Electrification of the GO Transit Rail Network
Stakeholder Workshop - High Level Evaluation

September 22, 2010
AGENDA

- Study Overview & Where We Are

- Re-cap:
  - Reference Case
  - Rolling Stock Technology Assessment
  - Power Supply
  - Option Progression

- High Level Evaluation
  - Technology Evaluation
  - Corridor Prioritization

- Next Steps
  - Detailed Assessment Overview
  - Land Use and Population Analysis
  - Multiple Category Evaluation (MCE)
Study Overview & Where We Are

- *Objectives*
  - Development of network options
  - Screening to short-list up to 6 options
  - Detailed assessment, findings and conclusions

- *Criteria*
  - Objectives, baseline conditions, technical feasibility and network compatibility

- *Screening*
  - Stakeholder Engagement and Communication
Reference Case

- Basis for comparison of options
- Evaluate the incremental impacts of each technology

### Net Impact

- **Net Benefits & Costs of Technology 1**
- **Net Benefits & Costs of Technology 2**

### Components

- **Today’s Network**
- **Future Enhancements (Reference Case)**

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4
Rolling Stock Technology
Alternatives Shortlist

- Diesel Loco
- Electric Loco
- Dual Mode Loco
- Electric Multiple Unit
Power Supply - 2 x 25 KV OCS
Option Progression

Where

Potential Network Options Pre-Screening

Network Option – High Level Evaluation

How & When

Network Option – Detailed Evaluation

Decision Making

Potential Network Options

4 \( ^7 \) > 16,000

18 Network Options

Up to 6 Network Options

Report Study Findings

Technology Alternative Screening

4
Applying Pre-Screening Criteria

<table>
<thead>
<tr>
<th>Pre-Screening Criteria</th>
<th>Options Remaining</th>
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<tbody>
<tr>
<td>No pre-screening</td>
<td>16,384 (4^7)</td>
</tr>
<tr>
<td>1. Consider three technologies as a single family of electric trains at this stage</td>
<td>128 (2^7)</td>
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<tr>
<td>2. Lakeshore East and West to operate on the same technology</td>
<td>64 (2^6)</td>
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<td>3. Prioritizing highest service/demand corridors</td>
<td>18 + Reference Case</td>
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</tbody>
</table>
18 Network Options + Reference Case

<table>
<thead>
<tr>
<th>Lakeshore West</th>
<th>Lakeshore East</th>
<th>Georgetown</th>
<th>Milton</th>
<th>Barrie</th>
<th>Richmond Hill</th>
<th>Stouffville</th>
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✓ Indicates partial or full electrification of corridor
High Level Evaluation Principles

- Comparative assessment
- Assumes operationally feasible
- 19 service sections
Corridor Sections

- GT3
- GT2
- GT1
- BA2
- BA1
- RH2
- ST2
- ST1
- RH1
- MT1
- MT2
- LW2
- LW3
- LW4
- LW1
- UN
- LE1
- LE2
- LE3

- Current routes
- Future potential extensions

Lake Ontario
Downtown Toronto Detailed Sections
## Service Sections Electrified

### Cumulative from Union outwards

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Service Section</th>
<th>Corridor Section(s)</th>
<th>Service Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakeshore East</td>
<td>LE-a</td>
<td>UN1+UE1+UE2+LE1</td>
<td>Union to Pickering</td>
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<tr>
<td></td>
<td>LE-b</td>
<td>UN1+UE1+UE2+LE1+LE2</td>
<td>Union to Oshawa</td>
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<td></td>
<td>LE-c</td>
<td>UN1+UE1+UE2+LE1+LE2+LE3</td>
<td>Union to Bowmanville</td>
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<tr>
<td>Lakeshore West</td>
<td>LW-a</td>
<td>UN1+UW1+LW1</td>
<td>Union to Oakville</td>
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<tr>
<td></td>
<td>LW-b</td>
<td>UN1+UW1+LW1+LW2</td>
<td>Union to Hamilton James</td>
</tr>
<tr>
<td></td>
<td>LW-c</td>
<td>UN1+UW1+LW1+LW2+LW3</td>
<td>Union to Hamilton James and Hamilton TH+B</td>
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<tr>
<td></td>
<td>LW-d</td>
<td>UN1+UW1+LW1+LW2+LW4</td>
<td>Union to St Catharines</td>
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<tr>
<td></td>
<td>LW-e</td>
<td>UN1+UW1+LW1+LW2+LW3+LW4</td>
<td>Union to Hamilton TH+B &amp; St Catharines</td>
</tr>
<tr>
<td>Milton</td>
<td>MI-a</td>
<td>UN1+UW1+UW2+UW3+MI1</td>
<td>Union to Meadowvale</td>
</tr>
<tr>
<td></td>
<td>MI-b</td>
<td>UN1+UW1+UW2+UW3+MI1+MI2</td>
<td>Union to Milton</td>
</tr>
<tr>
<td>Georgetown</td>
<td>GT-a</td>
<td>UN1+UW1+UW2+UW3+GT1</td>
<td>Union to Brampton</td>
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<tr>
<td></td>
<td>GT-b</td>
<td>UN1+UW1+UW2+UW3+GT1+GT2</td>
<td>Union to Georgetown</td>
</tr>
<tr>
<td></td>
<td>GT-c</td>
<td>UN1+UW1+UW2+UW3+GT1+GT2+GT3</td>
<td>Union to Kitchener</td>
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<tr>
<td>Barrie</td>
<td>BA-a</td>
<td>UN1+UW1+UW2+BA1</td>
<td>Union to Bradford</td>
</tr>
<tr>
<td></td>
<td>BA-b</td>
<td>UN1+UW1+UW2+BA1+BA2</td>
<td>Union to Allandale</td>
</tr>
<tr>
<td>Richmond Hill</td>
<td>RH-a</td>
<td>UN1+UE1+RH1</td>
<td>Union to Richmond Hill</td>
</tr>
<tr>
<td></td>
<td>RH-b</td>
<td>UN1+UE1+RH1+RH2</td>
<td>Union to Bloomington</td>
</tr>
<tr>
<td>Stouffville</td>
<td>ST-a</td>
<td>UN1+UE1+UE2+ST1</td>
<td>Union to Mount Joy</td>
</tr>
<tr>
<td></td>
<td>ST-b</td>
<td>UN1+UE1+UE2+ST1+ST2</td>
<td>Union to Lincolnville</td>
</tr>
</tbody>
</table>
Technology scenarios per corridor

- **Reference Case**
  - Tier 4 Diesel

- **Full Electrification**
  - Electric Locomotive
  - EMU

- **Partial Electrification**
  - Electric Locomotive + T4 Diesel
  - Electric Locomotive + Dual Mode
  - EMU + T4 Diesel
  - EMU + Dual Mode
Getting to the 6 Network Options

Compilation of data for **comparative** analysis to rank sections

- Technology characteristics
  - Rolling stock capital and O&M costs
  - Journey time benefits
  - Environmental (CAC, GHG, noise, vibration)

- Corridor section characteristics
  - Infrastructure and OCS capital and O&M costs
  - Population within 200m zone of influence
Capital Cost per Trainset

Cost ($m 2010 Prices)

- Diesel Locomotive
- Electric Locomotive
- EMU
- Dual Mode Locomotive

Locomotive = 10 passenger cars + 1 loco; EMU = 12 passenger cars
Comparative Operating Costs per Train Kilometer

- **Heavy Maintenance**
- **Light Maintenance**
- **Energy**
- **Staff**

Cost ($/train-km CAD 2010 Prices)

- Diesel Locomotive
- Electric Locomotive
- EMU
- Dual - Electric Mode
- Dual - Diesel Mode
Journey Time Improvement Index

![Bar chart showing Journey Time Improvement Index for different types of locomotives. The chart compares Diesel Locomotive, Electric Locomotive, EMU, Dual-Electric Mode, and Dual-Diesel Mode. The EMU has the highest improvement index, followed by the Electric Locomotive and Diesel Locomotive, with Dual-Electric Mode and Dual-Diesel Mode being the least improved.]
Environmental Considerations

Criteria Air Contaminant (CAC) Emissions
- Electric trains reduce local CAC emissions compared to Diesel loco
- Impact depends on population density adjacent to corridor

Greenhouse Gas Emissions
- EMU and Electric loco both reduce GHG compared to Diesel loco
- EMU’s higher energy demand results in more GHG emissions compared to Electric loco

Noise and Vibration
- All electric technologies deliver a reduction in noise and vibration compared to Diesel loco
High Level Evaluation Measures

1. Transportation Efficiency
   • Incremental Costs and Benefits
     – Capital costs – rolling stock, OCS, power supply, structures
     – O&M costs
     – User Benefits – journey time savings for users
       ▪ Ridership x time savings + estimated benefits from demand uplift
High Level Evaluation Measures

1. Transportation Efficiency (con’t)
   - High level Transportation Efficiency Index (TEI) using comparative data \[\text{User Benefits}/(\text{Capital} + \text{O&M Cost})\]
   - Higher TEI equates to greater return in user benefits per $ invested
   - TEI does not include all impacts & should not be compared to Metrolinx BCA’s
High Level Evaluation Measures

2. Environmental Efficiency

- Cost per % GO’s GHG/CAC/noise/vibration impact reduced
  - Lower cost per % impact reduced, greater return in environmental benefits per $ invested

- % Change in GO Transit’s contributions to:
  - Regional GHG
  - Local CAC, noise, vibration (weighted by population)
Electric Loco taken forward to detailed evaluation

- Elec Loco better transportation efficiency
- EMU – 2.9x journey time savings but Life cycle cost 4.7x more
- EMU – 4.7x more expensive so lower environmental efficiency
- EMU - Higher technology risk, implementation and affordability considerations
- Additional EMU transportation efficiencies could be realized with future modifications to the system.
High Level Evaluation Findings (2)

- With Electric Locomotives it is more cost effective to electrify the entire corridor
  - Elec Loco cost less than Dual Mode Loco
  - Elec Loco give O&M savings
  - Transportation and environmental benefits maximized

- Except:
  - Lakeshore West to Hamilton Th+B
  - Lakeshore West to St. Catharines
High Level Evaluation Findings (3)

- Diesel Loco trains for Hamilton TH+B and St. Catharines.

- Dual Modes
  - Not worthwhile if only a small fleet required
  - May be considered under implementation/ phasing strategy
6 Options for Detailed Evaluation
## Multiple Category Evaluation

<table>
<thead>
<tr>
<th>Environment &amp; Health</th>
<th>Quality of Life/User Benefits</th>
<th>Social Community</th>
<th>Economic/Financial</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission Reductions</td>
<td>Transportation Efficiency</td>
<td>Land Use</td>
<td>Cost-Effectiveness</td>
<td></td>
</tr>
<tr>
<td>Noise &amp; Vibration</td>
<td>Transportation Efficiency (Non-Users)</td>
<td>Community</td>
<td>Land Use and Property Value</td>
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<tr>
<td>Health</td>
<td>Transit Network/ System Access</td>
<td>Safety</td>
<td>Property Effects</td>
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<tr>
<td>Biodiversity</td>
<td>Reliability</td>
<td>Heritage and Archaeology</td>
<td>Construction Employment Effects</td>
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<tr>
<td>Water Environment</td>
<td>Comfort and Expandability</td>
<td>Visual Effects</td>
<td>Operating Employment Effects</td>
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<tr>
<td>Effect on Parks/ Public Open Space</td>
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<td>Operating Employment Effects</td>
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<td></td>
<td>Effect on Parks/ Public Open Space</td>
<td>Taxes</td>
<td></td>
</tr>
</tbody>
</table>

- **Implementation**
  - Constructability
  - Acceptability
  - Funding
  - Risks
Land Use & Population Analysis
Next Step - Detailed Evaluation

- Undertake the detailed MCE on the six shortlisted network options, including sensitivity and scenario testing (compare with the Reference Case)
- Undertake a detailed risk assessment on issues which may affect the case for electrification
- Consider wider constraints and opportunities and implications of other Metrolinx studies
- Determine key phasing and implementation considerations
- Continue to consult with the public and stakeholders and receive feedback
Questions and Comments