Sacramento Area Council of Governments

Roseville Transit Fleet Electrification

April 15, 2020
Agenda

1. Speaker Introductions
2. Firm Background
3. Transit Electrification Philosophy
4. Roseville Transit Case Study
5. Long Term Planning and Regional Coordination
Our knowledgeable team is here to share our insights from Roseville with the region.
**Willdan Overview**

- Founded 1964
- Publicly traded
- 1,200+ employees
- 60+ offices
- Local offices in Roseville and Elk Grove
- Headquarters in Anaheim, CA

Nationwide, Willdan has performed 14,000+ projects for close to 800 cities and counties

Within California, Willdan has served 424 of the 482 cities and 50 counties

**Takeaway**

*Willdan was founded to serve public agencies over 55 years ago, and continues to do so today*
There is a right away and an expensive way to do this – we want to help transit agencies find the right way.
Willdan’s Approach to Bus Fleet Electrification

- Route Modelling (CALSTART/3rd Party)
- Bus Selection and Phase-in Schedule
- Charging Requirements and Strategy
- Facility and Infrastructure Design
- Financial Analysis

Takeaway: Understanding fleet energy consumption is key to a thorough analysis
Roseville Transit

- “Small transit agency” per CARB ICT
- Bus Fleet and routes
  - Twelve 40’ transit buses serving 10 commuter routes into downtown Sacramento
  - Fourteen 35’ transit buses serving 11 fixed local routes throughout the City
  - All Gillig diesel buses
- Willdan tasked with developing a business plan to evaluate the economics of transitioning to a zero-emission fleet and helping the City procure up to 5 pilot electric buses and chargers

Takeaway: First step is to understand the existing conditions and how fleet operates
• CALSTART’s Electric Bus Corridor Analysis Tool predicts energy consumption:
  - Uses Altoona test reports to model individual bus characteristics
  - Uses actual route maps and weather to determine seasonal efficiencies
  - Simulates energy loss by lap and on-route charging (if needed)

• Energy usage informs minimum battery capacity needed to meet service requirements

• Helps determine total energy requirements, charging needs, charging strategy, and final cost

Route modelling and understanding of route efficiencies drives vehicle selection
## Commuter Route Selection

<table>
<thead>
<tr>
<th>Commuter Route Combination</th>
<th>Seasonal Total Daily Energy Usage (kWh/day)</th>
<th>Lowest Final SOC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AM Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>Interline 1 and 7</td>
<td>319.70</td>
<td>285.84</td>
</tr>
<tr>
<td>Interline 2 and 10</td>
<td>362.30</td>
<td>315.10</td>
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<tr>
<td>Interline 3 and 10</td>
<td>357.42</td>
<td>351.44</td>
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<tr>
<td>4</td>
<td>225.21</td>
<td>215.83</td>
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<td>5</td>
<td>251.35</td>
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<tr>
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<td>194.28</td>
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<tr>
<td>8</td>
<td>328.72</td>
<td>324.80</td>
</tr>
</tbody>
</table>

*Commuter Routes can be reliably operated with available 40’ 440 kWh EV buses. - Interlined routes can, and should, be recharged midday at the depot*

- Most local route service requirements cannot be met with 35’ 440 kWh EV Bus
  - Would require 3 on-route chargers ($1.5M) based on shared stops
  - Larger battery sizes don’t exist on this size bus so we tried again with a bigger bus with a bigger battery ($1.4M added cost)

**Upsizing to 40’ 660 kWh still not enough**

Routes still need more battery (not available), require 3 on-route chargers (no savings) or additional bus purchases ($3M) or technology switch ($4M+).
BEB Phase-In Strategy

- Blend EVs into the natural bus replacement schedule – assume 12 year useful life
- Evaluate if EV bus that meets service needs will be available at time of replacement. If not, do you delay and wait another cycle? Do you consider alternate technologies?
- Check replacement schedule and strategy with CARB ICT compliance
- Phase-in recommendations
  - Electrify commuter buses as they retire because service requirements can be met with available solutions
  - Delay electrifying FLR until 2026 replacements, when CARB mandates that purchases must include ZEBs
  - This allows technology to develop further and the City can reevaluate capabilities

Takeaway:
Prioritize replacements with needs that can be met with today’s technology
Charging Methods

- **High Power plug-in charging**
  - Charger output range from 50-200kW
  - Can have multiple ports/dispensers

- **Overhead pantograph charging**
  - Typically 300 kW, 450 kW
  - Can be used on-route or in depot

- Power levels are going up BUT, bus battery ultimately determines the maximum charge it can take at a given time – charging curve

Optimal charging strategy requires a balance between cost and flexibility
### Charging Requirements and Strategy

**Six 60 kW two-port chargers**
- City requires a mix of depot chargers for commuter and short FLRs and on-route chargers for long FLRs
- Willdan simulated depot charging scenarios with different levels of chargers (60-150KW)
- Identified optimal solution given clients goals: first or ongoing costs, flexibility, speed
- Generates bus charging demand profiles → used to calculate demand charges

**Four 150 kW three-port chargers**

#### Takeaway:
Higher power chargers result in higher demand, but provide more flexible schedules
Financial Analysis

- We used conservative assumptions to create a “semi-optimized worst-best case” scenario
- Total EV bus costs are projected to be higher than existing diesel bus costs
- EV operating costs are expected to be less than diesel, but not enough to overcome upfront cost difference
- BUT, continuing Business as Usual (BaU) with diesel buses is not an option, so now the City can start budgeting and planning accordingly

Takeaway: EVs will likely cost more over time; charger power level doesn’t significantly impact financials
**Conceptual Plan**

- Potential depot charging locations
  - Current parking locations
  - Grassy knoll
  - Underused northern lot
- Things to consider: access to power, installation cost, bus flow
- Design for a maximum full buildout
  - Eight 150KW chargers with three ports each
  - Assumes future FLRs don’t charge on-route
  - Backup charger
  - DAR, while not modelled, can likely blend into this setup, charging during the day when transit buses are in service.
- Allow for future DER installation including solar canopies and battery arrays

**Takeaway:** Plan for the future, but build incrementally
Planning for the Future

Today: Detailed planning allows for future infrastructure to be envisioned. Hard to reach infrastructure can be installed now.

Tomorrow: Incremental phase-in plan uses pre-installed hard-to-reach infrastructure to expand system capabilities as demand grows and technology matures.
While we developed this approach for transit agencies, these concepts and holistic planning strategies apply to other vehicle segments including light-duty municipal fleets, commercial fleets, heavy-duty freight, and general regional EV adoption.
## Regional Coordination

### TECHNOLOGY LIMITATIONS
- Still limited range on electric buses, though improving
- High mileage routes (>250 mi) will probably require on-route charging

### BENEFITS
- Shared or avoided infrastructure costs
- Revenue generation for host agency
- Ability to share buses between agencies

### REGIONAL INTEROPERABILITY
- Follow Open Charge Point Protocols (OCPP)
- SAE J3105 for overhead pantographs
- SAEJ1772 for plug-in charging

### IDEAL LOCATIONS
- Transfer stations or other agency connection points
- Locations with ample grid capacity

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**Takeaway:** By coordinating together, each agency can reduce costs and share local best practices.
Q&A