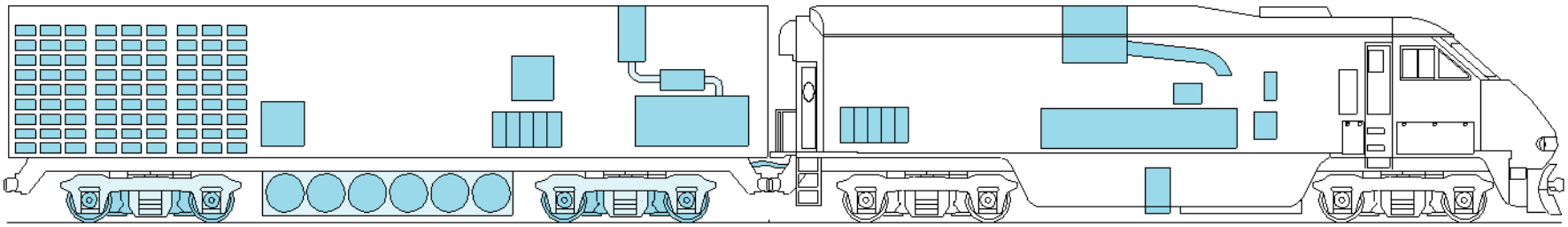
CNG/Hybrid Locomotives and the Path to Near Zero Emissions

High Performance Commuter Passenger and Freight Switcher Locomotives



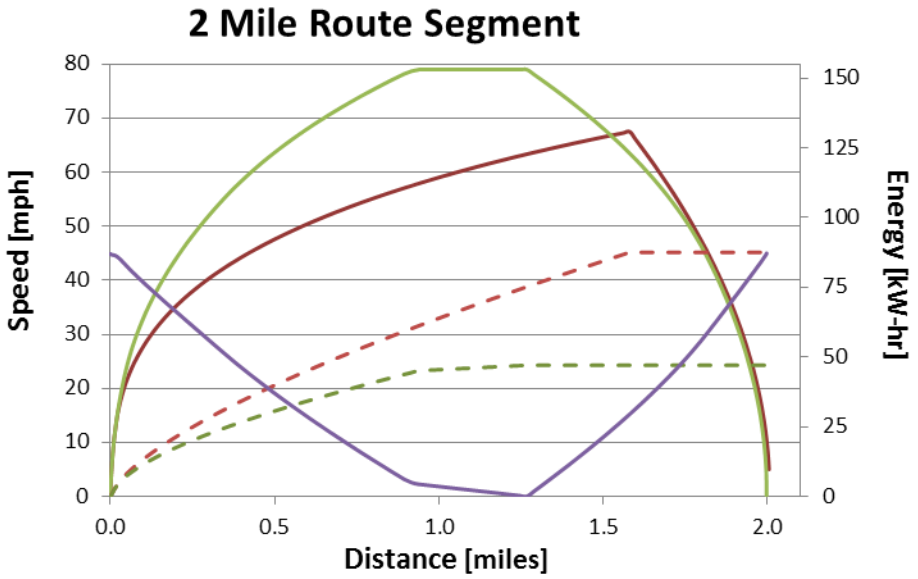


CNG/Hybrid Commuter Rail



- Near Zero .09 g/hp-hr NOx
  - CNG/Hybrid .6 g/hp-hr
  - Reduced additional 85% by SCR system
  - 93% Reduction from Tier 4 Locomotive
- 75% fuel cost reduction
- >100% increase in acceleration rate
- Target Upgrade Cost: 20% more than current production diesel Tier 4 passenger locomotives

Hybrid Commuter Performance

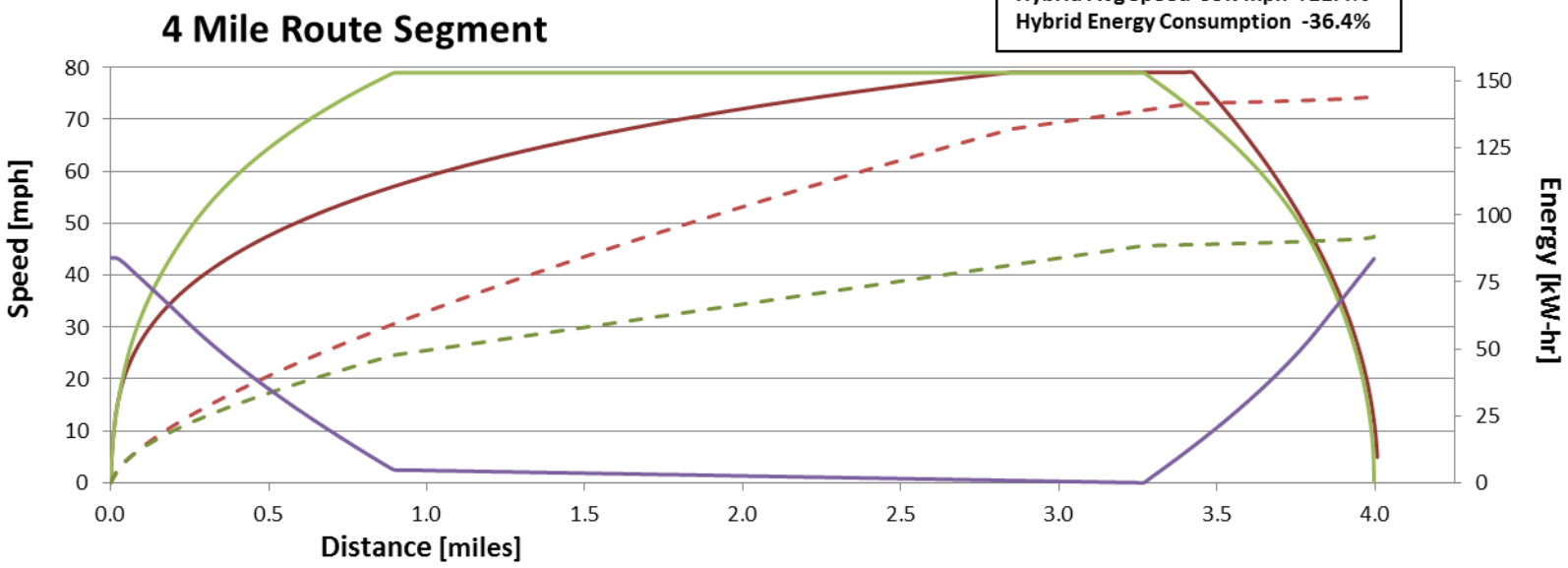


6 Rotem Bilevel Cars: 405,000kg
F59PHI: 122,000kg
3200HP
Hybrid Locomotive/Tender: 244,000kg
87 kWhr Ultra Caps 82% Recovery
8 MW Peak Decel Energy

3200HP Avg Speed 42.5mph
Hybrid Avg Speed 47.9mph +12.8%
Hybrid Energy Consumption -46.5%

3200HP Speed
Hybrid Speed
3200HP Energy Consumption
Hybrid Energy Consumption
Energy Storage [kWhr]

Hybrid Avg Speed 59.7mph +11.4%
Hybrid Energy Consumption -36.4%



Mother-Slug Switcher

- A ‘Slug’ is a locomotive with its engine removed, basically a tender car with its own traction motors powered by the ‘mother’
- Doubles low speed tractive effort
- Doubles independent braking effort
- Higher productivity
- Common in Class 1 switching
  - Norfolk Southern, Canadian National

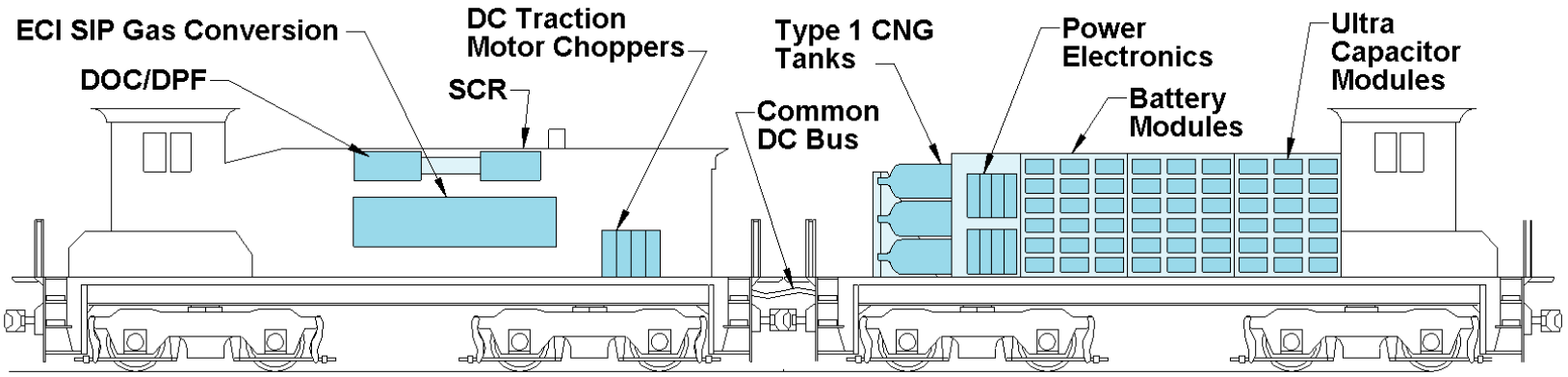
Near Zero CNG/Hybrid Switcher

Double Cab Mother Slug

- Use obsolete GP9 locomotive
  - Natural Gas converted EMD engine
  - Spark Ignited Prechambers
- 4500psi CNG tubes
  - 150 DGE/tube – 450 DGE total
- 750 Volt DC Bus
  - Individual traction motor control
- 50% GHG Reduction
- 80% Fuel Cost Reduction

Costs

2 obsolete GP9's	$100k
3 CNG Tubes	$75k
ECI SIP Conversion	$300k
Compact SCR	$120k
Power Electronics	$450k
8 kWhr Ultra Caps	$320k
100 kWhr batteries	$100k
Rebuild Misc	$350k
Total	$1815k



Switcher Hybridization

- Slug allows space for Hybrid Energy Storage
- Slug allows space for more CNG
- Mixed Battery and Ultracaps
  - Ultra Capacitor Advantages
    - High Power Capacity
    - Near Infinite Cycle life
  - Battery
    - Lower cost per kWhr
    - Higher energy density
- Hybridization minimizes Notch 1 thru 3 operations
  - Higher average EGT's
  - SCR system now practical

Near Zero

- Typical duty cycle on 1500HP Switcher has low average EGT
- Makes SCR Impractical
- SCR allows 90% reduction of NOx from Tier 4
  - NOx @ .13 g/(hp-hr)
- Hybridization reduces fuel consumption 40%
  - NOx now at .08 g/(hp-hr)