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

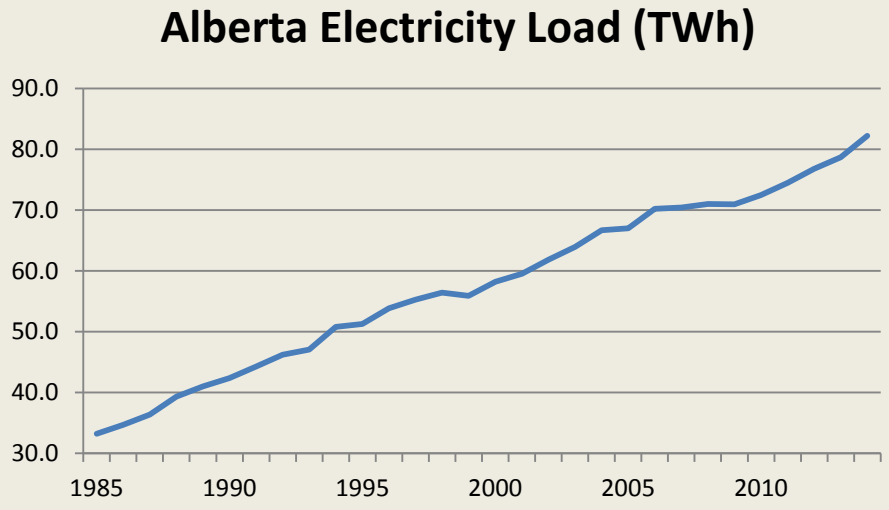
- Environmental objectives may compete i.e. air emission controls or GHG targets may impact water consumption
- Electric power generation sector will continue to require water for the foreseeable future

Power Generation Sector

Background Information

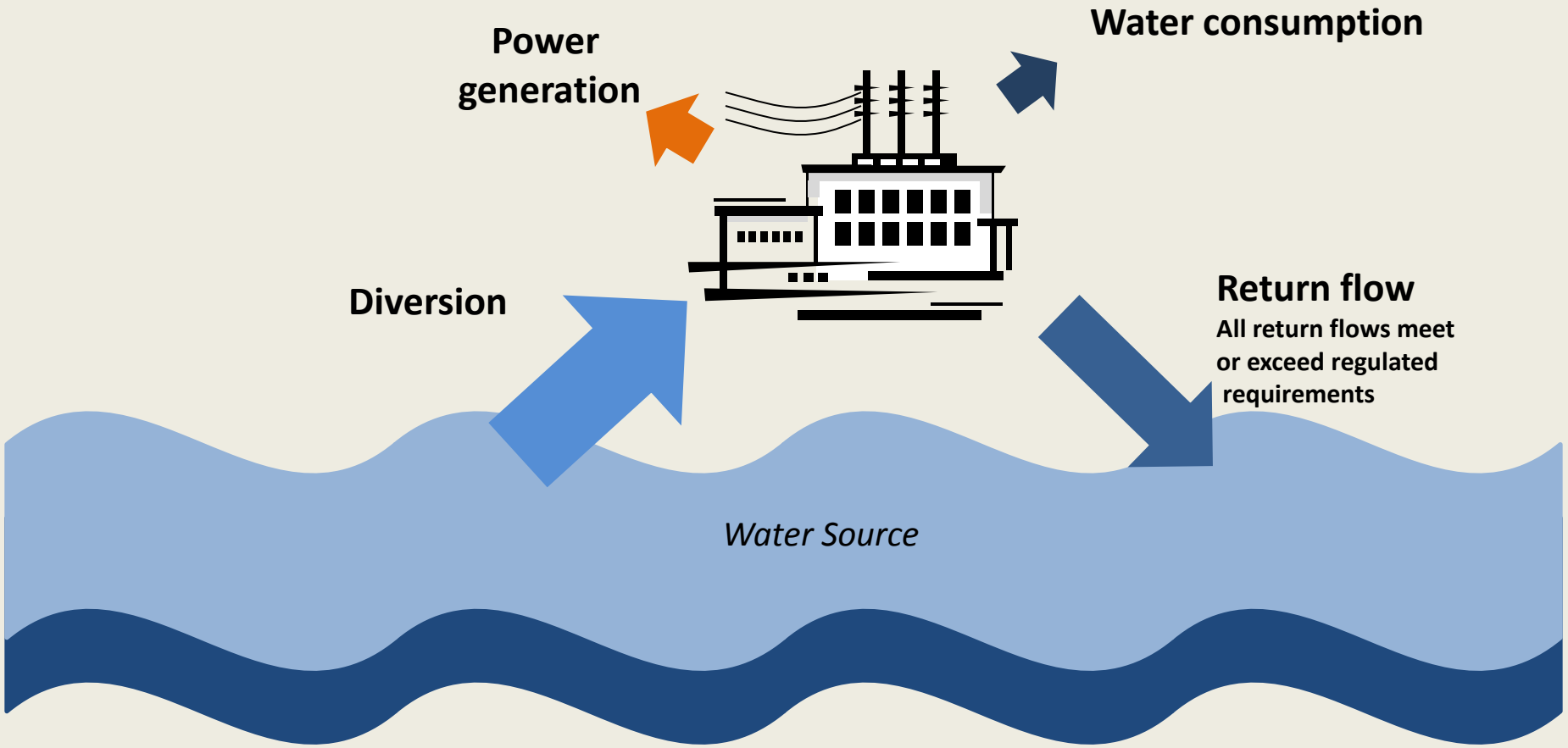
- Deregulated Wholesale Electricity Market market balances demand and supply in real time
- Capital intensive industry; Generators bear the risk of investment
- In 2014, total installed capacity of ~16,000 MW serving a peak demand of ~11,000 MW

Load up 41% since 2000



Source: AUC – Alberta Electric Energy Generation (GWh) by Resource and Interchange

Application of Water Terminology to the Power Sector



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

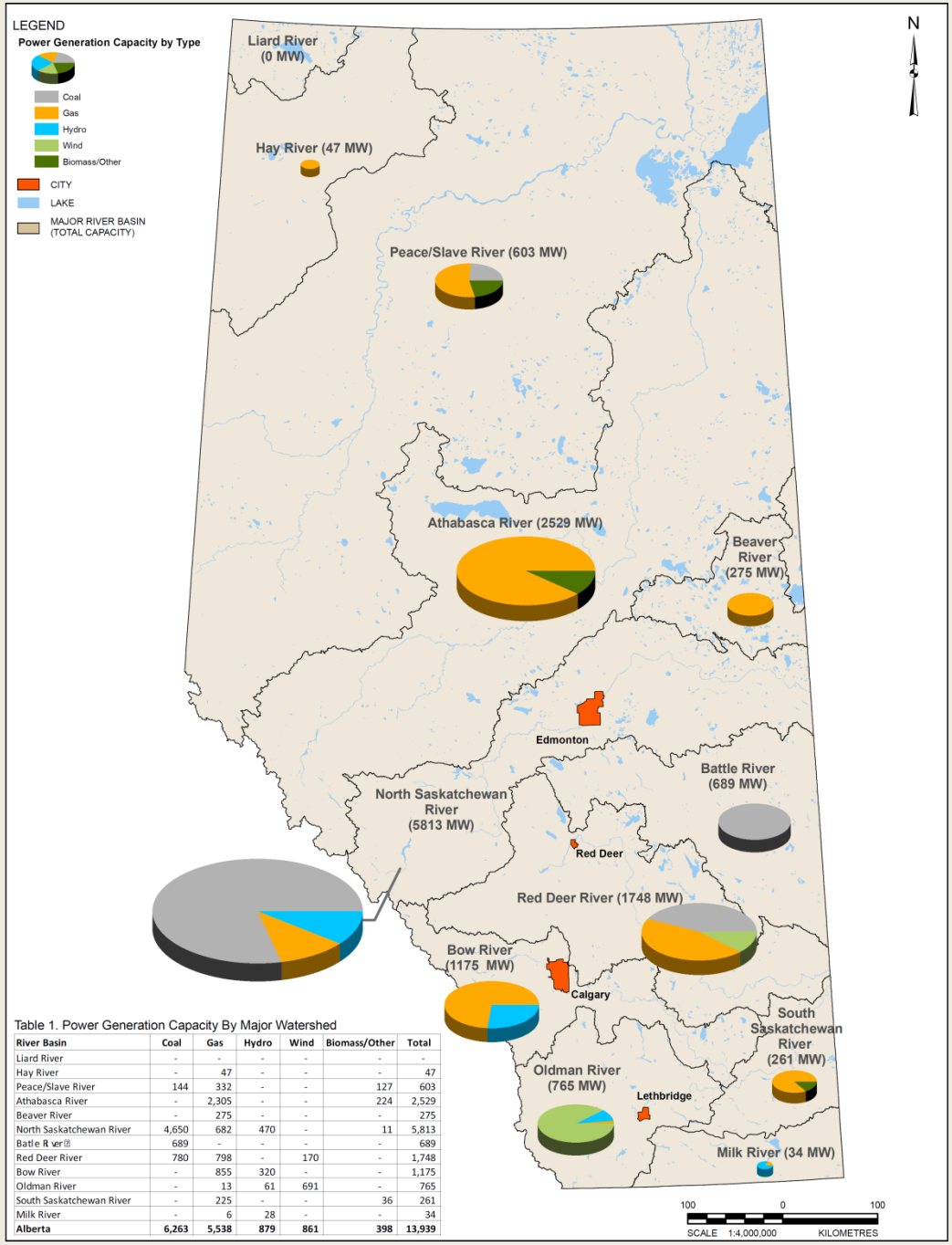


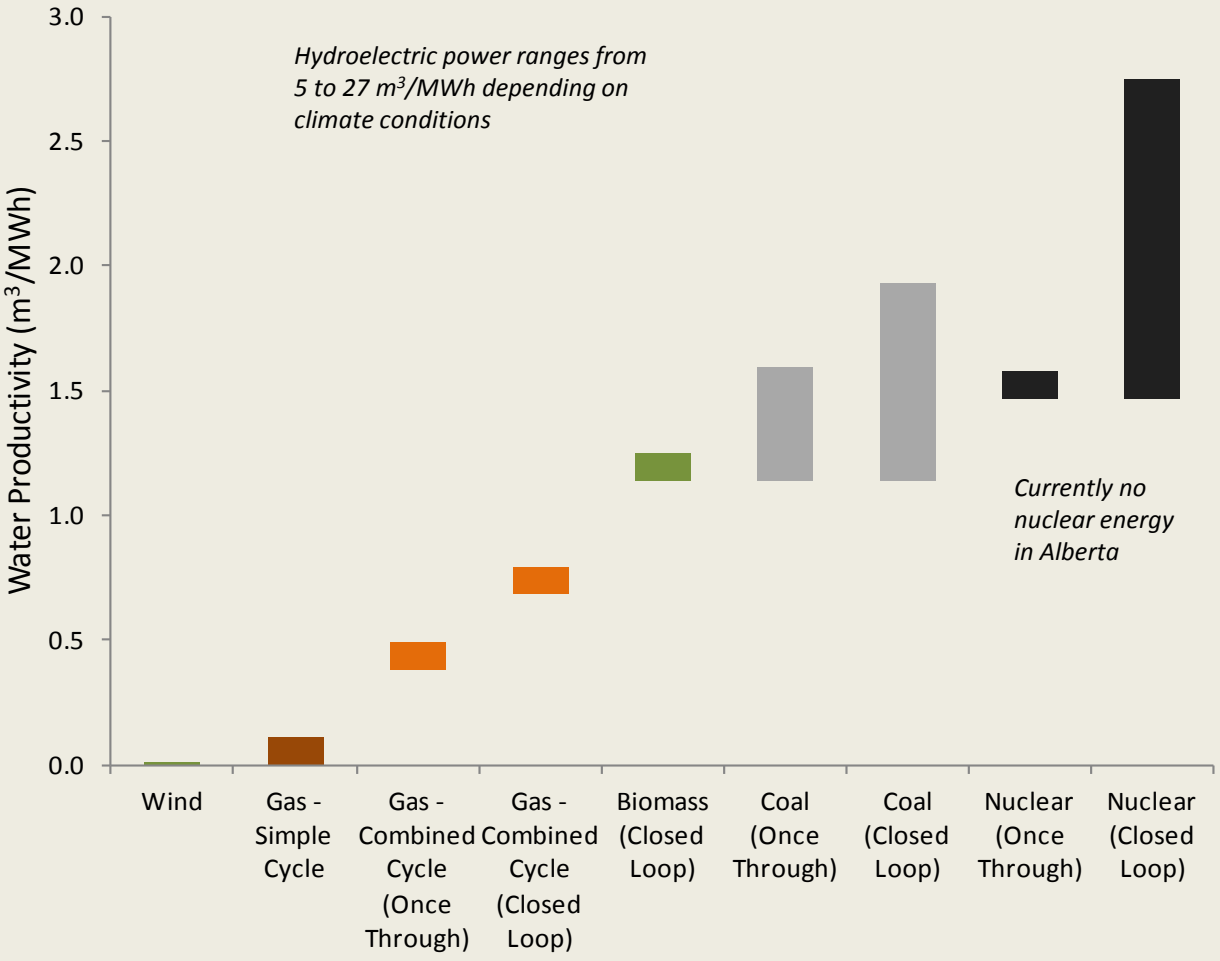
Table 1. Power Generation Capacity By Major Watershed

River Basin	Coal	Gas	Hydro	Wind	Biomass/Other	Total
Liard River	-	-	-	-	-	-
Hay River	-	47	-	-	-	47
Peace/Slave River	144	332	-	-	127	603
Athabasca River	-	2,305	-	-	224	2,529
Beaver River	-	275	-	-	-	275
North Saskatchewan River	4,650	682	470	-	11	5,813
Battle River	689	-	-	-	-	689
Red Deer River	780	798	-	170	-	1,748
Bow River	-	855	320	-	-	1,175
Oldman River	-	13	61	691	-	765
South Saskatchewan River	-	225	-	-	36	261
Milk River	-	6	28	-	-	34
Alberta	**6,263**	**5,538**	**879**	**861**	**398**	**13,939**

Sources:
•AESO List of Generators, 2011

Typical Water Consumption by Generation Type

For the power sector:
Water productivity = water consumption (m^3) divided by power generation (MWh)

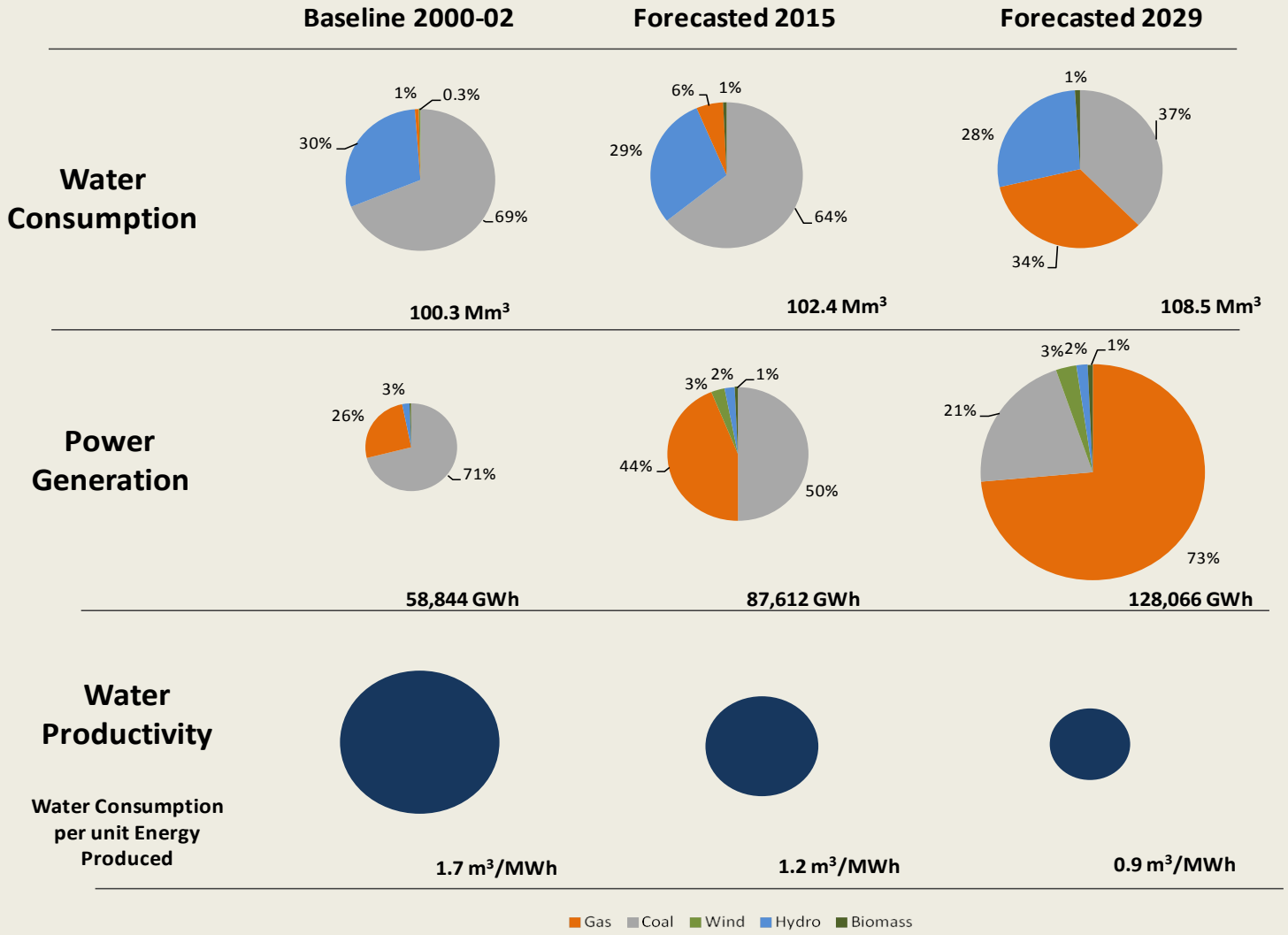


Source: Energy Technology Innovation Policy Research Group (2010)

Consumptive use includes:

- Cooling (e.g. evaporative loss)
- Boiler (e.g. water treatment)
- Plant Facility (e.g. washing, domestic use)

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)*
- *Typical consumption rates from Energy Technology Innovation Policy Research Group (2010)*

Water Productivity and Conservation

	Baseline 2000-02	Forecasted 2015	Forecasted 2029
Change in Water Productivity (% improvement from baseline years)	 0%	 + 31%	 + 50%
Equivalent Water Conservation (water consumption assuming no change to power demand over time)	 100.3 Mm^3	 68.8 Mm^3	 49.8 Mm^3

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: • Aging facilities to retire over next 20 years - expected replacement with lower water intensity technology	Productivity
2. Continue to evaluate process improvements at individual facilities: • Water treatment improvements and reuse	Efficiency
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