A proposal for zero-emissions, electrified short-haul intermodal freight rail in Southern California

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The Ports of Los Angeles and Long Beach together handle about 40% of all containerized U.S. imports.

In 2017, nearly 17 million twenty-foot-equivalent units (TEUs) of intermodal container traffic moved through the San Pedro Bay Ports.
• In 2016, 28% of containerized import cargo moving through the San Pedro Bay ports left the docks by rail, and 72% by truck.

• In 2012, the San Pedro Bay Ports were responsible for approximately 55,000 direct daily regional truck trips, many of which are for moving containers.

(Photo: Port of Long Beach)
Over 1/3 of LA/LB port containers are moved by truck less than 80 miles to the Inland Empire (thousands of daily truck trips)
During congested times of day, truck travel time from Ports to Inland Empire is over 2 hours.

Warehousing, distribution, trans-shipment and logistics centers in Southern California boast about 1.5 billion square feet of storage space, representing 15% of the entire U.S. market, and 40% of the West Coast market.
If the Inland Empire were its own container port, the region would rank 4th busiest in the U.S. (just behind combined Port of New York and New Jersey), and in the top 25 in the world.
The cost of trucking in Southern California is increasing:
Port fees, fuel prices, cost of newer & cleaner trucks, congestion delays.

Road congestion in the Los Angeles-Inland Empire area costs the trucking industry greater than $2 billion per year in added operational costs, the most of any metropolitan area in the nation (2019 Urban Mobility Report, Texas A&M Transportation Institute)
Projected 2040 Highway Congestion

Map:
Southern California Association of Governments-
2016 RTP/SCS
Goods Movement

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Emissions from goods movement, (majority from diesel trucks) is a significant part of Southern California’s air pollution.
Diesel Particulates in South Coast Air Basin, linked to over 2,000 premature deaths each year
(Source: California Environmental Protection Agency, http://graphics.latimes.com/responsivemap-pollution-burdens/)
View from San Bernardino train station on a smoggy day,
Real-time EPA AirNow air quality map at time of photo
(Photo by Brian Yanity)
Air Pollution from Freight Movement

Looking over Inland Empire and LA Basin

(Photo: Brian Yanity)
Railyard Pollution

**Cancer Risk:** People living near BNSF Railway operations in San Bernardino face a much greater railyard-related cancer risk than people living near any of 16 other rail operations examined in state studies.

<table>
<thead>
<tr>
<th>Railyard</th>
<th>Company</th>
<th>Max cancer risk to resident*</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Bernardino</td>
<td>BNSF Railway</td>
<td>3300</td>
</tr>
<tr>
<td>Four railyards in the city of Commerce</td>
<td>BNSF &amp; UP</td>
<td>Less than 1,000</td>
</tr>
<tr>
<td>Container transfer facility</td>
<td>Union Pacific</td>
<td>800</td>
</tr>
<tr>
<td>Long Beach &amp; Carson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oakland</td>
<td>UP</td>
<td>460</td>
</tr>
<tr>
<td>Barstow</td>
<td>BNSF</td>
<td>450</td>
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<tr>
<td>City of Industry</td>
<td>UP</td>
<td>450</td>
</tr>
<tr>
<td>Los Angeles Transportation Center</td>
<td>UP</td>
<td>250</td>
</tr>
<tr>
<td>Watson Railyard, Wilmington</td>
<td>BNSF</td>
<td>174</td>
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<tr>
<td>Colton</td>
<td>UP</td>
<td>150</td>
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<tr>
<td>Stockton</td>
<td>UP</td>
<td>150</td>
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<tr>
<td>Stockton</td>
<td>UP</td>
<td>120</td>
</tr>
<tr>
<td>Mira Loma auto railyard</td>
<td>UP</td>
<td>100</td>
</tr>
<tr>
<td>Richmond</td>
<td>BNSF</td>
<td>100</td>
</tr>
<tr>
<td>San Diego</td>
<td>BNSF</td>
<td>70</td>
</tr>
</tbody>
</table>

* Number of cancer cases expected per million people, based on 70 years of exposure.

**Danger Zone:** A state study found that people living downwind of the BNSF railyard in San Bernardino face an increased cancer risk of as many as 2,500 cases per million people. The estimated regional cancer risk from all air pollution is 1,000 cases per million people.

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Source: California Air Resources Board

The Press-Enterprise

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Major parts of the solution:

1. Mode shift of more freight from truck to rail
   • Better integration of rail and truck intermodal operations/infrastructure
   • New intermodal facilities for short-haul freight rail services

2. Electrification of rail (zero-emissions)
Short Haul Freight Rail

• The Port of Long Beach & Port of Los Angeles are currently studying the short-haul freight rail shuttle concept, which has periodically been studied in the region over the past two decades.

• Ports have a goal of 50% of all cargo shipped by rail in 2030, up from 28% in 2016- short-haul freight rail service is needed for this.
Several major studies of the past two decades (most recent was completed in 2008) found short-haul freight rail in Southern California to be operationally feasible, but not yet cost-effective.

Class I railroads (UP and BNSF) have traditionally not seen short-haul freight service to be profitable enough to pursue:

- Capital cost of new or upgraded inland intermodal facilities
- Complex ‘disruption’ of existing operations
- Do not want it to interfere with profitable long-haul trains

Today, increasing road traffic congestion is making short-haul rail look more competitive with trucks for drayage between San Pedro Bay and the Inland Empire.
Completed in 2002, Alameda Corridor is operated by the Alameda Corridor Transportation Authority (ACTA), a public joint powers authority formed by the cities of Long Beach and Los Angeles.

The project’s main goal is the shifting more freight to rail instead of truck.
The 20-mile, triple-tracked, grade-separated line has vertical clearance for an overhead catenary wire over a double-container stacked train.
Source: Figure 3-2 from *Transitioning to a Zero or Near-Zero Emission Line-Haul Freight Rail System in California: Operational and Economic Considerations, Final Report*. Prepared for State of California Air Resources Board by University of Illinois at Urbana-Champaign Rail Transportation and Engineering Center (RailTEC), Spring 2016.
Short-haul rail would build upon ongoing investments in regional freight rail network.
Short-haul rail would build upon ongoing investments in regional rail capacity expansion, intermodal facilities, and rail-road grade separations.

Map: Southern California Association of Governments
2016 Regional Transportation Plan
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Moving a ton-mile of freight by rail uses $1/3^{rd}$ to $1/5^{th}$ the energy (and resulting pollution) compared to truck.

Rail transportation with steel wheels will always be more energy efficient than vehicles with rubber tires, due to the physical (mechanical) relationship between traction & friction.

(source: VTD Rail Consulting)
Intermodal Electric Freight Rail

Hector Rail intermodal freight train in Germany, pulled by Bombardier TRAXX electric locomotive

(Photo: pxhere.com, Creative Commons CC0)
Rail Electrification

- Zero emissions
- Quieter than diesel locomotives
- Lower energy cost, can be powered by renewable energy via the power grid
- Simpler locomotives, lower O&M costs
- Established, proven technology (main lines in Europe and Asia are electrified)

Overhead Catenary Wire:

- Required for conventional electric locomotives to run
- Typical cost >$10 million/mile
- Needs clearance of overhead obstructions, i.e. bridges
- Can face NIMBY opposition for aesthetic reasons
Electric freight trains were once common in Southern California

Pacific Electric Railway all-electric local freight train in South LA, 1953

(Photo: Pacific Electric Railway Historical Society)
Battery Electric Switcher Locomotive
(under construction by RPS)

Converting MK1200G natural gas locomotive,
with re-used lithium-ion EV batteries

(Photo: Brian Yanity)
Battery Electric Switcher Locomotive Range Extension

To work outside of a railyard, range-extension to pull trains up to 80 miles (short-haul distance between San Pedro Bay and Inland Empire) is possible by hybridization with:

- Natural gas
- Hydrogen
- Overhead Contact System (Catenary Wire)
- Wireless Power Transfer
Austrian Federal Railways ÖBB InnoShunt eHybrid prototype catenary-supercapacitor-battery switcher. Rebuild of Class 1063 electric locomotive by vehicle modernisation company TecSol.
All-electric locomotive operation has been required, & hybrids used, in New York City since the 1920s

GE “three-power boxcab”, 1928
New York Central #1525
Catenary- Diesel Hybrid Electric
“Dual Mode” Locomotive

Bombardier ALP-45

(Photo: Robert Pisani, railcolor.net)
RPS Proposed Stages of Southern California Rail Electrification

1. Battery-electric ‘yard switcher’ locomotives, (that do not leave railyards).

2. Range-extension of battery-electric locomotives for port switching and short-haul regional rail passenger and freight service (less than 100 miles).

3. Battery-”booster” locomotives paired with existing diesel-electric units (passenger and freight).

4. Regional deployment of electric locomotives and supporting infrastructure (overhead catenary wire, charging stations, etc.)
Possible operating scenario of Alameda Corridor electrification using catenary/battery hybrid locomotives

Rail lines (black) and rail yards (red) overlaid on map of existing, adjacent electric utility transmission lines and substations (yellow circles)

(Background map: California Energy Commission)
Short-haul electric freight trains eliminate the need to ‘change-out’ electric and diesel locomotives at inland railyards such as West Colton, San Bernardino, Barstow or Indio.

Electrified, zero-emissions Inland Ports possible.

“Rolling Highway” Roll-on/Roll-off Intermodal “Truck Train”, Switzerland

Fast electric ‘land ferry’ freight trains, running on regular schedules like a passenger train, designed to be competitive with highway trucking for distances less than 500 miles.

Photo: RAILpin
The person who operates the train can load and unload directly from the train cabin. Or, the truck driver can load and unload by him/her self.
Each railcar can be loaded or unloaded in as little as 7 minutes.

Simultaneous loading/unloading with many tractor/trailers of an entire train in as little as 10 -15 minutes.
Can load and unload under overhead electric wire,
Train can also carry passenger cars
Intermodal facility can be simple and low cost, can use existing railyards and sidings.
Logistic Solution: Example ICA Sweden
Borlänge city - Umeå City 578 km one way

Today
35 distribution trucks

Smaller warehouse, Umeå

Number of trucks= 27 st (Swedish 24 meter trucks) that supply the interlayer daily with food

9 Hours

Central warehouse, Borlänge

Profit / savings / year

53% Cost reduction
11,000 tonnes CO² reduction
4,000,000 Litre diesel reduction
150 MSEK Society cost reduction

Tomorrow
35 distribution trucks

6 hours

Central warehouse, Borlänge

• The 35 distribution trucks transported on flexiwaggons to the central warehouse in Borlänge city in the afternoon-evening

• Loaded up and transported again on flexiwaggons overnight to Umeå city

• Be in place in the morning when drivers come to drive out the goods to the customer
Southern California has potential for European-style “Rolling Highway” or roll-on/roll-off intermodal sites

..at existing railyards and sidings, minimal new infrastructure required.
Inland Empire - potential “rolling road” intermodal sites
San Bernardino Intermodal Yard

Photo: Brian Yanity
Next steps

Demonstrations needed in Southern California:

• Battery-electric switcher and charging infrastructure deployed in railyard (Anaheim, then others)

• Construction of electric freight rail demonstration line
  – Conventional overhead wire
  – Battery-charging stations
  – Emerging technologies (wireless power transfer, etc.)

• Pilot deployment of roll-on/roll-off intermodal rail car short-haul freight rail service-
  San Pedro Bay to an inland location
Thank you

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