California Air Quality and Climate Change Mandates

2006
AB 32
California Global Warming Solution Act

2020
Reduce GHG emissions to 1990 levels

2030
Reduce GHG emissions to 40 percent below 1990 levels

2050
Reduce GHG to 80 percent below 1990 levels
Sustainable Community Strategies
### California Fleet

<table>
<thead>
<tr>
<th>Name</th>
<th>Capitol Corridor</th>
<th>Pacific Surfliner</th>
<th>San Joaquin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
<td>Auburn – Sacramento – Oakland – San Jose</td>
<td>San Luis Obispo – Santa Barbara – Los Angeles – San Diego</td>
<td>Oakland/Sacramento – Stockton-Fresno-Bakersfield</td>
</tr>
<tr>
<td>Route Mileage</td>
<td>168</td>
<td>350</td>
<td>364</td>
</tr>
<tr>
<td>No. of Stations</td>
<td>18</td>
<td>29</td>
<td>18</td>
</tr>
<tr>
<td>Railroad Companies</td>
<td>Union Pacific/Locally Owned</td>
<td>Union Pacific/BNSF/Locally Owned</td>
<td>Union Pacific/BNSF</td>
</tr>
<tr>
<td>No. of Cab Cars</td>
<td>Caltrans: 19  Amtrak: 0</td>
<td>Caltrans: 3  Amtrak: 10</td>
<td>Caltrans: 19  Amtrak: 3</td>
</tr>
<tr>
<td>No. of Locomotives</td>
<td>Caltrans: 25  Amtrak: 3</td>
<td>Caltrans: 14  Amtrak: 0</td>
<td>Caltrans: 25  Amtrak: 3</td>
</tr>
</tbody>
</table>
Rolling Stock Procurement History in California

Most Bi-level equipment needs to be replaced by 2025
Procurement Challenges & Decisions

- Uncertain short / long-term demand
- Operations and Maintenance standards not on par with other industries
- Network is not electrified
- Fleet Availability and Utilization: big improvement potential
- Aged and fragmented fleet
- Changing environment
Fleet Planning – Partnering with Deutsche Bahn Group

CA State Rail Plan

2018 California State Rail Plan
Connecting California

Our partner Deutsche Bahn Group

Travelers per day in Germany (GER) 6.0 Mio
Trains per day (GER) 24,300
Overall Fleet (GER) 269 High-speed trains
1,300 locomotives
4,100 multiple-units

high speed
other long distance
regional
Caltrans/DB Operational Analysis

- Caltrans/DB launched Operational Study on Capitol Corridor in January 2019
- Collected Technical Information from multiple carbuilders
- Alstom’s iLint is one of the vehicles selected
- Viriato will be used for the study
- Final Report will aide the future procurement decision
Sunline Transit Agency – Hydrogen Buses

- 1st ZEB Procured in 2000
- 1st Fuel Cell Hybrid Procured in 2002
- Currently 7th Generation of Fuel Cell Bus
- Currently Operating 11 Hydrogen Buses
- Multiple Fund Sources to Support Hydrogen Buses
- SunLine is the “Test Bed” for Technology Development, Infrastructure and Commercial Operations
- CoEZET for Training
SBCTA’s DMU Conversion Project

- 4 Bridge Replacements
- 9 Miles of Track Replacement
- 26 Grade Crossings
Hydrogen On Passenger Rail Application R&D
California Locomotive Emissions

- Class 1 LH
- Switcher
- Shortline
- Passenger

Comparison of NOx and PM2.5 emissions.
CARB’s Locomotive Petition

• CARB petition to U.S. EPA (April 2017)
• Proposed new Tier 5 emission standards
• 7 Agencies submitted letters of support
CA Sustainable Freight Action Plan

Governor’s Executive Order B-32-15
• Improve freight efficiency
• Transition to zero emission technologies
• Increase economic competitiveness

CalSTA
CALIFORNIA STATE TRANSPORTATION AGENCY

CalEPA
California Environmental Protection Agency

Caltrans
CALIFORNIA AIR RESOURCES BOARD

Energy Commission
STATE OF CALIFORNIA

CALIFORNIA GOVERNOR’S OFFICE OF BUSINESS AND ECONOMIC DEVELOPMENT
CARB Technology Assessment

- Multiple technologies assessed
- No Clear Path to zero
- Major challenges in line haul application
# Freight Locomotive Requirements

<table>
<thead>
<tr>
<th></th>
<th>Switcher</th>
<th>Line Haul</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Characteristics &amp; Requirements</strong></td>
<td>Sporadic peak at 1,006-2,300hp (750-1,715kW)</td>
<td>Extended operation at &gt;4,000hp (&gt;3MW)</td>
</tr>
<tr>
<td><strong>Refueling Range/Time</strong></td>
<td>8-16 hours</td>
<td>1,000 miles</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>Constrained by Locomotive Envelope</td>
<td></td>
</tr>
</tbody>
</table>
## Zero Emission Locomotive Challenges

<table>
<thead>
<tr>
<th>Application</th>
<th>Battery</th>
<th>PEM Fuel Cell</th>
<th>SO Fuel Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Haul</td>
<td>Uncertain? (Range)</td>
<td>Uncertain? (Power)</td>
<td>Possible?</td>
</tr>
<tr>
<td>Switcher</td>
<td>Probable?</td>
<td>Probable?</td>
<td>Possible?</td>
</tr>
</tbody>
</table>
CARB Incentives

- AQIP
  - Criteria pollutant and toxics reductions

- Carl Moyer Program
  - SIP emission reductions

- Community Air Protection
  - Criteria, toxics, GHG reductions for communities

- Low Carbon Transportation
  - GHG reductions and AB 1550 benefits

- VW Mitigation Trust
  - NOx mitigation

- Prop 1B Goods Movement
  - NOx and PM reductions in freight corridors

Open to variety of zero-emission locomotive technologies including fuel cell.
CARB Locomotive Demonstrations

• 2 current demonstration projects
  • Line Haul: Battery Electric Hybrid Consist
  • Switcher: Battery All-Electric

• Challenge for Locomotive Projects
  • Timeline
  • Cost
  • Emission reduction requirements
California Energy Commission - ARFVTP

AB-8 allocates $20M/yr to establish at least 100 public hydrogen stations. End of 2018:

- 38 stations open to the public
- 26 stations in development
- Funded network will provide 17,000 kg/day of nameplate capacity
- Funded two new renewable hydrogen production facilities
California Energy Commission – R&D

- Growing interest in hydrogen as long term energy storage to support an increasingly renewable and variable grid.

- Potential for hydrogen to electrify sectors that would be difficult to address with battery-electric, including rail and marine.

- FY19-20 Natural Gas Research Program Budget Plan ($24M/yr) has a research initiative for fuel cell demonstrations in locomotive and harbor craft applications at California ports.

- California ports are key targets for decarbonizing freight and reducing air pollution. There are opportunities to shared infrastructure across trucks, cargo handling equipment, cars, and potentially rail and marine.
Job Growth and Economic Development (GO-Biz)

- **Hydrogen Cost Reduction**
  - Rail is part of a comprehensive strategy to drive down the price of hydrogen
    - Reducing hydrogen kg price point will support development of H2 technology

- **Job Creation - Scalability**
  - Creates opportunities for local businesses
  - Developers estimate over 500 jobs (short- and long-term) created in California from funded light duty hydrogen stations
    - Outside of the currently existing 39 light duty hydrogen stations, there are 25 hydrogen stations that are in development

- **Tax Revenue**
  - Sales tax, property tax, income tax
Questions?

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Reducing Rail Emissions in California Webpage:
https://ww2.arb.ca.gov/our-work/programs/reducing-rail-emissions-california
Questions?

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