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Presentation to Standing Senate Committee on Energy, the Environment and Natural Resources

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Outline

- Alberta’s electricity system today
- Outlook for the future
- Challenges of transition
Snapshot: Alberta’s Power Grid

- Over 26,000 km of transmission
- Over 240 generating units
- 16,409 MW installed generation
- 11,229 MW peak demand record set Jan 2015
- Three interconnections to B.C., SK, Montana
Different Needs Across Jurisdictions

How power is consumed in…

Alberta: 52% Industrial, 24% Commercial, 15% Residential
Ontario: 24% Industrial, 52% Commercial, 15% Residential
California: 15% Industrial, 52% Commercial, 15% Residential
Load Outlook

Average annual growth rates

<table>
<thead>
<tr>
<th>Period</th>
<th>Low Growth</th>
<th>Mid Growth</th>
<th>High Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005-2015</td>
<td>1.9%</td>
<td>1.9%</td>
<td>1.9%</td>
</tr>
<tr>
<td>2015-2022</td>
<td>2.0%</td>
<td>2.8%</td>
<td>3.9%</td>
</tr>
<tr>
<td>2015-2037</td>
<td>1.1%</td>
<td>1.7%</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

Source: AESO, Conference Board of Canada
Generation Outlook: Rapid Transition From Coal to Gas and Renewables

<table>
<thead>
<tr>
<th>Year</th>
<th>Total capacity</th>
<th>Coal-fired</th>
<th>Cogeneration</th>
<th>Combined-cycle</th>
<th>Simple-cycle</th>
<th>Hydroelectric</th>
<th>Wind</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>19,476 MW</td>
<td>5,420</td>
<td>5,355</td>
<td>2,626</td>
<td>1,499</td>
<td>894</td>
<td>3,213</td>
<td>469</td>
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<tr>
<td>2027</td>
<td>22,313 MW</td>
<td>4,491</td>
<td>5,408</td>
<td>4,446</td>
<td>1,642</td>
<td>894</td>
<td>4,963</td>
<td>469</td>
</tr>
<tr>
<td>2030</td>
<td>23,424 MW</td>
<td>0</td>
<td>5,550</td>
<td>8,541</td>
<td>2,307</td>
<td>894</td>
<td>5,663</td>
<td>469</td>
</tr>
</tbody>
</table>

Existing
All peak: 11,229 MW

- 39% Coal-fired: 6,289 MW
- 28% Cogeneration: 4,504 MW
- 11% Combined-cycle: 1,716 MW
- 6% Simple-cycle: 996 MW
- 5% Hydroelectric: 894 MW
- 9% Wind: 1,463 MW
- 3% Other: 428 MW

Total capacity: 16,290 MW
Generation Outlook: Potential in Alberta

Wind Resources

[Map showing wind resources in Alberta with different percentage ranges indicated by color gradients. Major cities like Edmonton, Calgary, Medicine Hat, Lethbridge, Grande Prairie, and Fort McMurray are marked. Extreme right map highlights potential generation sites with icons for different generation sources such as wind, solar, hydro, gas, and coal.]
Transition Challenges

**Pace**
- to ensure enough firm generation is in service when coal retires

**Transparency**
- to ensure the market can send signals to incent firm replacement generation

**Transition**
- to ensure new firm generation is operating reliably before coal retires
Operational Considerations

- Supply and transmission adequacy
- Changing system performance
- Balancing of supply and demand in real time; ramping requirements
- Need for improved visibility
- Increased complexity of transmission and generation outage planning
- Impacts of increased variability on interties, price, generation dispatch
Operational Challenges: Wind Integration

Day Ahead Wind Power Forecast vs. Actual Wind Production for the Month of January 2016

Accuracy Statistics:
- Mean absolute percent error (MAPE) = 10.5%
- Average range between the maximum and minimum forecast = 578 MW

This figure is intended to illustrate the correlation between the wind power forecast received from WEPROG and actual wind production.
Operational Challenges: Wind Integration

- Volatility in wind generation causes challenges for the system controller
- Main challenge: balancing AIES generation and load while maintaining grid reliability in primarily thermal operating environment

Day Ahead Wind Power Forecast vs. Actual Wind Production
June 18 – June 25, 2016
Operational Challenges: Wind Integration (Texas)

From Electric Reliability Council of Texas (ERCOT)
Operational Challenges: Solar Integration (California)

The duck curve shows steep ramping needs and overgeneration risk.

Sample Net Load – March 31, 2012

- Overgeneration risk
- Ramp need ~13,000 MW in three hours

(from the California Independent System Operator)
Emerging Challenge: Distributed Energy Resources (DER)

• Approx 470 MW of DER currently on system
  – From household solar to 29 MW wind facility
• CLP will drive DER development interest
• DER connection requirements currently differ from those for transmission generators
• AESO will need to revise/develop rules to accommodate DER growth
• Potential DER is 2,000+ MW across Alberta