Water Conservation, Efficiency and Productivity (CEP) Plan: Power Generation Sector Update

October 28, 2015
Key Messages

Significant Improvements Already Achieved

• Generation technology improvements have increased process efficiency and reduced water consumption
• Current transition from existing fossil-fueled thermal facilities (e.g. coal) to combined-cycle, cogeneration and renewable reduces water consumption

Challenges

• Environmental objectives may compete i.e. air emission controls or GHG targets may impact water consumption
• Electric power generation sector will continue to require water for the foreseeable future
Power Generation Sector

Background Information

- Deregulated Wholesale Electricity Market market balances demand and supply in real time
- Capital intensive industry; Generators bear the risk of investment
- In 2014, total installed capacity of ~16,000 MW serving a peak demand of ~11,000 MW

Load up 41% since 2000

**Alberta Electricity Load (TWh)**

Source: AUC – Alberta Electric Energy Generation (GWh) by Resource and Interchange
Application of Water Terminology to the Power Sector

- Power generation
- Water consumption
- Diversion
- Return flow
  All return flows meet or exceed regulated requirements

Water Source
Power Generation Water CEP Plan Scope

- Includes water consumption for Alberta generation only (not including water requirements for power imports)

- Includes power generation from:
  - Fossil-fueled thermal (e.g. coal)
  - Combined-cycle, simple-cycle, co-generation (e.g. Gas)
  - Biomass
  - Renewables (e.g. hydroelectric, wind, solar)

- Excludes water diverted for:
  - Concurrent uses (i.e. steam production from co-generation)
  - Resource extraction and delivery
Existing Power Generation Capacity by Watershed

- Disk Locations = Specific Watershed
- Disk Size = Relative Magnitude of Installed Generation Capacity
- Disk Colours = Different Generation Types

Sources:
• AESO List of Generators, 2011
Typical Water Consumption by Generation Type

For the power sector:
Water productivity = water consumption (m³) divided by power generation (MWh)

Consumptive use includes:
• Cooling (e.g. evaporative loss)
• Boiler (e.g. water treatment)
• Plant Facility (e.g. washing, domestic use)

Hydroelectric power ranges from 5 to 27 m³/MWh depending on climate conditions

Currently no nuclear energy in Alberta

### Generation Mix v. Water Consumption

#### Sources:
- Alberta Environment & Sustainable Resource Development Water Diversion and Return Flows (2005 to 2011) for coal
- AESO Annual Net Generation Data (2000 to 2011 power generation) and AESO Long-term Transmission Plan (2011) for forecasted information (2012 to 2029)

#### Water Consumption

<table>
<thead>
<tr>
<th></th>
<th>Baseline 2000-02</th>
<th>Forecasted 2015</th>
<th>Forecasted 2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>30%</td>
<td>29%</td>
<td>28%</td>
</tr>
<tr>
<td>Productivity</td>
<td>100.3 Mm³</td>
<td>102.4 Mm³</td>
<td>108.5 Mm³</td>
</tr>
<tr>
<td>Power</td>
<td>69%</td>
<td>64%</td>
<td>37%</td>
</tr>
<tr>
<td>Generation</td>
<td>3%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

#### Power Generation

<table>
<thead>
<tr>
<th></th>
<th>Baseline 2000-02</th>
<th>Forecasted 2015</th>
<th>Forecasted 2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>58,844 GWh</td>
<td>87,612 GWh</td>
<td>128,066 GWh</td>
</tr>
<tr>
<td>Productivity</td>
<td>1.7 m³/MWh</td>
<td>1.2 m³/MWh</td>
<td>0.9 m³/MWh</td>
</tr>
</tbody>
</table>

### Water Productivity
- Gas: 1.7 m³/MWh
- Coal: 1.2 m³/MWh
- Wind: 0.9 m³/MWh
- Hydro: 1.2 m³/MWh
- Biomass: 0.9 m³/MWh
## Water Productivity and Conservation

<table>
<thead>
<tr>
<th>Change in Water Productivity</th>
<th>Baseline 2000-02</th>
<th>Forecasted 2015</th>
<th>Forecasted 2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>(% improvement from baseline years)</td>
<td>0%</td>
<td>+31%</td>
<td>+50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equivalent Water Conservation</th>
<th>Baseline 2000-02</th>
<th>Forecasted 2015</th>
<th>Forecasted 2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>(water consumption assuming no change to power demand over time)</td>
<td>100.3 Mm³</td>
<td>68.8 Mm³</td>
<td>49.8 Mm³</td>
</tr>
</tbody>
</table>
CEP Power Sector Past Successes

• Application of new technology and equipment increases efficiency, reduces energy consumption and water use
• Water treatment improvements reduce chemical and water usage
• Use of low water use air-emission control equipment, when technology is appropriate
• Use of cooling ponds to reduce the volume of diverted water
• Co-benefits of generation facilities include provincial parks, local habitat improvement opportunities, infrastructure sharing (e.g. community water source management, irrigation)
## CEP Opportunities

| Opportunity                                                                 | Benefits          |
|                                                                            |                   |
| 1. Consider generation technologies with lower water consumption:          | Productivity      |
|   • Aging facilities to retire over next 20 years - expected replacement  |                   |
|   • replacement with lower water intensity technology                      |                   |
| 2. Continue to evaluate process improvements at individual facilities:    | Efficiency        |
|   • Water treatment improvements and reuse                                 |                   |
| 3. Upgrades to transmission infrastructure reduce electricity transmission losses, increase distributed site opportunities | Conservation     |
| 4. Improved availability and completeness of water diversion, consumption and return flow information submitted to AESRD from all sources | CEP              |
| 5. Continued development of meaningful Demand Management opportunities to reduce energy consumption | Consumers        |
| 6. Consumers expected to choose improved energy efficiency options (e.g. energy conservation, usage patterns) | Consumers        |
CEP Challenges

Electric power generation sector is influenced from outside...

- Magnitude, location and timing of electricity demand
  - Affect power generation options and choices

- Commodity prices and market dynamics (e.g. gas price, location)
  - Influence the future generation mix and operations with a corresponding effect on water consumption

- Regulations to reduce air emissions and GHG may impact water consumption – details of policy requirements are not yet known
CEP Implementation

- Continue to consider water efficiency measures for individual facilities
- Developed metrics that can be used to estimate sector water consumption - utilize the measures as the primary metrics for future tracking of sector CEP progress
- Improve availability and completeness of water diversion, consumption and return flow information submitted to AESRD from all sources to improve estimates of actual water consumption and use
- Promote balanced assessment between conflicting air, water and land environmental objectives – by evaluating tradeoffs as part of the planning process for new power generation
Summary

- Significant water productivity improvements have been achieved to date
- Current transition from existing fossil-fueled thermal facilities (e.g. coal) to combined-cycle, cogeneration and renewable reduces water use intensity
- 2012 CEP Plan forecast a 31% water productivity improvement by 2015 from baseline year – preliminary 2014 estimate indicates that sector is on track
- Metrics are in place to estimate sector’s future water consumption
- Challenges:
  - Regulatory Policy in Air Emissions and GHG may impact water CEP objectives – changes to policy are not known at this time
  - Electric power generation sector will require water for the foreseeable future