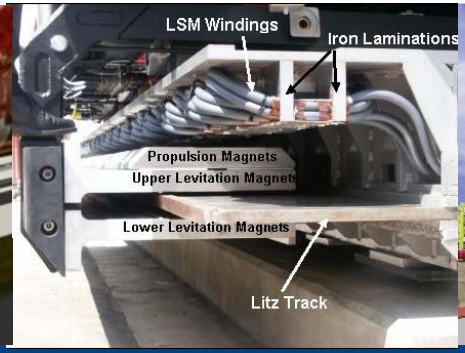
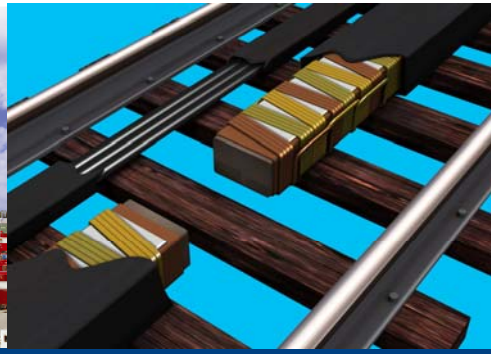
MagneTruck™:
A New Concept for Zero-Emission Goods Movement

Presentation to Port of Los Angeles
18 March 2009





Agenda

- **General Atomics Overview**
  - Company History
  - Relevant Programs and Technologies
- **Concepts for Port-Related Transportation**
  - Overview
  - ECCO™ Maglev Systems
  - LIM-Rail™ Systems
  - Road Systems
- **Business Considerations**
  - Risk and Return
  - Strategy
  - Open Discussion of Port Needs and Potential Opportunities

GENERAL ATOMICS OVERVIEW

Key General Atomics Business Areas

Founded: 1955

Ownership: Privately Held

Employees: Over 5,000 Worldwide

Defense

- UAV Systems
- Advanced Sensors
- Naval Ship Electrification
- Weapons Destruction
- EMALS/AAG
- Rail-Guns

Energy

- Fusion
- Fission Reactors (HTGR)
- Uranium Mining
- Algae Synfuels

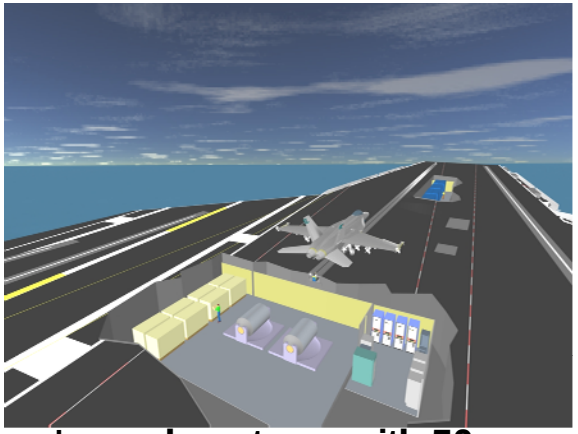
Transportation

- Linear Motor Transportation Technologies
- Maglev Systems
- Streetcar Refurbishment
- Mining Truck Drives

Electric Transportation Technologies Use Core GA Competencies

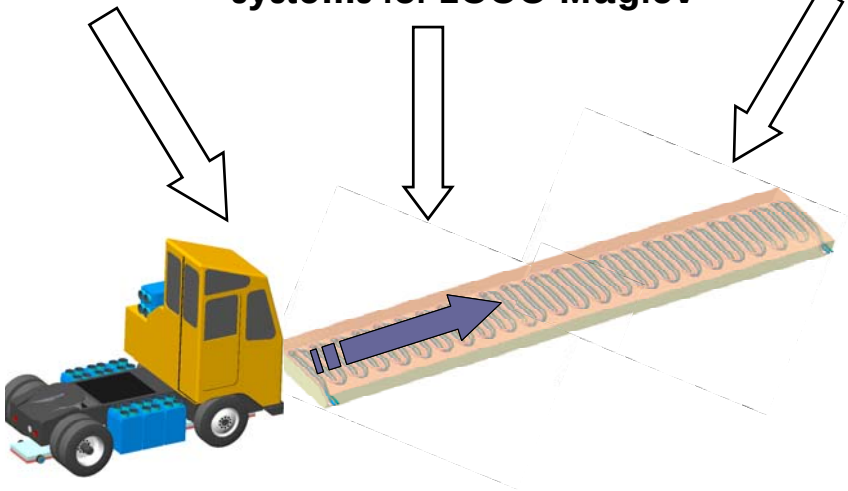
Inverters for 400-ton mining trucks, light and heavy rail

Linear electric propulsion, control, and train protection systems for ECCO Maglev



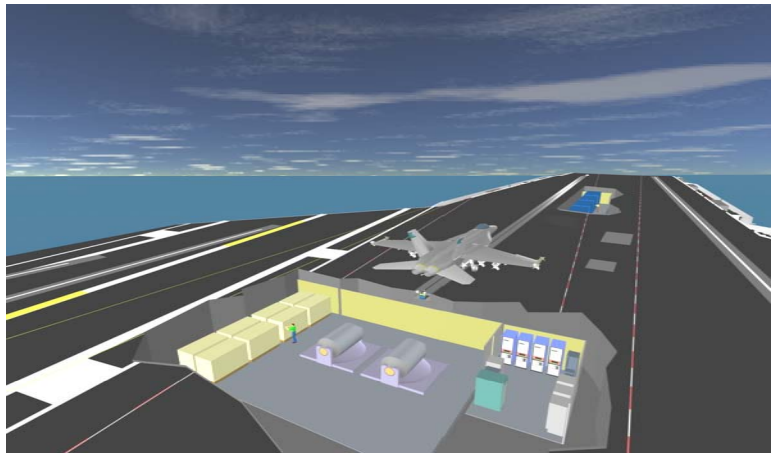
Launch systems with 50-year design life in full-scale development

All electric truck uses existing chassis replacing the diesel engine with an all – electric drive-train and onboard energy storage system (*patent pending*).



Linear motor imbedded below road surface propels the vehicle and charges the energy storage system while vehicle is automatically transported to its destination (*patent pending*).

ElectroMagnetic Aircraft Launch (EMALS) and Recovery (AAG) Systems



GA EMALS Land-Based Testing Using Full-Scale 150 ft. Long Launch Motor in Lakehurst, N.J.

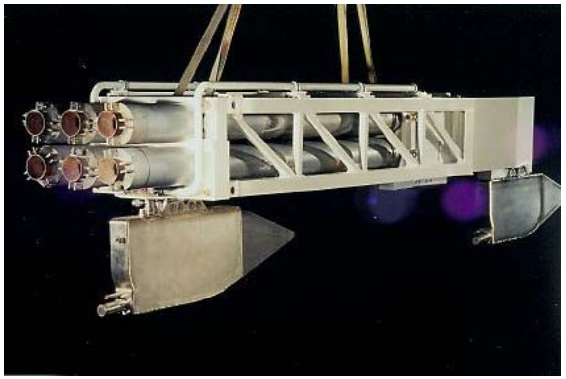
9,800 lbs. @ 150 knots (173 mph)

GA Maglev Projects

FTA Urban Maglev

ECCO System

California-Nevada Maglev



Air Force Holloman

< 100 mph

> 240 mph

Mach 10

CONCEPTS FOR PORT-RELATED TRANSPORTATION

- Overview
- ECCO Maglev Systems
- LIM-Rail™ Systems
- Road Systems

Evolution from Maglev to MagneTruck™

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009

Urban Maglev Program

- Funded by FTA and Penn DOT, with GA cost share
- Licensed Livermore "Halbach Array" maglev technology
- 400-foot test track demonstrates proof-of-concept in 2004
- Developed levitation, propulsion, guidance, control, and ATP

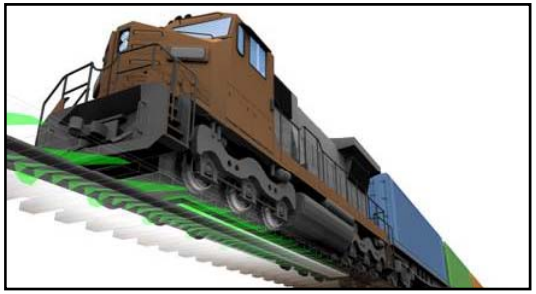
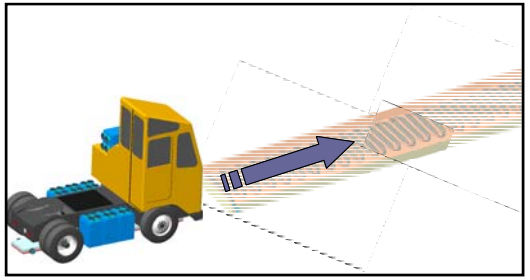
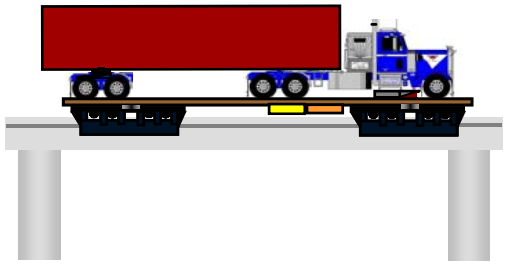
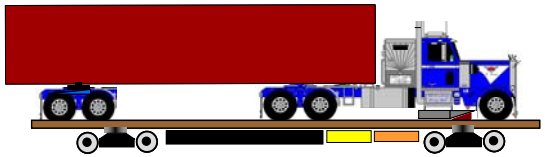
Electromagnetic Cargo Conveyor (ECCO)

- ECCO concept using maglev for goods movement originated by CSULB
- Developed for port applications using same GA passive maglev ("Halbach Array") technology as Urban Maglev Program

Existing Infrastructure Solutions

- Concepts using existing rail (e.g., LIM-Rail)
- Concepts that can operate at port terminals
- Concepts that can operate on existing roads

Family of Linear Motor Applications

	Maglev Guideway	Conventional Rail	Conventional Roadway
New Rolling Stock	 **ECCO™ Maglev** •Long-distance routes •Regional solution	 **LIM-Rail™ (Train Retrofit)** •Rail yards •Shuttle Trains •Alameda Corridor	 **MagneTruck™** •Terminal operations •Freeway truck lanes
Existing Rolling Stock	 **ECCO-Truck™ Maglev** •Medium-distance routes •Eliminates extra “lifts”	 **LIM-Rail™ (Truck Carrier)** •Short to medium routes •Roll-on/Roll-off	 **MagiCarpet™** •Weigh stations •Border crossings

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- LIM-Rail™ Systems
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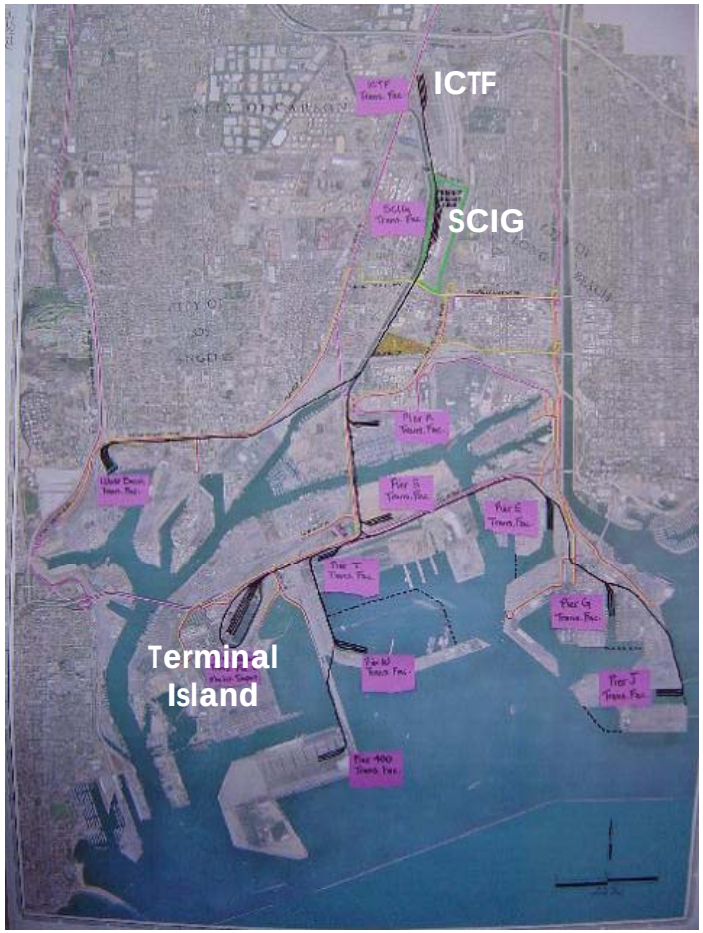
ECCO™: Maglev for Freight Movement

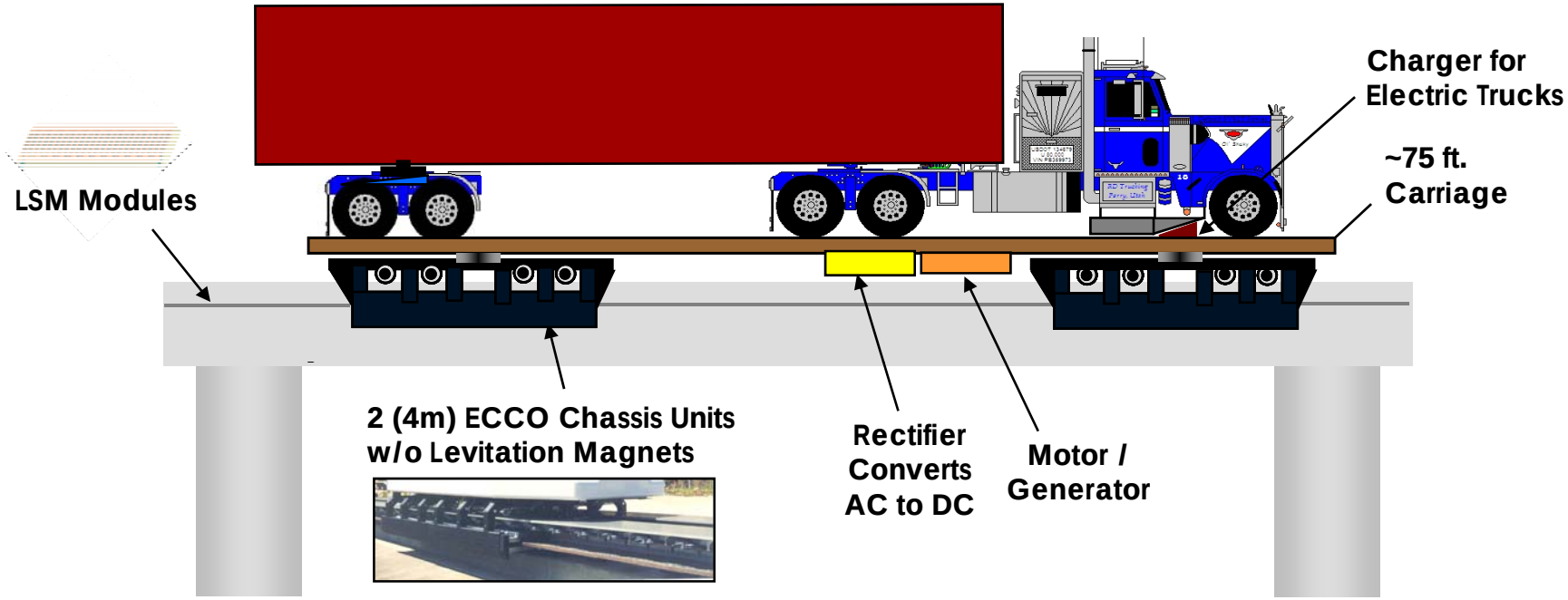


First's First Cargo Maglev Move – June 8, 2006

LSM Coils Being Assembled on Guideway Weldment

New Optimized Maglev Chassis on Track

ECCO™-Truck Maglev



- Eliminates need for container lifts – trucks roll on and off system
- Uses 2 ECCO chassis units – can operate without levitation for on-port operations
- Uses a two-bogie system for tight turn radius
- Supports both diesel and alternative fuel trucks – including electric
- Charges electric trucks with on-board charger driven by the LSM

CONCEPTS FOR PORT-RELATED TRANSPORTATION

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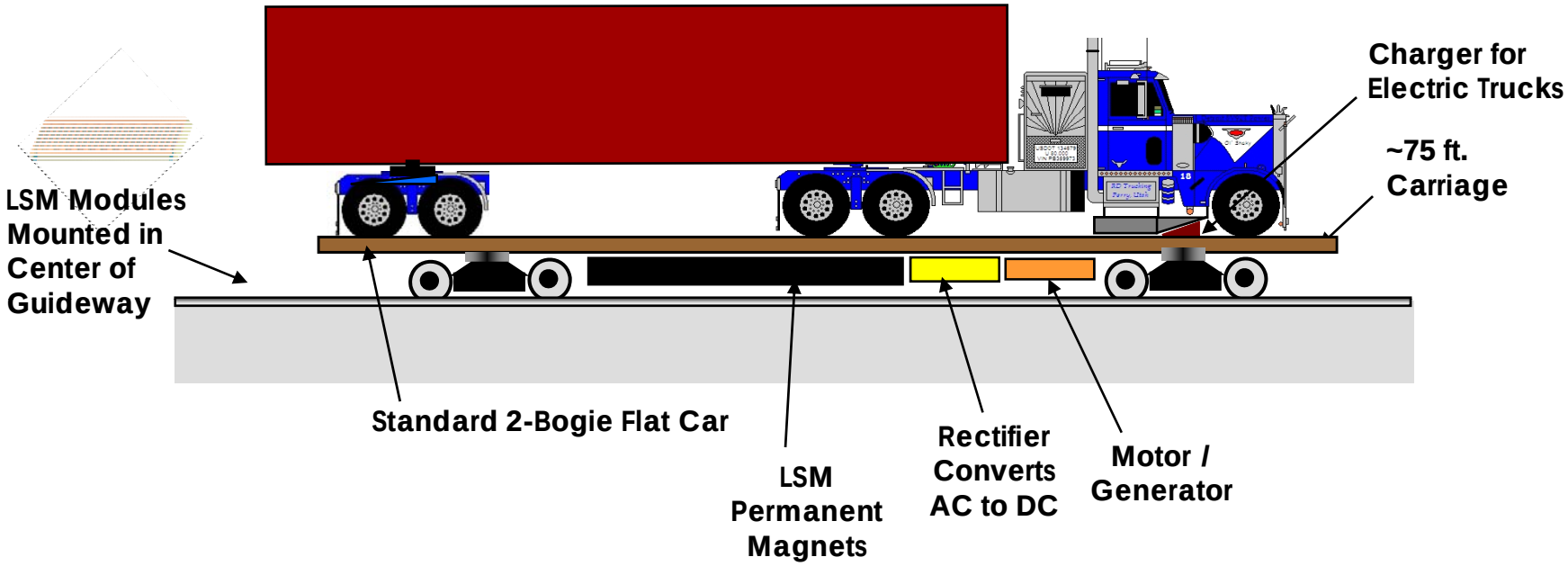
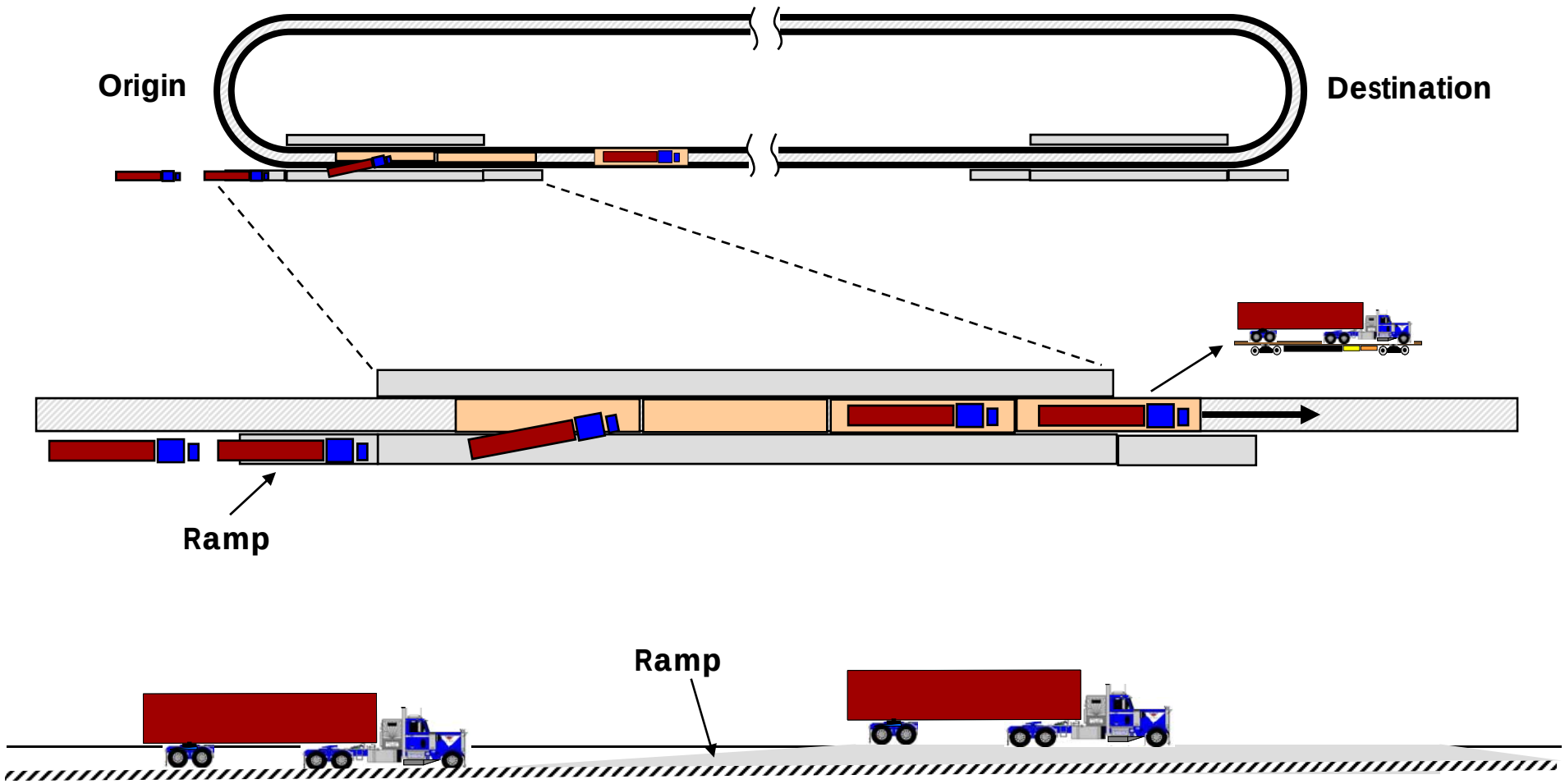
LIM-Rail™ - Truck Carrier Option



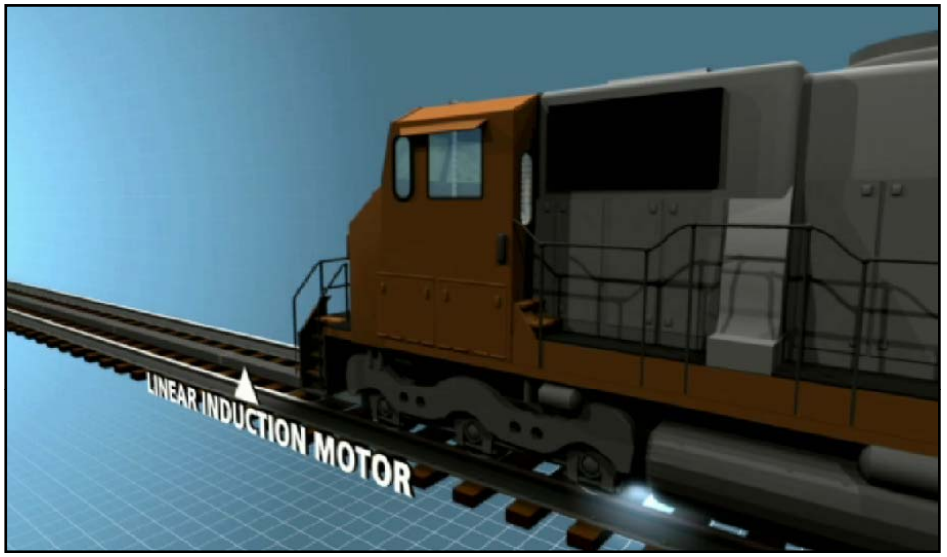
- Runs on standard rails – elevated or at grade
- Uses standard 2-bogie flat car – allowing for tight turn radius
- Trucks can roll on and off – <u>no container lifts!</u>
- Supports both diesel and alternative fuel trucks – including electric
- Charges electric trucks with on-board charger driven by the LSM

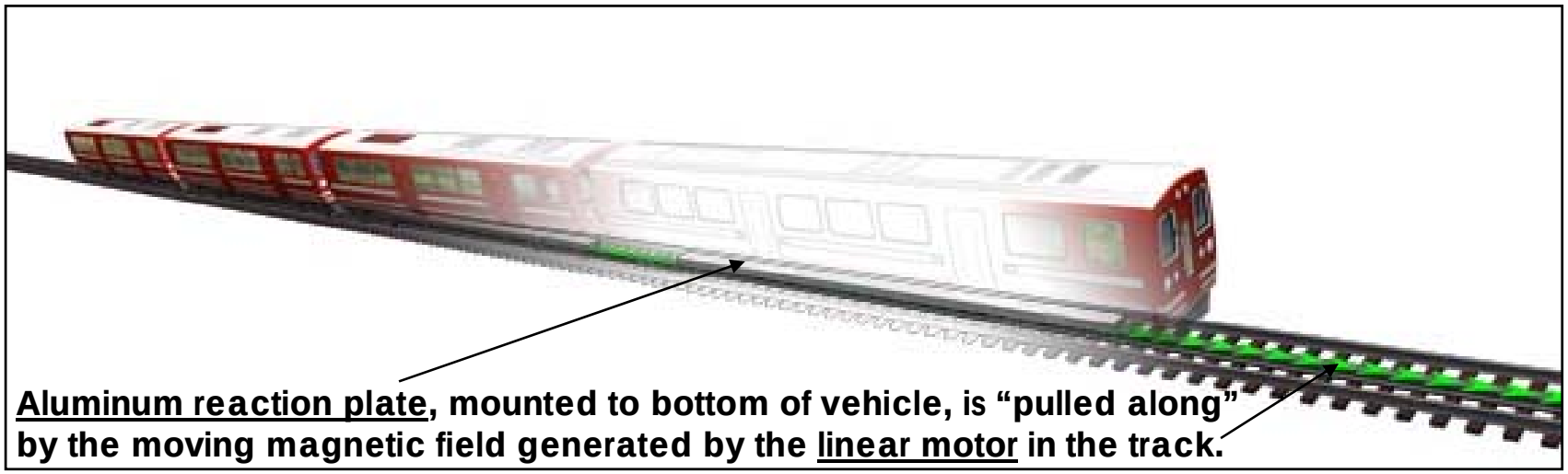
“Circulator” System Configuration



LIM-Rail™ - Train Retrofit Options

- **Freight trains**
  - **Rail yards**
  - **Ports**
  - **Alameda Corridor**
- **Commuter rail**
  - **Replace diesel engines**
  - **Replace overhead electric "catenary" lines**





Aluminum reaction plate, mounted to bottom of vehicle, is "pulled along" by the moving magnetic field generated by the linear motor in the track.

CONCEPTS FOR PORT-RELATED TRANSPORTATION

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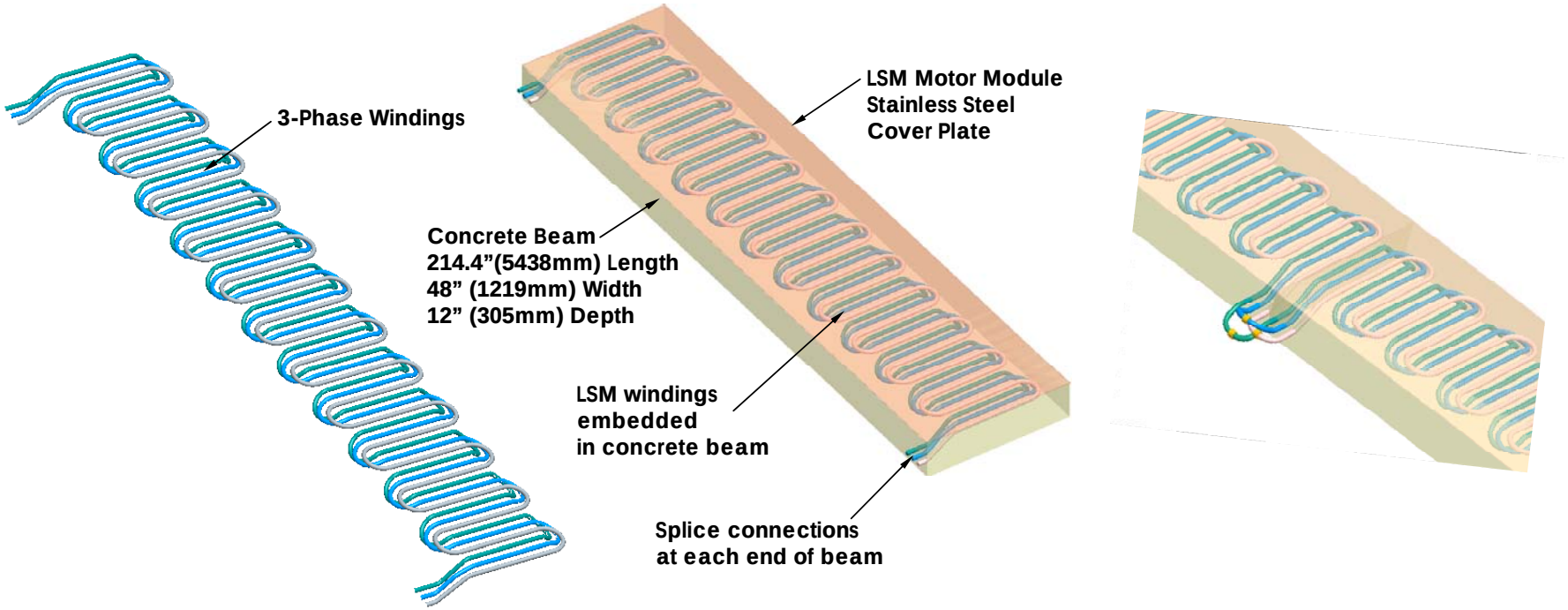
LSM Motor Modules for Road Applications*

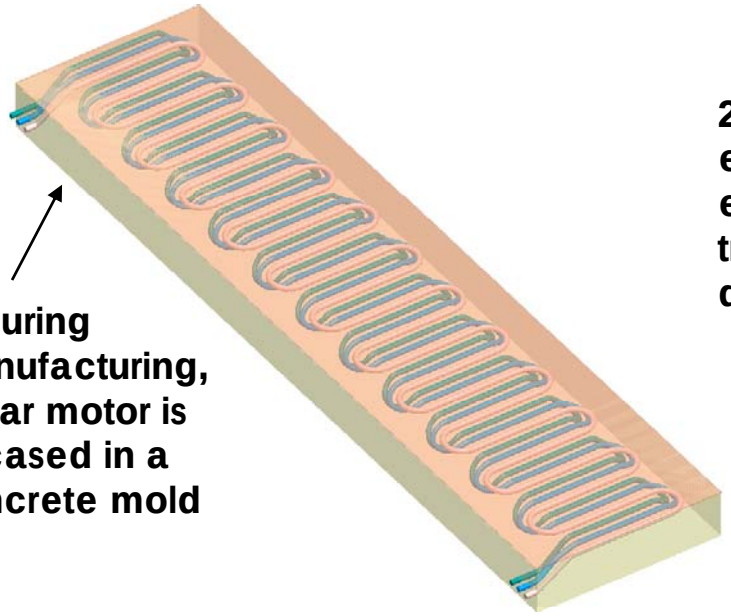


Wind LSM Cables → **Encase in Concrete/Composite** → **Join Modules**

- Simple modular design – minimum impact during construction
- Efficient electric linear motor – minimizes operating costs
- No moving parts – minimizes maintenance costs
- Provides continuous all-electric operation – no plug in required
- Automated operation – high throughput capabilities

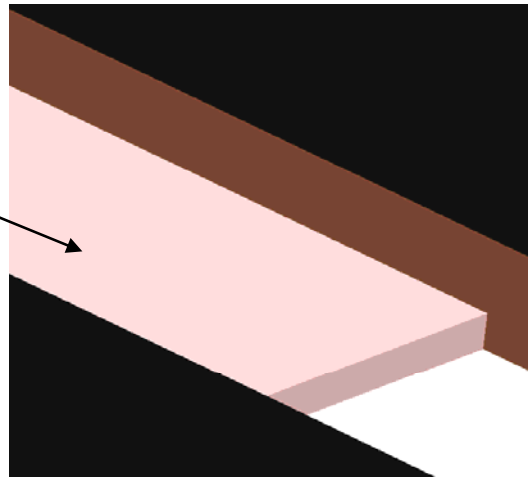
* Patent Pending

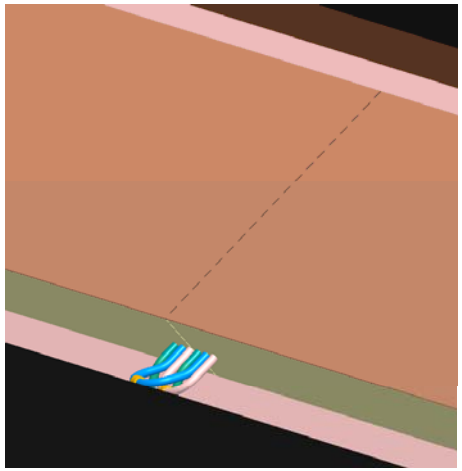
LSM Module Road Installation Process



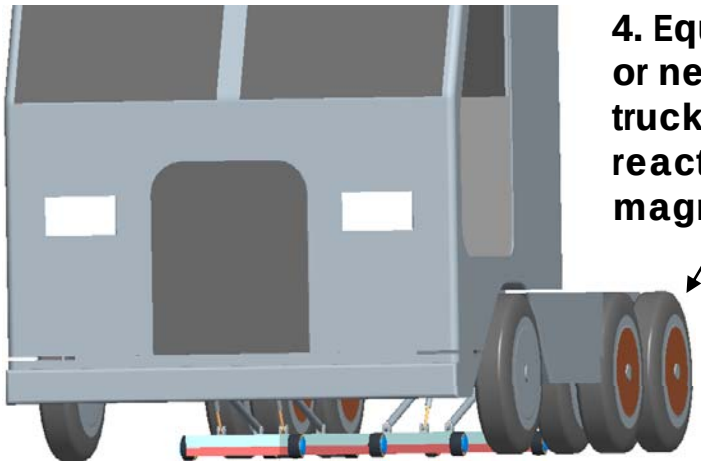
1. During manufacturing, linear motor is encased in a concrete mold

2. In road to be electrified, excavate a trench (~18" deep x 71" wide)





3. Install linear motor block segments into roadway and connect electrical windings



4. Equip existing or new electric trucks with reaction plates or magnets

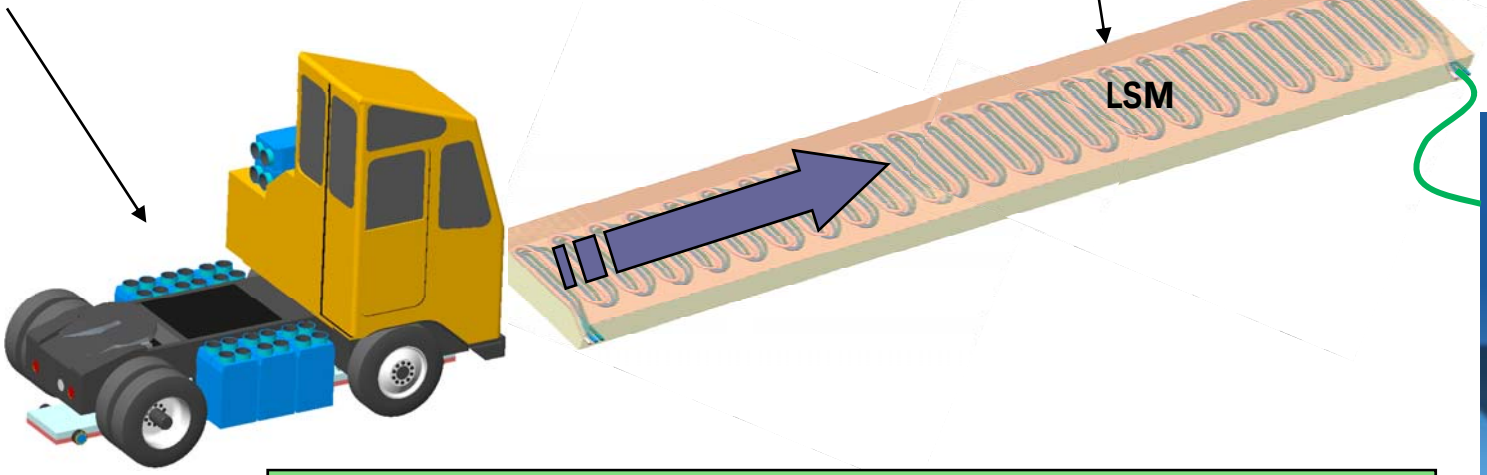
MagiCarpet™ Truck-Mover Concept

- **Accommodates existing trucks**
  - Trucks drive onto rolling platform
  - Engine is turned off
  - Permanent magnets in platform react against linear motor in road to pull truck
- **Applications**
  - Short low speed routes
  - Examples: border crossings, weigh stations, possibly port terminal applications?

MagneTruck™ Operating Scenario

Electric vehicle uses onboard batteries while operating on conventional roadways

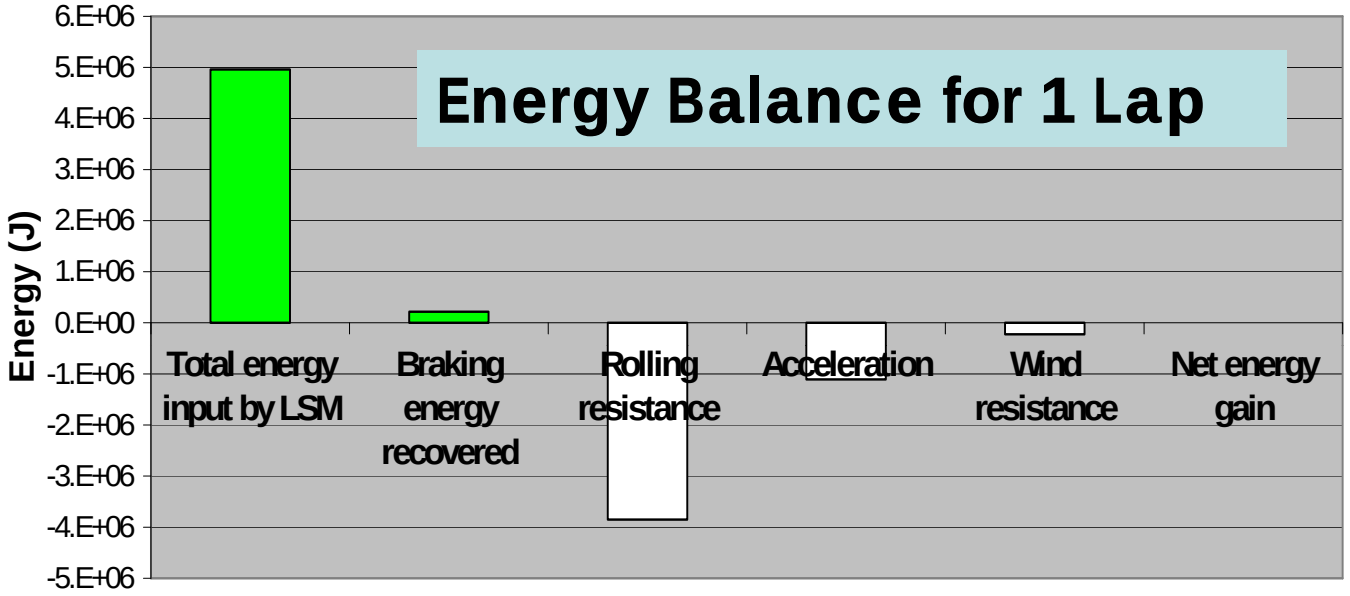
While operating on linear motor-retrofitted road (or elevated guideway) segment, power is supplied by road/guideway and batteries are simultaneously recharged



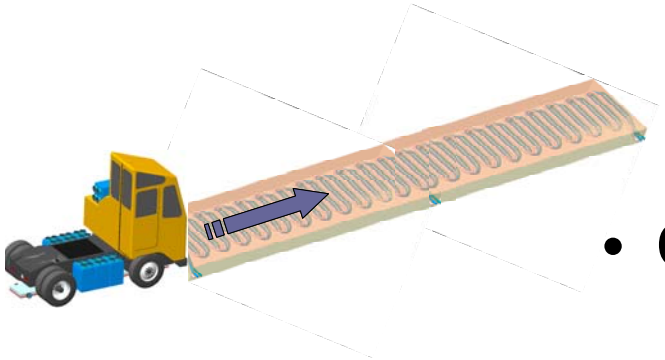
Benefits

- Trucks operate in zero-emission mode 100% of time
- Eliminates need for heavy, expensive battery packs
- Vehicles are recharged "on the go" – do not need to be removed from service to recharge batteries

Typical Terminal Operating Scenario/ Energy Balance



MagneTruck™ Freeway Example: I-710



- **Getting onto I-710**
  - Driver maneuvers truck onto dedicated truck lane with linear motor in ground
  - Engine is turned off
  - Road provides power – driver just steers
  - Batteries are recharged
- **Getting off I-710**
  - Onboard electric drive motor activated
  - Vehicle steers onto offramp
  - Battery power used to get truck to its destination and then back to I-710

BUSINESS CONSIDERATIONS

GA Business Approach to Port Opportunity

- **Private Financing**
  - Meet port desire for private investment in system
  - Assemble strong financial team (ITSC, Macquarie, AECOM)
- **Technical Approach**
  - Must be driven by business considerations
  - Minimize up-front investment, technical risk
  - Capture enough business to yield an attractive return
  - Phase in more advanced capabilities as justified economically
- **Logical Evolution**
  - Near Term – Systems like MagneTruck™ that can use existing infrastructure
  - Longer Term – Systems like ECCO maglev with added benefits

Linear Motors: Already Proven in Transportation

Urban Light Rail Systems

- "Short-stator" linear motors installed on vehicles
- React against metal plate in track
- In passenger transport operations since 1987
- Examples: JFK AirTrain (New York), Detroit People-Mover

Maglev Systems

- Can use "short-stator" linear motors on vehicles or "long-stator" motors in guideway
- Transrapid system in passenger transport operations since 2005
- Other systems in development in U.S., Japan, Korea

Electric Truck Capital Cost Comparison

	Battery-Electric Truck	Magne-Truck™	Assumptions
Battery-electric operating range	50 miles	5 miles	All destinations are within 2.5 miles of linear motor roadway
Battery pack size	150 kWhr	15 kWhr	Truck consumes 3 kWhr of energy per mile
Battery pack cost	$150,000	$15,000	Battery pack costs $1,000 per kWhr of usable energy capacity
Magnet array and pickup system cost	$0	$35,000	$27,500 for magnets + $7,500 for supporting equipment
Total truck cost	$250,000	$150,000	Balance of truck costs $100,000 ($50K glider + $50K drive system)

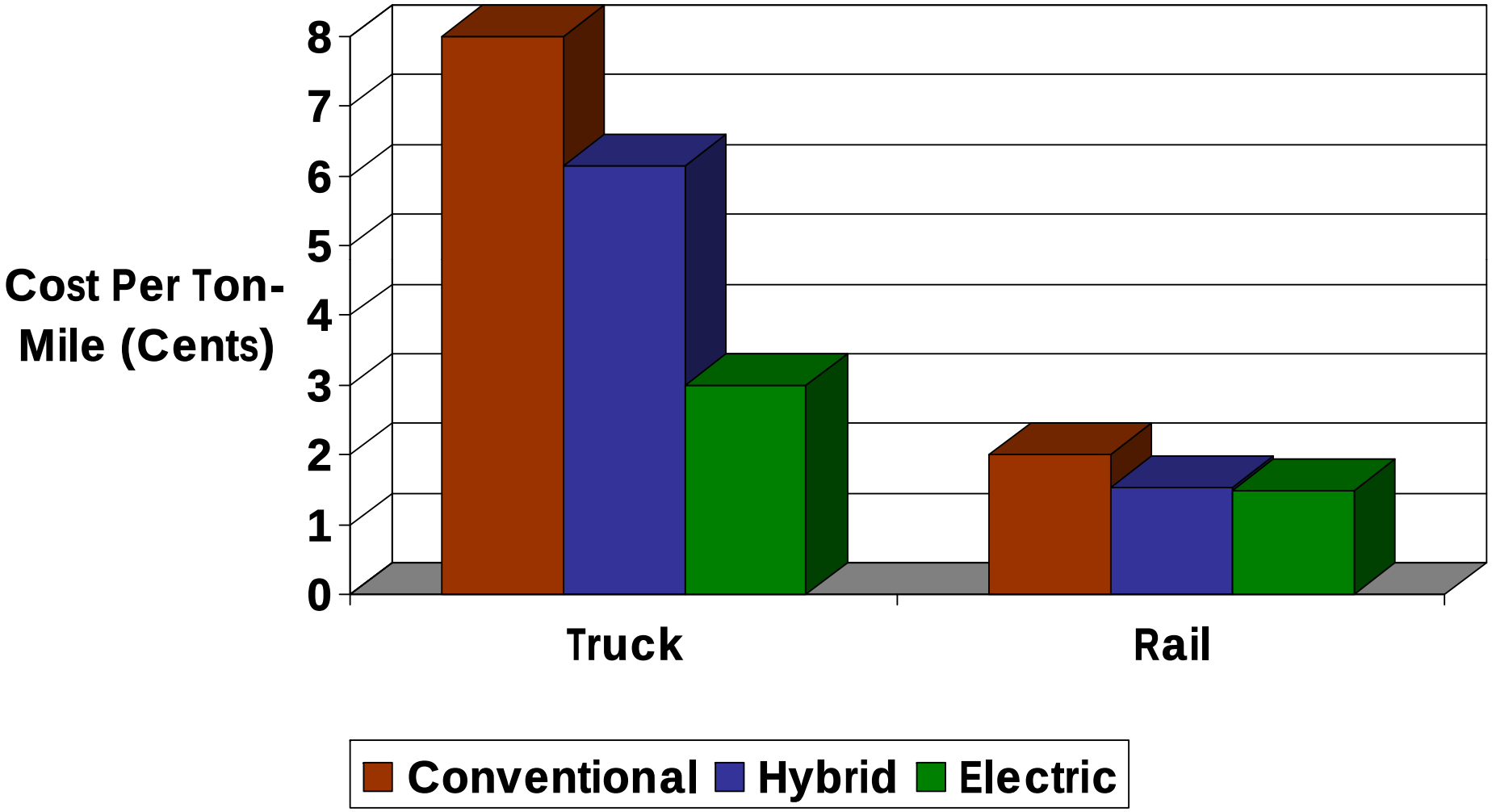
ROM planning estimates – example only

Life-Cycle Economics Comparison

	Battery-Electric Truck	Magne-Truck™	Assumptions
10-year mileage	500,000 miles	625,000 miles	Battery Truck: 4 RT/day x 250 days/year MagneTruck™: 5 RT/day x 250 days/year
Capital cost	$250,000	$150,000	From previous page
Battery replacement costs	$150,000	$15,000	One battery pack replacement during 10-year operating life
Maintenance costs	$75,000	$45,000	3% of capital cost per year
Energy costs	$225,000	$281,250	45 cents/mile based on 15 cents/kWhr
TOTAL COSTS	$700,000	$491,250	
Total Revenue	$2,000,000	$2,500,000	$200 per round trip
NET REVENUE	$1,300,000	$2,008,750	Over 10 years, revenues minus costs

ROM planning estimates – example only

Transportation Electrification: Cost Impact
(Cargo Transport, Based on $8/gallon for Diesel Fuel)



Public-Private Partnership Concept

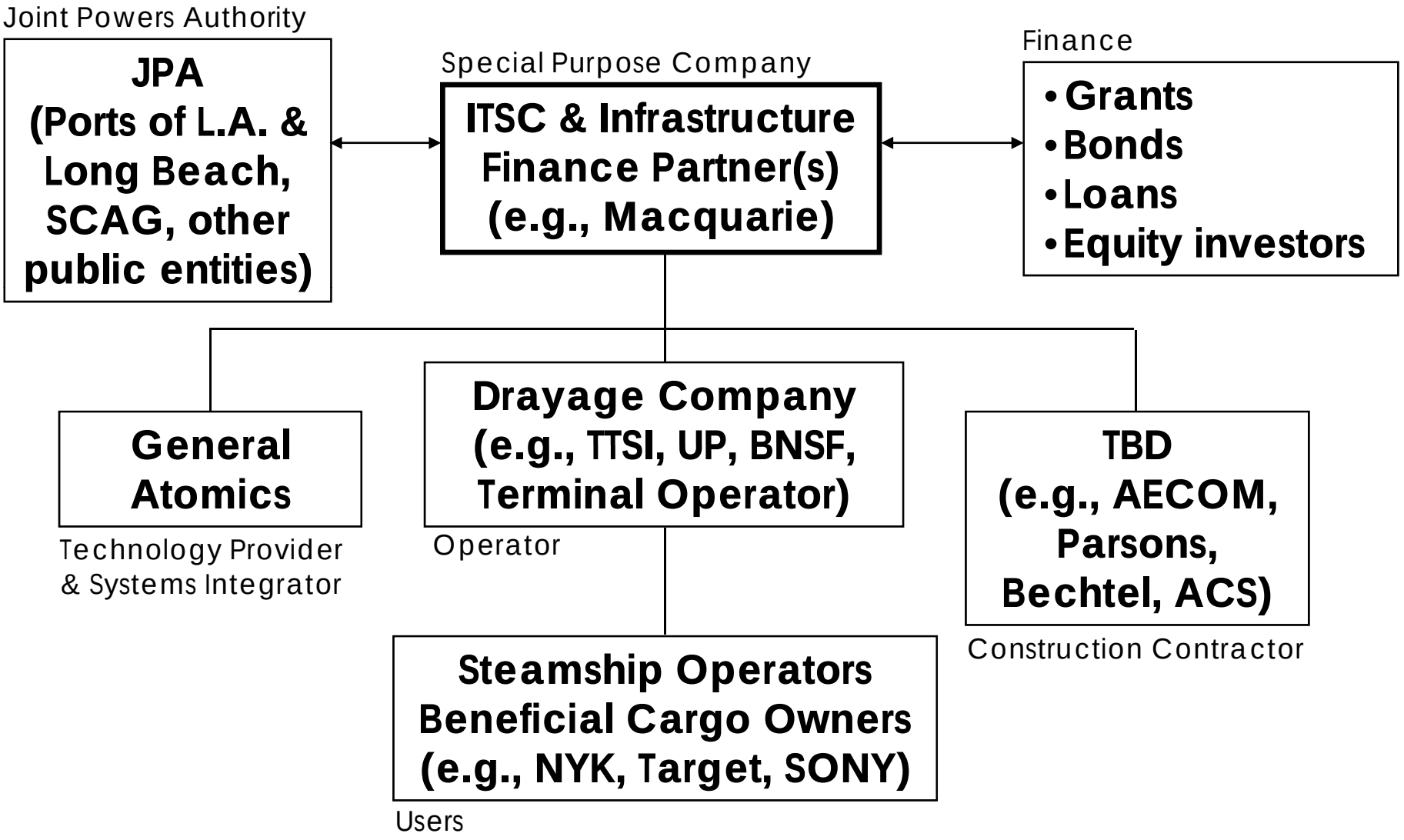
Public Sector Role

- **Provide seed funding to mitigate risks**
  - Environmental
  - Right-of-Way
  - Economic/Legal
- **Grant maglev operating "concession"**
- **Establish Joint Powers Authority (JPA) to achieve above**

Private Sector Role

- **Build and operate maglev system**
- **Arrange for most of maglev construction financing**
  - Debt
  - Equity
- **Bill users (passengers, shippers) for maglev use**
  - Repay debt
  - Earn return on equity investment

Electric Cargo Mover Business Model



Conclusions

- **Maglev and linear motor technologies have advanced considerably over the past decade**
- **Many innovative options exist for meeting port-related transportation needs**
- **We seek a business partnership with the ports and other stakeholders to determine the most cost-effective, profitable way to evolve linear motor-based systems**