New Technology Alternatives for Line-Haul Freight

Technology Review

Presented to Regional Stakeholder Committee

SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS

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- Introduction
- Families of Technology
  - Self-Contained Power
  - Wayside Power
  - Intelligent Transportation System
- Findings

The Purpose of the Technology Review

. . . is to summarize recent literature regarding new and alternative technologies that may be applicable to a zero-local-emissions container freight network for the Los Angeles Basin.

Purpose of Technology Review (continued)

- Focus is on technologies applicable to the electric/battery truck system envisioned in the Interstate 710 (I-710) Corridor EIR/EIS.
- The review also covered information on new technologies to reduce the emissions of conventional railroad locomotives.

Definition of Electric/Battery Truck Technology

- Zero-local-emissions electric/battery truck system
- Two operating modes:
  - Independent operation (Ports and Terminals)
    - Off-guideway using battery or other energy storage device
    - Human operation
  - Line-haul operation
    - Dedicated or shared guideway
    - Electric power from fixed distribution system (overhead catenary, third rail, embedded linear induction, or other) while charging batteries – *OR*
    - Battery power or other stored energy alone

Definition of E/B Truck Technology (continued)

- Match technology solutions to performance requirements (e.g. operations, capacity, interfaces, emissions)
- "Existing" or proposed products may not themselves be responsive, but may have desirable features
- Responsive technologies and components may be incorporated in systems developed for other applications
- Don't discount technologies that are not commercially available today, but identify technologies that may be suitable for a new container transport application.

Applicable Technologies Reviewed

- Vehicles with Self-Contained Power (Electric Motor, Hybrid, Battery)
- Vehicles Powered from Wayside Distribution Systems
- Intelligent Transportation Systems (ITS)

Self-Contained Power: 100% Battery Truck

- Electric motor propulsion
- Energy storage battery
- Battery re-charged via temporary connection to electric grid
- Overnight or rapid charging

Balquon-Nautilus XE30 Electric Tractor

Optare Solo EV

Self-Contained Power: 100% Battery APM

- Evolution of conventional APM technology
- Electric motor propulsion
- On-board energy storage battery
- Operates entirely on batteries; quick-charges during every station stop

Mitsubishi Heavy Industries "Crystal Mover"

Self-Contained Power: Fuel Cell / Electric

Vision Motors-Tyrano Heavy-Duty Class 8 Hydrogen Fuel Cell Electric Truck

Van Hool A330 with ISE ThunderVolt TB-40FCH fuel cell hybrid-electric drive

- Electric motor propulsion
- Hydrogen fuel cell energy storage
- Hydrogen refueling stations required
- By-products of energy conversion are heat and water

Self-Contained Power: Hybrid Diesel / Electric

- Diesel motor/generator powers electric traction motor
- Batteries charge by diesel engine and regenerative braking

Peterbilt 386 Hybrid Class 8 Heavy Duty Hybrid

- Battery power supplements diesel engine in response to demand for additional torque
- Hybrid operation evens energy consumption and enhances efficiency

Wayside Power: OCS - Electric Trolley Coach

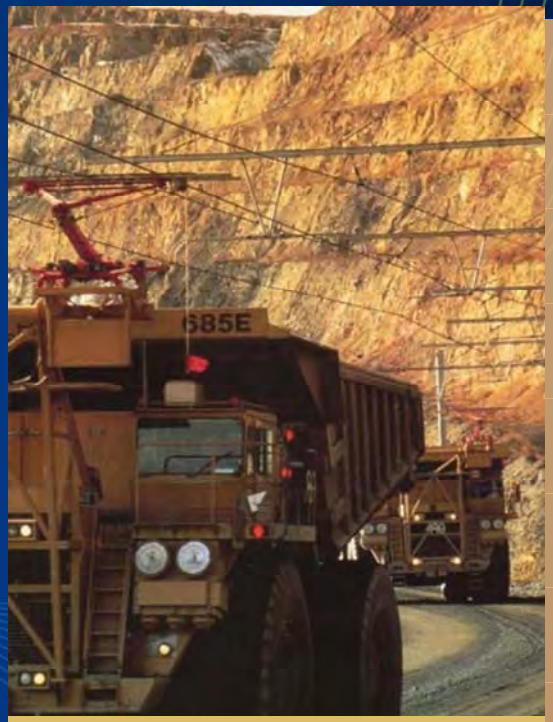
- Electric motor propulsion
- Traction power via overhead catenary system (OCS)
- Wayside power may be paired with battery, motor/generator or combustion auxiliary power
- Regenerative braking returns residual energy to power grid

Irisbus Articulated CIVIS Trolley Coach with Optical Guidance – Bologna, Italy

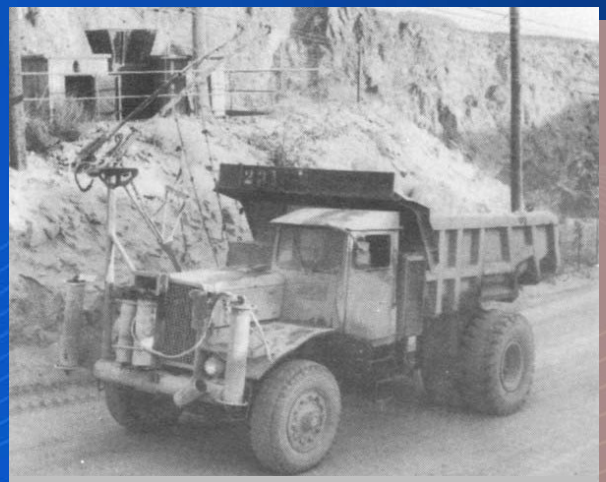
New Flyer E60 Articulated Trolley Coach – San Francisco

Wayside Power: OCS - Trolley Truck

- Electric propulsion; diesel motor generator with trolley assist, *OR*
- Entirely electric
- Auxiliary battery might be added for off-OCS operation



Komatsu 685E Electric Drive Trucks with Trolley Assist – Barrick Goldstrike Mine, Nevada



Kenworth Truck modified for 100% Electric Operation - Riverside Cement, Crestmore CA 1971

Wayside Power: Third Rail / Dual-Mode Truck

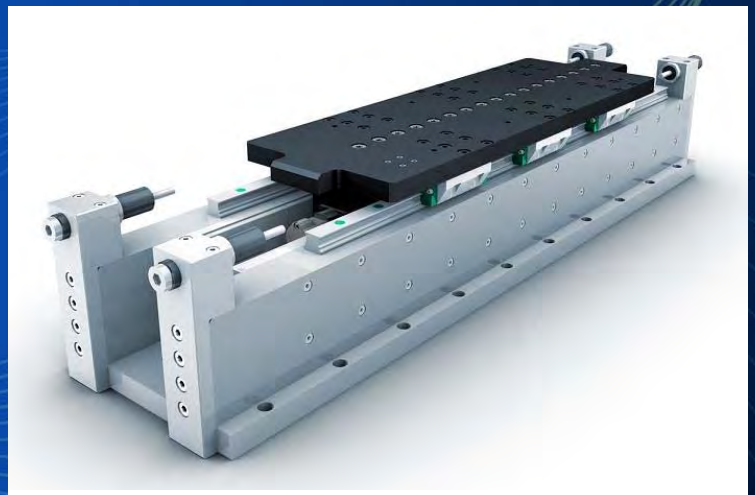
- Electric motor propulsion
- Traction power delivered via third rail
- Batteries can be charged from the third rail to allow independent operation off guideway
- Third rail limits shared uses of guideway

MegaRail Transportation Systems: Dual-Mode (Third-Rail and Roadway) CargoRail™ Heavy Duty - CargoTram™

Wayside Power: Linear Motor (LIM / LSM)

- Propulsive force from electric current run through linear stator in the guideway, which creates an electro-magnetic field
- EM field interacts with magnets on the vehicle to create thrust.
- Lateral guidance requires constrained, exclusive, grade-separated guideway

LIM Passenger Transport Application



LSM Precision Machining Application

Wayside Power: Electromagnetic Induction

- Electric traction power delivered by current conductor embedded in the roadway
- Power delivered directly to traction motor, to battery, or to both
- Lateral guidance less critical than for linear motor

Korean Advanced Institute of Science and Technology -
Seoul Grand Amusement Park

Conceptual Highway Application -
IAV Automotive Engineering

Intelligent Transportation Systems (ITS)

- Platooning technology aims to increase roadway capacity and enhance safety
- 1997: UC Berkeley PATH demonstration of automated operate in close formation
- Combination of radar, video, wireless communications technologies to coordinate spacing, speed, steering

The Review of Technology Alternatives for Line-Haul Freight (Task 8) yields these findings:

- There is no proven, available product or system that represents the zero-emission alternative technology envisioned in the I-710 Corridor Project EIR/EIS
- A zero-local-emission container transport system will likely be a synthesis of technologies used in transportation and other applications
- Terminal, near-dock, off-dock, and regional container transportation are differing missions, with differing criteria and technical solutions

Findings (continued)

- Currently evolving truck technologies (e.g. battery, fuel cell, hybrid) may offer greater benefit at lower cost and risk than a single application of a new, untried solution
- Flexibility and adaptability should be a criterion for defining any zero-emission container transport solution
- The complete work has not yet been done to define the entire range of functionalities, interfaces and solutions necessary for a successful zero-local-emission container transport application

Task 8: New Technology Alternatives for Line-Haul Freight

Technology Review

Questions and Discussion