Rewarding Zero-Emissions Container Movements

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San Pedro Bay Ports

• Ports of Los Angeles and Long Beach (POLA/LB)
  • 30%+ of total imported goods to the U.S.
  • 60% of freight tonnage imported/exported in the West Coast

• Located in the South Coast air basin
  • Chronic air quality issues

• Since 2012 conducting zero emission drayage demonstration projects
  • Millions in funding
Clean Air Action Plan (CAAP) 2017

• All vehicles accessing the port to be zero-emission by 2035
  • Near-zero emission heavy duty trucks (NZEHDT)
  • Zero-emission heavy duty trucks (ZEHDT)

• Clean Truck Fund Rate (CTFR)
  • Charged to beneficial cargo owners (BCOs)
  • Every container moved in non-ZEHDTs
  • Harbor Commission approved a CTFR of $10 per TEU

Los Angeles Times

L.A.-Long Beach ports approve truck fee too low to clean smog, groups charge

LA, LB Ports Postpone Plan for Clean Truck Fund
April 1, 2022 CTF Started

$10 per TEU

Expects to collect $90 million in the first year
Transitioning to ZEHDTs and NZEHDTs

Incentives are Needed
Key Factors Affecting the Use and Efficiency of ZEHDTs for Drayage

Operational:
- Shift duration and travelled distance
- Average loads
- Trips vs. tour composition
- Dual transactions
- Truck turn times

Fleets and vehicles:
- Nature of business and fleet size
- Truck price
- Vehicle characteristics and fueling/charging characteristics
Incentives

• Most in the form of purchase vouchers
• Example:
  • Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
  • Up to $150,000 for Class 8 Battery Electric Trucks
  • There are ~15,000 – 18,000 drayage trucks serving the POLA/LB
    • ~$2.3 – $4.5 billion on incentives

• Challenges:
  • Lack of capacity to internalize risk
  • Vouchers for drayage would require billions of dollars
  • Existing funding level is not commensurate with needs
  • Incentives may favor large carriers
Rewards Program: Leveraging the CTFR

- Innovative coupling of the CTFR with a rewards program attached to zero-emission transport at the ports
  - Reward carrier for every container movement made by ZEHDT
  - Reward level to bridge the gap between diesel and ZEHDT costs
- Evaluate the program as potential solution to accelerate the transformation to cleaner technologies

- Opportunities:
  - Improve efficiency
  - Consistent with other programs that reward use
  - Mitigates the burden on carriers
Methodology
Method

1. Gather data from secondary sources;
2. Characterize and synthesize drayage operations;
3. Forecast improvements in operations, vehicle characteristics, and port activity;
4. Mathematical optimization: estimate CTFR and Reward levels
5. Generate and simulate different scenarios
6. Impact assessment
Container Forecast and Technology Penetration

Scenarios:
Container demand – low, mid, high
ZEHDT penetration – low, high
NZEHDT penetration – low, high

Container-ZEHDT-NZEHDTS
Optimal CTFR & Reward Level

Bridge the gap between ZEHDT and Diesel

Min $Z_{CTFR, reward} = CTFR_{reward} + \sum_{t=1}^{MT} S^t \cdot AZE_t$

Subject to:

$ZE_t = ZE_{t-1} - ZE_{t-1}, \forall t$

$NZE_t = NZE_{t-1} - NZE_{t-1}, \forall t$

$AZE_t = \min \left( \frac{D_t}{313 \cdot \text{teu} \cdot t_{313-ZE}^t}, \frac{ZE_t}{2} \right), \forall t$

$ANZE_t = \min \left( \frac{D_t - 313 \cdot \text{teu} \cdot t_{313-ZE}^t \cdot AZE_t - NZE_t}{313 \cdot \text{teu} \cdot t_{313-ZE}^t}, \frac{NZE_t}{2} \right), \forall t$

$ANE_t = \left( \frac{D_t - 313 \cdot \text{teu} \cdot t_{313-ZE}^t \cdot AZE_t + t_{313-ZE}^t \cdot ANZE_t}{313 \cdot \text{teu} \cdot t_{313-ZE}^t} \right), \forall t$

$CTF_{Collection} = \left\{ \begin{array}{ll} 313 \cdot \text{teu} \cdot t_{313-ZE}^t \cdot \text{teu} \cdot CTFR_t \cdot ANE_t, & \forall t < 9 \text{ (year 2030)} \\ 313 \cdot \text{teu} \cdot t_{313-ZE}^t \cdot \text{teu} \cdot CTFR_t \cdot (ANE_t + ANZE_t), & \forall t \geq 9 \end{array} \right.$

$IRR_{Disbursement} = 313 \cdot \text{teu} \cdot t_{313-ZE}^t \cdot ANE_t \cdot CTFR_t, \forall t$

$CTF_{Cum\_Collection} = CTF_{Cum\_Collection} + CTF_{Collection}, \forall t$

$IRR_{Cum\_Disbursement} = IRR_{Cum\_Disbursement} + IRR_{Disbursement}, \forall t$

$CTFR_t = CTF_{Cum\_Collection} - IRR_{Cum\_Disbursement}, \forall t$

$CTFR_t \geq 0, \forall t$

$CTFR_t \geq CTFR_{t-1}, \forall t$

$IRR_t \leq IRR_t, \forall t$

$IRR_t^5 = \left\{ \begin{array}{ll} \text{Min}_{t \leq 5} IRR_{TEU}, & \forall t \leq 5 \\ \text{Min}_{t > 5} IRR_{TEU}, & \forall t > 5 \end{array} \right.$

$IRR_t \geq IRR_t^5, \forall t$

$n_{CTF} S^t = \sum_{t=1}^{MT} IRR_t^5 \cdot 313 \cdot \text{teu} \cdot t_{313-ZE}^t, \forall t \geq t$

Minimum level of reward needed

Fleet penetration and active fleet balance

CTFR collection and Reward Disbursement

Minimum reward
Optimal CTFR & Reward Level

Continuous reward

Mid-Price Scenario

Low-Price Scenario
Optimal CTFR & Reward Level

Impact of Turn Time Improvements

Mid-Price Scenario

Low-Price Scenario

M-L-H: Mid Container Demand, Low NZEHD, High ZEHDT penetration
Optimal CTFR & Reward Level

Covering 5-year lease

• CTFR: $22-$56 per TEU
• Reward:
  • 2022: ~$90
  • 2035: ~$5-$23

M-L-H: Mid Container Demand, Low NZEHD, High ZEHDT penetration
Potential Benefits

Example:

• Can transition 17,000+ trucks by 2035

• Emissions reduction:
  • 10.3 million metric tons CO2
  • ~50% PM
  • ~95% NOx & SOx
Discussion

• A self-supported rewards program could achieve significant benefits
  • More if other incentives are available

• Considerations:
  • Price gap to bridge
  • Small fleet and owner operators
  • Reward limits
  • Most effective if ZEHDTs conduct local and regional as opposed to near-dock movements
  • Could be tied to e-mileage, or even market-based reward value pricing
Questions?

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Miguel Jaller
# Vehicle Efficiency Forecasts

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<th>Year</th>
<th>Fully Loaded Container (mile)</th>
<th>Empty Container (mile)</th>
<th>No Container (mile)</th>
<th>Battery Capacity (kWh)</th>
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*The first row of data is based on demonstration results; **Based on HVIP offerings

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<th>Year</th>
<th>Consumption Rate with Fully Loaded Container (kWh/mile)</th>
<th>Consumption Rate with Empty Container (kWh/mile)</th>
<th>Consumption Rate with No Container (kWh/mile)</th>
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*240kwh for present year is based on demonstration interview results & US Hybrid Battery Electric Class 8 Truck Spec Sheet.
# Truck Movement Efficiency

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<th>Adjusted % of Gate moves</th>
<th>Loaded % of Gate moves</th>
<th>Emptied % of Gate moves</th>
<th>kWh Loaded</th>
<th>kWh Emptied</th>
<th>kWh Full &amp; Empty</th>
<th>kWh Full &amp; Empty - Single-tour</th>
<th>Time Single-tour (ST)</th>
<th>Max ST per shift</th>
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*Adjusted values do not consider the "Long Distance" trips*