

Long-Term Transmission System Planning

AESO Stakeholder Consultation

November 16, 2007

Reliable **Power**

Reliable **Markets**

Reliable **People**



Jeff Nish,
Director, Resource
Adequacy



Agenda



- **Opening Remarks: Welcome & Introductions**
 - Jeff Nish
- **AESO's Future Demand and Energy Outlook 2007-2027**
 - LaRhonda Papworth
- **Draft Generation Scenarios**
 - Nicole LeBlanc
- **Next Steps**
 - Jeff Nish

Purpose of Today's Session



- **Long-term Planning for Alberta**
 - 20-Year Transmission System Outlook
 - 10-Year Transmission System Plan
- **Present Key Planning Inputs**
 - Load forecast
 - Generation scenarios
- **Consultation Process**
 - Open, transparent, publicly available
 - Comments & questions at meeting
 - Email comments and questions to AESO by November 30
 - Feedback and response posted to AESO website

Transmission Planning Approach



20-Year Outlook
Generation and Load Focused
High Level, Conceptual Transmission Alternatives

10-Year Transmission Plan
Roadmap for Transmission Development
Context for Need Applications

Individual Need
Applications

Future Demand and Energy Outlook 2007 - 2027

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LaRhonda Papworth,
Senior
Economics Analyst



Highlights



- **Input into our long-term transmission and operational plans**
- **Winter Peak:**
 - **We expect to see 3.5% growth in AIL winter peak over the next 10 years, 3.2% growth for the following 10 years**
 - **Northeast region leads growth with +3900 MW growth in the 20 year timeframe**
 - **Calgary and South Central region is second in load growth with +2500 MW expected**
- **Summer Peak:**
 - **Northeast region growing +3800 MW for the next 20 years**
 - **Calgary and South Central region growth of +2040 MW**
- **Study the past convergence of winter and summer Alberta Internal Load (AIL) peaks**
- **We see many challenges in forecasting the Alberta electricity demand on the horizon**

- **Definitions**
- **What are the drivers of the long-term electricity load forecast and how is the forecast used by the AESO?**
- **How does the AESO prepare an hourly electricity demand forecast?**
- **Summary of Results**
- **Historical Peak Analysis and Forecast Comparisons**
- **Methodology Summary**
- **Challenges**
- **Appendices**

Definitions

- **POD - Point of Delivery**
- **Behind-the-Fence Load (BTF) =
Load served by self-generation**
- **Alberta Integrated Electric System (AIES) =
POD Load + Transmission Losses**
- **Alberta Internal Load (AIL) =
POD Load + Transmission Losses + BTF Load**
- **Physical Load =
Electricity Retail Sales + BTF Load**
- **Load – hourly maximum demand of electricity**
- **Energy – sum of hourly load over a period of time**

What are the drivers of the long-term electricity load forecast?



- **AESO recognizes that there is a relationship between historical physical electricity load in the province and historical economic indicators**
 - GDP
 - Population
- **AESO uses this relationship along with forecasts of the indicators, to predict future physical electricity energy.**

How is the long-term electricity load forecast used by the AESO?



- **Provide a baseline for comparison in assessing current electricity load conditions**
- **An input into transmission studies to understand future electricity load conditions**
- **An input into Resource Adequacy's generation scenarios**
- **Also used by operations and regulatory**

How do we prepare an hourly load forecast?

Physical Load (Energy) by Year

Transformation

Create Hourly Load Shape by POD

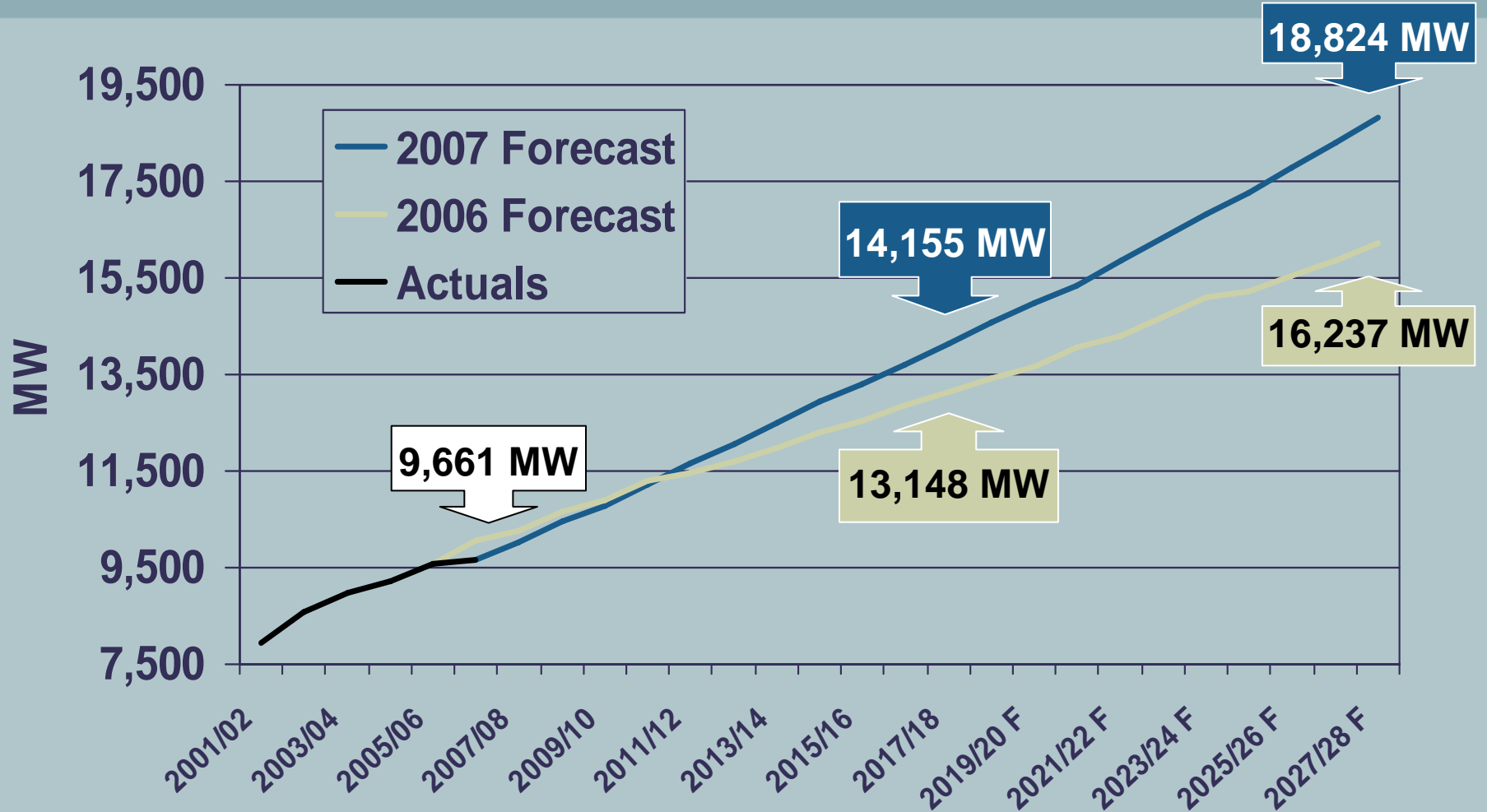
- Based on past 2 years load shape (averaged)

Locate Load Growth

- DFOs
- Industrial Customers
- Past growth performance

Hourly Demand by Point of Delivery (POD)

Summary of Results AIL Winter Peak



Summary of Results

AIL Winter Peak (MW)



Average Annual Growth Rates

2002/03 – 2006/07 Actual	3.0%	3.0%
2006/07 – 2017/18	3.5%	3.2%
2017/18 – 2027/28	2.9%	

Regional Results At Region Winter Peak



Northwest	Peak (MW)
2006/07 A	1,134
2007/08 F	1,160
2017/18 F	1,303
2027/28 F	1,588
20 yr Growth	+ 454

Calgary & South Central	Peak (MW)
2006/07 A	3,444
2007/08 F	3,604
2017/18 F	4,612
2027/28 F	5,973
20 yr Growth	+2,529

Edmonton & North Central	Peak (MW)
2006/07 A	2,155
2007/08 F	2,218
2017/18 F	2,715
2027/28 F	3,709
20 yr Growth	+1,554

Northeast	Peak (MW)
2006/07 A	2,040
2007/08 F	2,039
2017/18 F	4,459
2027/28 F	5,953
20 yr Growth	+3,913

South	Peak (MW)
2006/07 A	909
2007/08 F	918
2017/18 F	1,106
2027/28 F	1,512
20 yr Growth	+603

Regional Results At Region Summer Peak



Northwest	Peak (MW)
2007 A	1,080
2017 F	1,229
2027 F	1,475
20 Yr Growth	+395

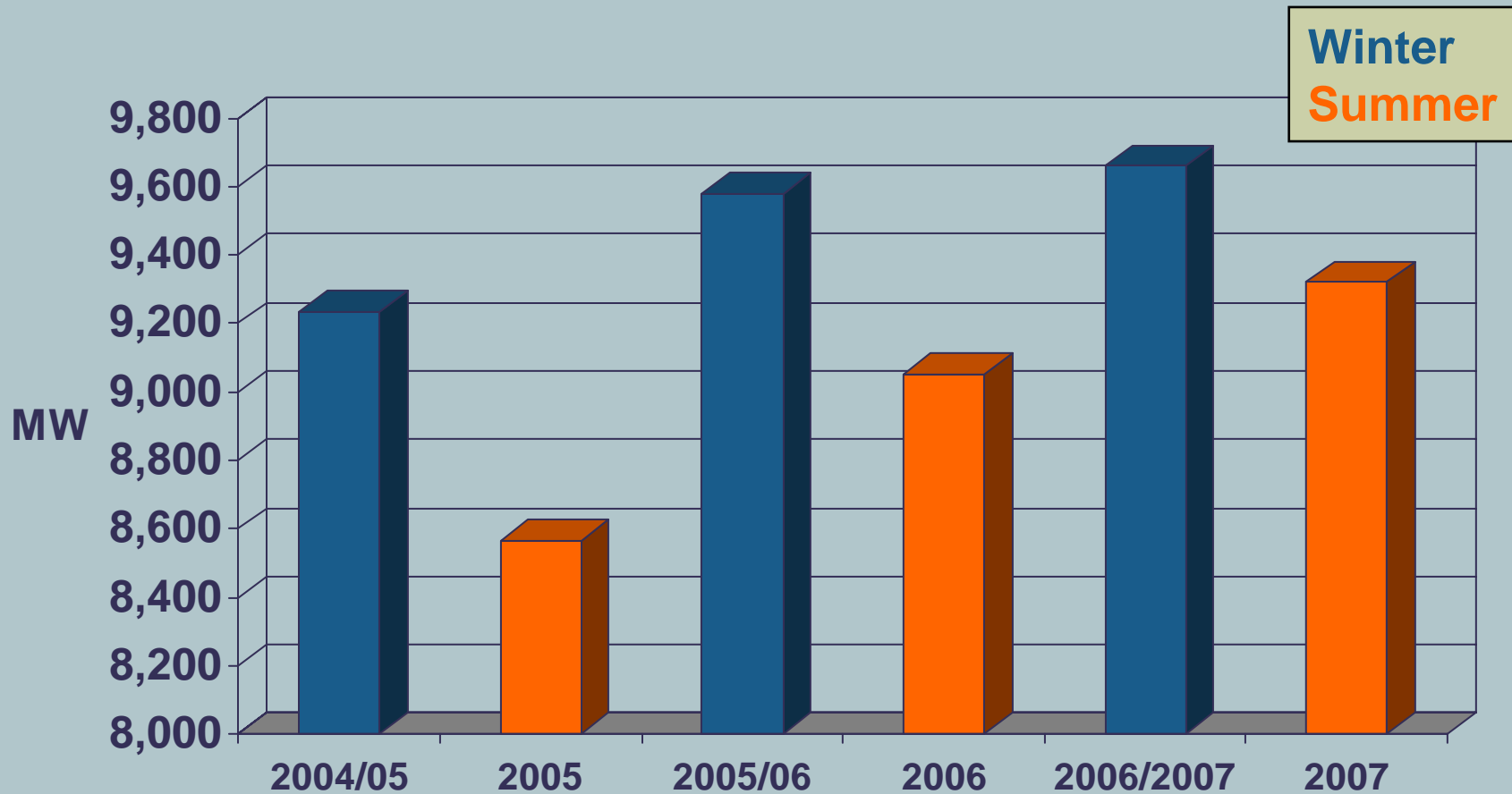
Edmonton & North Central	Peak (MW)
2007 A	2,018
2017 F	2,480
2027 F	3,387
20 Yr Growth	+1,369

Northeast	Peak (MW)
2007 A	1,852
2017 F	4,220
2027 F	5,685
20 Yr Growth	+3,833

Calgary & South Central	Peak (MW)
2007 A	3,175
2017 F	4,139
2027 F	5,215
20 Yr Growth	+2,040

South	Peak (MW)
2007 A	909
2017 F	1,155
2027 F	1,541
20 yr Growth	+632

AIL Historical Peak Analysis



Peak Load Forecast Comparisons



	Actuals (MW)	2004 Load Forecast	2005 Load Forecast	2006 Load Forecast	2007 Load Forecast
2004/05 Winter	9,236	9,307 -71	--	--	--
2005 Summer	8,566	8,840 -274	--	--	--
2005/06 Winter	9,580	9,513 +67	9,537 +43	--	--
2006 Summer	9,050	9,134 -84	9,277 -227	--	--
2006/07 Winter	9,661	9,790 -129	10,069 -408	10,046 -385	--
2007 Summer	9,321	9,360 -39	9,570 -249	9,107 214	9,225 +96

Energy Forecast Comparisons



	Actuals (GWh)	2004 Load Forecast	2005 Load Forecast	2006 Load Forecast	2007 Load Forecast
2005	66,267	67,207 -1.4%	66,906 -1.0%	--	--
2006	69,370	69,453 -0.1%	70,488 -1.6%	68,521 1.2%	--
2007YTD Oct	57,464	59,040 -2.7%	59,451 -3.3%	58,496 -1.8%	57,991 -0.9%

Methodology Summary



- **Conference Board of Canada's Long-term Economic Forecast – Provincial Outlook 2007**
 - Alberta Total GDP
 - Population
 - Alberta Agricultural GDP
- **Three customer sectors:**
 - Industrial & Commercial Physical Load = f (Alberta GDP, Historical)
 - Residential = f (#Customers = (f (population)), Avg Use)
 - Farm = f (Ag GDP, Historical)

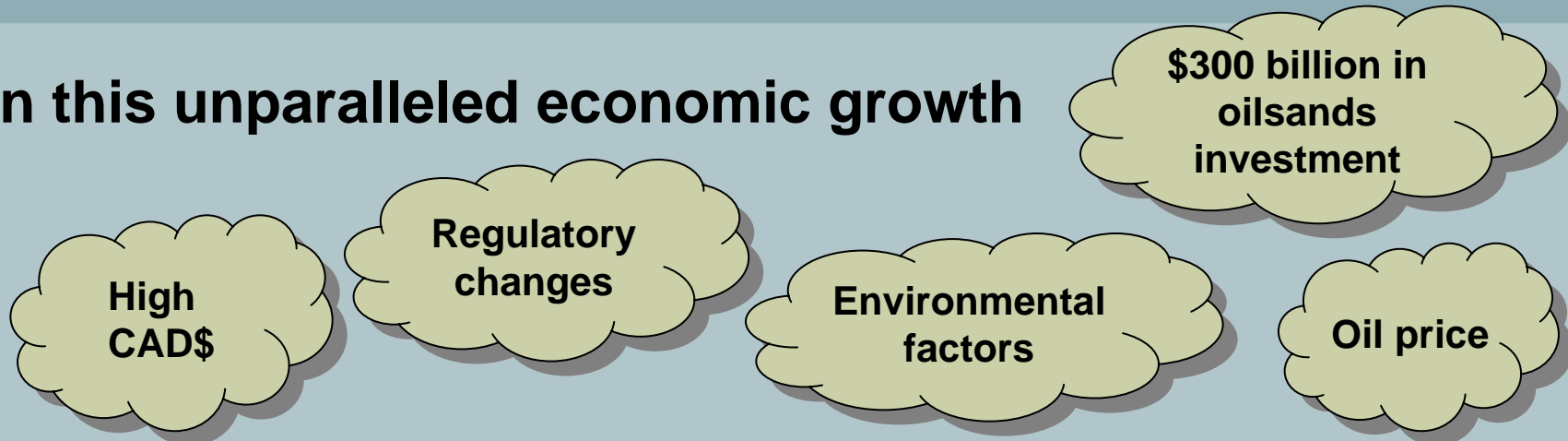
Current & Future Challenges



- **Challenges from the 2007 forecast:**
 - The large number of future oil sands and upgrader projects
 - Capture growth in regions outside of the Northeast region
- **Future areas of study:**
 - New demand side management initiatives, including demand response programs
 - New technology, with different electricity intensities
 - New environmental regulations around greenhouse gases
 - New exploration, particularly coal-bed methane extraction

Summary

In this unparalleled economic growth



- **How these factors and issues will affect the demand for electricity needs to be studied by the AESO**
- **The past relationship between economic factors and electricity demand is the best predictor, at this time, for future demand**

Future Demand and Energy Outlook 2007 - 2027

Appendices to November 16, 2007
Stakeholder Consultation Meeting

LaRhonda Papworth
Senior Economics Analyst

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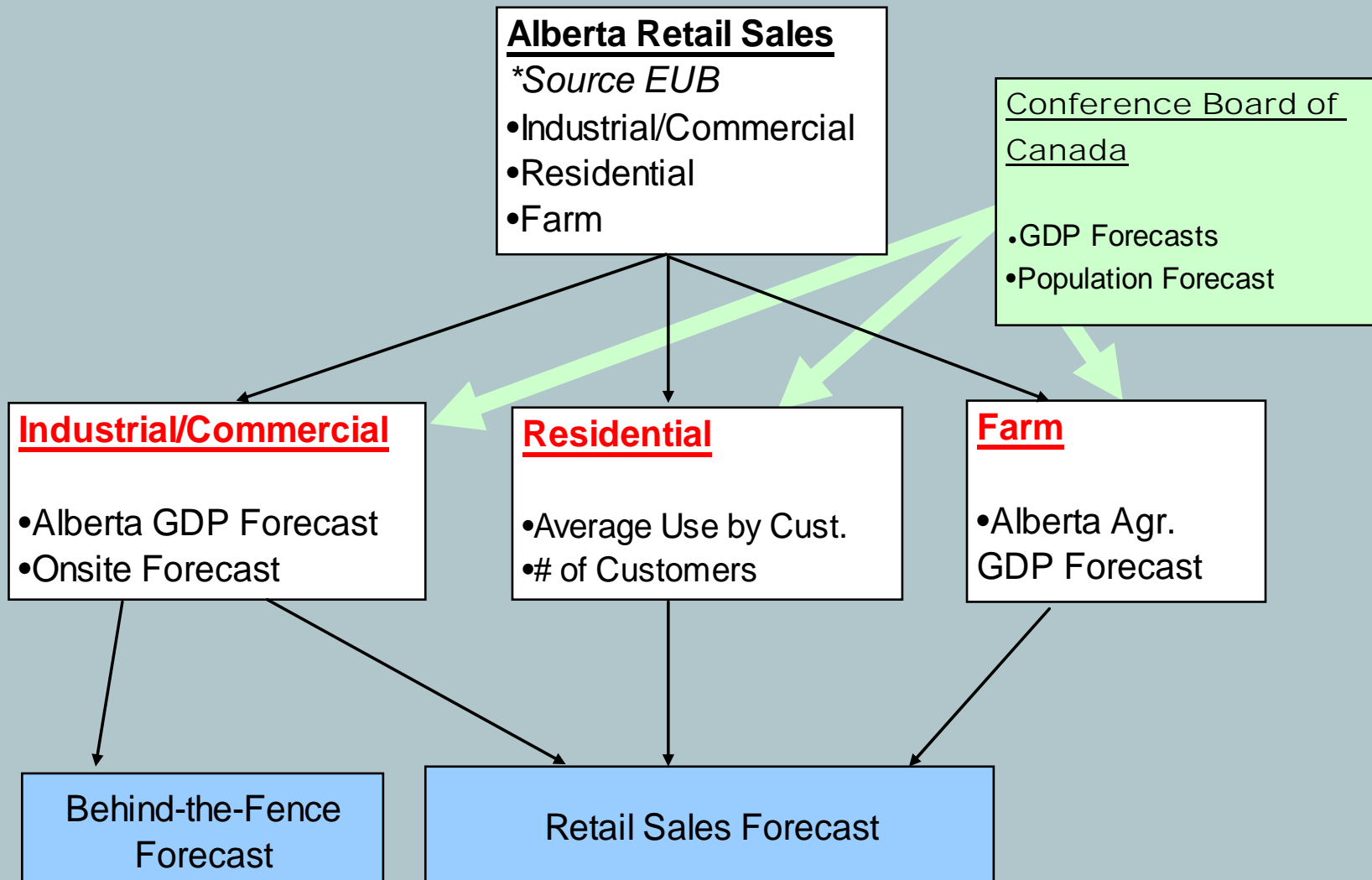


Appendices

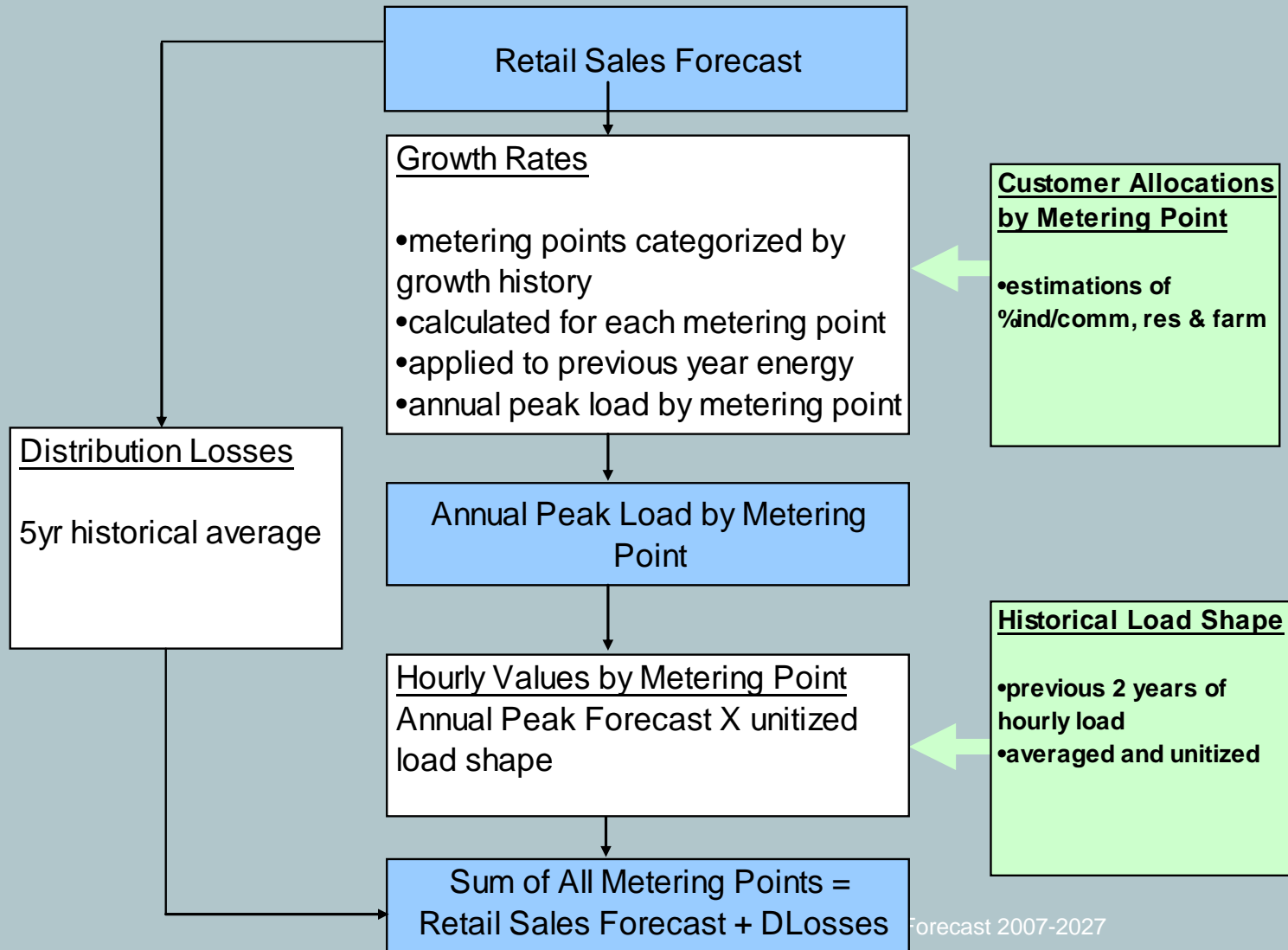


- **Load Forecasting Methodology**
- **Region definitions by transmission planning area**
- **Selected economic indicators**
- **Detailed Forecast Results**

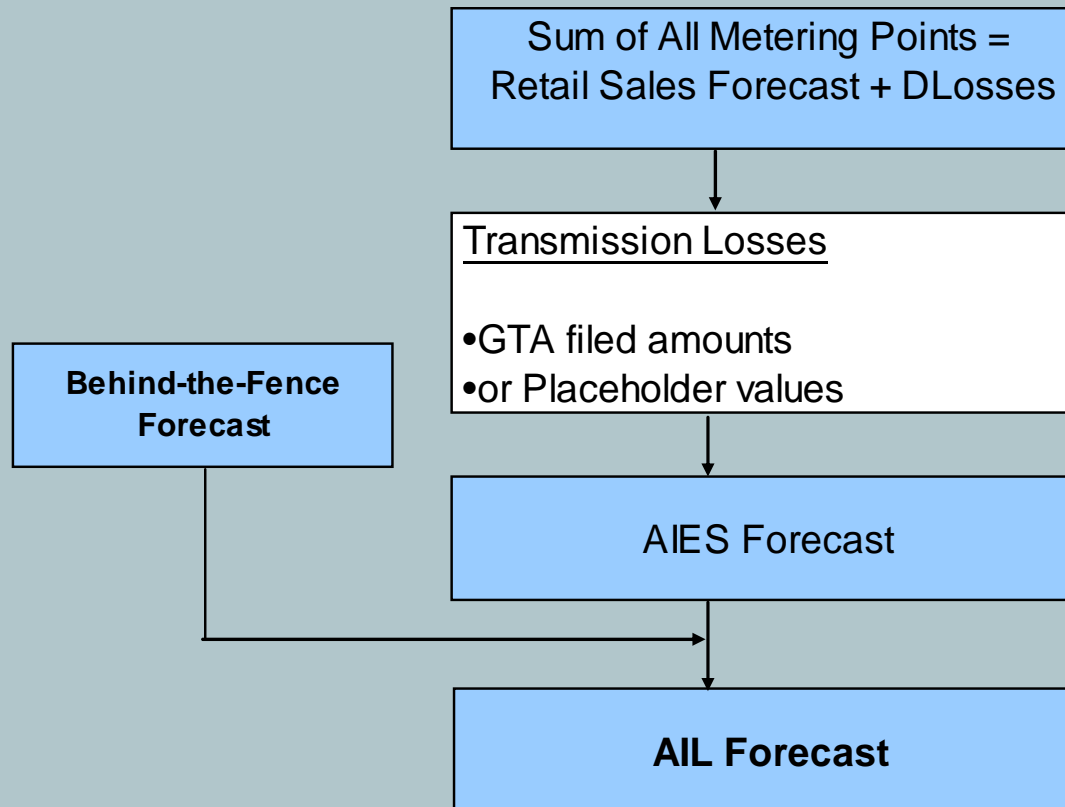
Load Forecasting Methodology



Load Forecasting Methodology



Load Forecasting Methodology



Regions by Transmission Planning Area



Northwest	Northeast	Calgary & South Central	South
Rainbow Lake	Fort McMurray	Calgary	Medicine Hat
High Level	Athabasca/Lac La Biche	Drayton Valley	Sheerness
Peace River	Cold Lake	Wetaskiwin	Brooks
Grande Prairie	Fort Saskatchewan	Wainwright	Empress
High Prairie	Edmonton & North Central	Abraham Lake	Vauxhall
Grande Cache	Lloydminster	Red Deer	Fort MacLeod
Valleyview	Hinton/Edson	Alliance/Battle River	Lethbridge
Fox Creek	Wabamun	Provost	Glenwood
Swan Hills	Vegreville	Caroline	Caroline
	Edmonton	Didsbury	
		Hanna	
		Seebe	
		Strathmore/Blackie	
		High River	
		Stavely	
		Airdrie	

Selected Economic Indicators



Alberta GDP (97\$ M)		
2006 - 2017	3.6%	3.1%
2017 - 2027	2.7%	

Alberta Population		
2006 - 2017	1.6%	1.4%
2017 - 2027	1.2%	

WTI (US\$)		
2006 - 2017	70.93	76.73
2017 - 2027	83.01	

Henry Hub (US\$)		
2006 - 2017	10.38	12.22
2017 - 2027	14.31	

Detailed Forecast Results



Alberta Internal Load (AIL)

Year	fc2006 (MW)*	fc2007 (MW)*	fc2007 Growth	Forecasts Diff
2000/01 A	7,785	7,785	---	0.0
2001/02 A	7,934	7,934	1.9%	0.0
2002/03 A	8,570	8,570	8.0%	0.0
2003/04 A	8,967	8,967	4.6%	0.0
2004/05 A	9,236	9,236	3.0%	0.0
2005/06 F	9,580	9,580	3.7%	0.0
2006/07 F	10,045	9,661	0.8%	-384.1
2007/08 F	10,262	10,028	3.8%	-234.2
2008/09 F	10,650	10,467	4.4%	-183.4
2009/10 F	10,911	10,793	3.1%	-118.4
2010/11 F	11,283	11,212	3.9%	-71.3
2011/12 F	11,467	11,662	4.0%	195.3
2012/13 F	11,684	12,062	3.4%	378.2
2013/14 F	11,986	12,519	3.8%	532.7
2014/15 F	12,308	12,929	3.3%	621.7
2015/16 F	12,560	13,312	3.0%	752.1
2016/17 F	12,859	13,711	3.0%	852.7
2017/18 F	13,148	14,155	3.2%	1,006.7
2018/19 F	13,431	14,566	2.9%	1,135.3
2019/20 F	13,667	14,971	2.8%	1,303.4
2020/21 F	14,071	15,355	2.6%	1,283.8
2021/22 F	14,316	15,852	3.2%	1,536.4
2022/23 F	14,705	16,323	3.0%	1,618.8
2023/24 F	15,087	16,808	3.0%	1,720.7
2024/25 F	15,226	17,241	2.6%	2,014.7
2025/26 F	15,548	17,796	3.2%	2,248.0
2026/27 F	15,878	18,304	2.9%	2,426.1
2027/28 F	16,237	18,824	2.8%	2,587.6
2028/29 F		19,303	2.5%	

Year	fc2006 (GWh)	fc2007 (GWh)	fc2006 Growth	Forecasts Diff
2000 A	54,054	54,054	---	0.0
2001 A	54,467	54,467	0.8%	0.0
2002 A	59,437	59,437	9.1%	0.0
2003 A	62,716	62,716	5.5%	0.0
2004 A	65,259	65,259	4.1%	0.0
2005 F	66,268	66,268	1.5%	0.0
2006 F	68,550	69,370	4.7%	819.8
2007 F	70,727	70,481	1.6%	-246.5
2008 F	73,534	73,696	4.6%	162.7
2009 F	76,204	76,792	4.2%	587.8
2010 F	77,886	79,478	3.5%	1,591.5
2011 F	80,419	82,710	4.1%	2,290.3
2012 F	82,371	85,978	4.0%	3,606.4
2013 F	84,315	89,205	3.8%	4,890.3
2014 F	86,462	92,312	3.5%	5,849.6
2015 F	88,363	95,420	3.4%	7,057.0
2016 F	90,654	98,629	3.4%	7,975.8
2017 F	92,728	101,715	3.1%	8,986.4
2018 F	94,637	104,706	2.9%	10,069.0
2019 F	96,584	107,645	2.8%	11,061.7
2020 F	98,520	110,692	2.8%	12,171.7
2021 F	100,553	113,744	2.8%	13,191.4
2022 F	102,890	116,836	2.7%	13,945.7
2023 F	104,995	119,980	2.7%	14,984.4
2024 F	107,180	123,176	2.7%	15,995.8
2025 F	109,298	126,436	2.6%	17,138.5
2026 F	111,511	129,759	2.6%	18,248.5
2027 F	113,884	133,158	2.6%	19,273.3
2028 F		136,616	2.6%	

*Note: Demand is winter peak demand (Nov. - Feb.)
 + 2002 redefinition added approx. 400 MW of 'behind the fence load'

Draft Generation Scenarios

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**Nicole LeBlanc,
Senior Analyst,
Generation Resources**



Outline



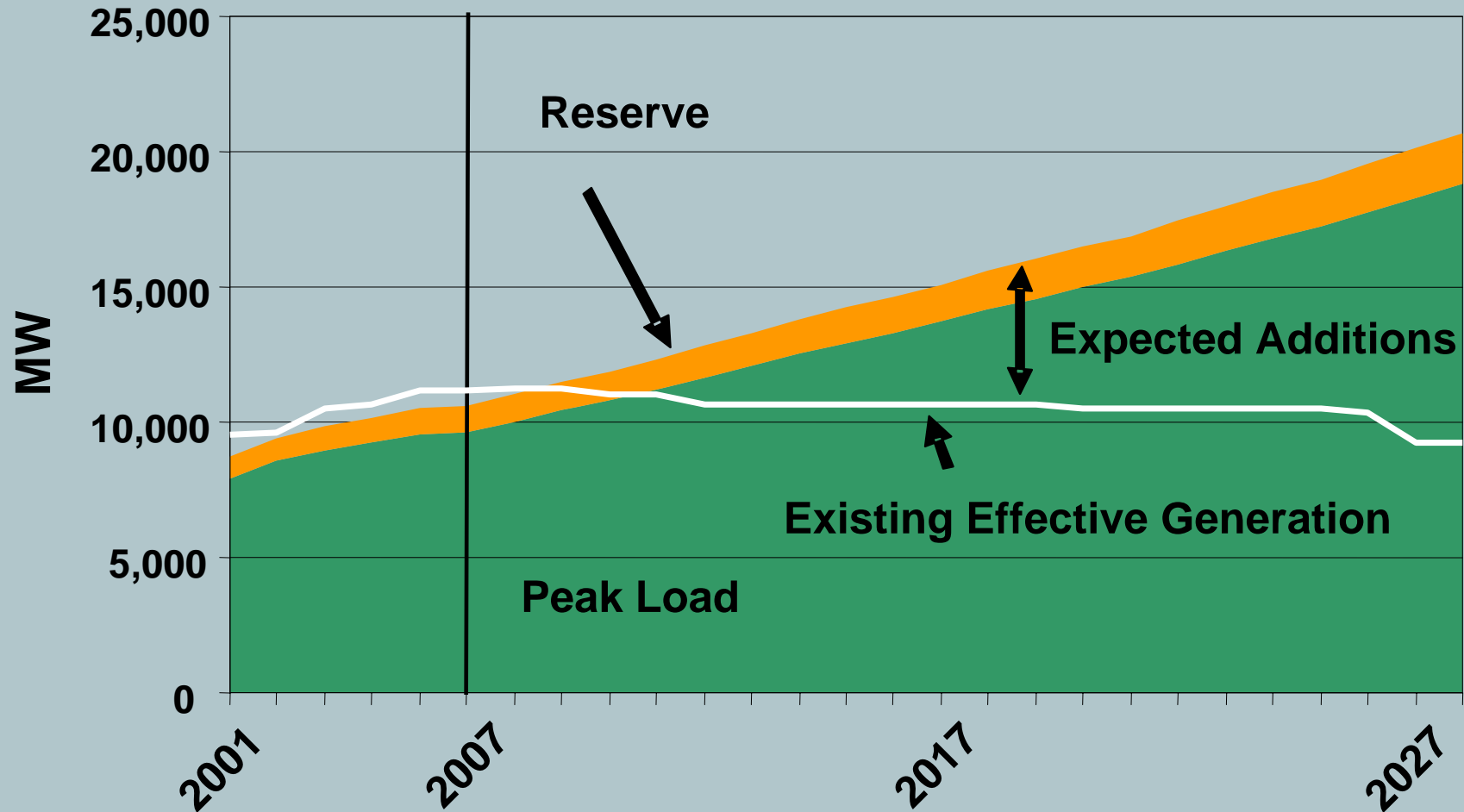
- Objective
- Expected generation requirements
- Generation technologies & resources
- Comparative electricity costs
- Generation Scenarios

Objective



- Provide reasonable generation development scenarios against which the transmission system can be tested to reveal where reinforcement is required to meet future needs
- Created on the basis of market driven additions scenario approach
 - How much
 - Where
 - What type
 - When

Expected Generation Additions



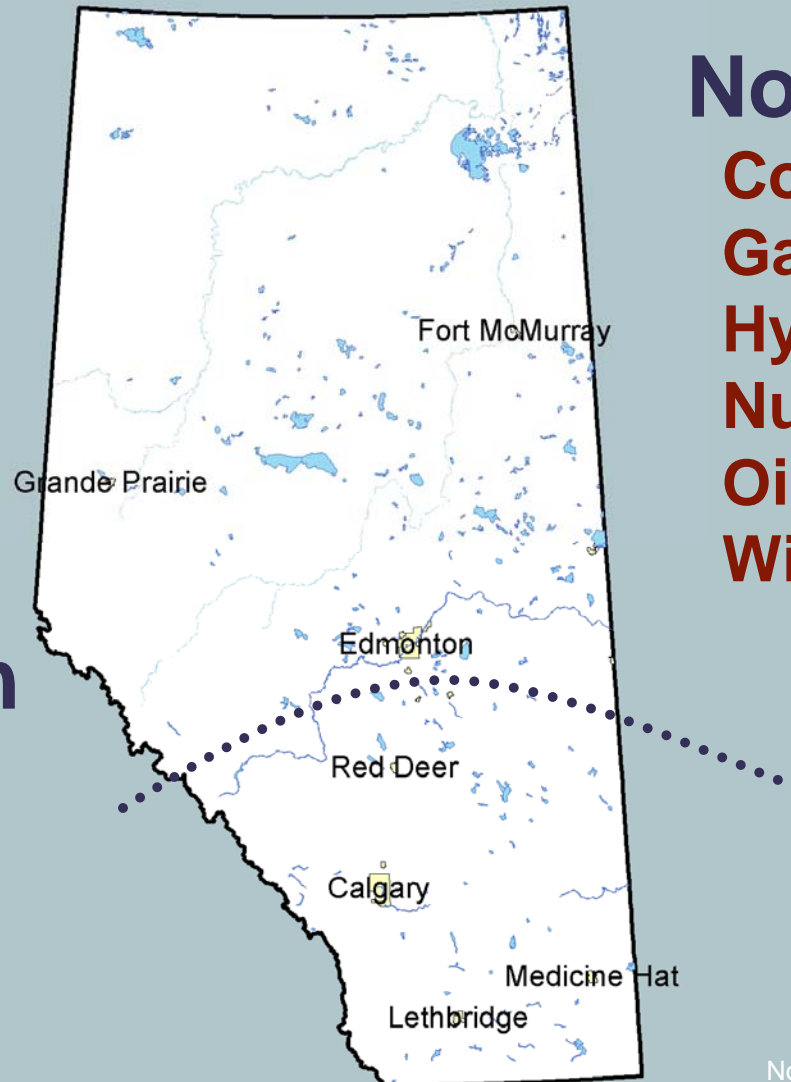
Expected Additions: **2017 - 5,000 MW** **2027 - 11,500 MW**

Future Generation Options



- Coal Fuelled
 - Supercritical Pulverized Coal (SCPC)
 - Ultra Supercritical Pulverized Coal
 - Integrated Gasification Combined Cycle (IGCC)
 - Oxy-fuel Combustion
- Gas Fired
 - Cogeneration
 - Combined Cycle (CC)
 - Simple Cycle (SC)
- Oilsands By-product Fuelled
 - Integrated Gasification Cogeneration
 - Integrated Gasification Combined Cycle
 - Integrated Gasification Polygeneration
- Biomass
- Hydroelectricity
- Nuclear
- Other small additions
 - Solar
 - Micro-generation
- Wind
 - Storage

Geographical Additions



Northern

- Coal
- Gas
- Hydro
- Nuclear
- Oilsands By-products
- Wind

Southern

- Coal
- Gas
- Wind

Generation Economics



	Net Capacity (MW)	Capacity Factor (%)	Capital Cost (\$/KW Net)	Fixed O&M (\$/KW/yr)	Variable O&M (\$/MWh)	Fuel Price (\$/GJ)	Heat Rate (GJ/MWh)	CO2 Emissions (Tonnes/MWh)	CO2 Intensity Reductions
Brownfield SCPC	450	92	3,050	31	6	1.00	9.4	0.9	2%/yr
Wind	100	35	2,200	56	0			0	(0.5 T/MWh)
Greenfield SCPC	450	92	3,350	31	6	1.70	9.4	0.9	2%/yr
Combined Cycle	500	60	1,350	13	4	7.7-13	7.1	0.36	2%/yr
IGCC	550	80	4,000	41	7	1.70	8.7	0.8	2%/yr
Simple Cycle	90	10	840	12	4	7.7-13	9.8	0.5	2%/yr

2008 CAD\$

Canadian GHG Offset Costs



Federal Air Emission Framework

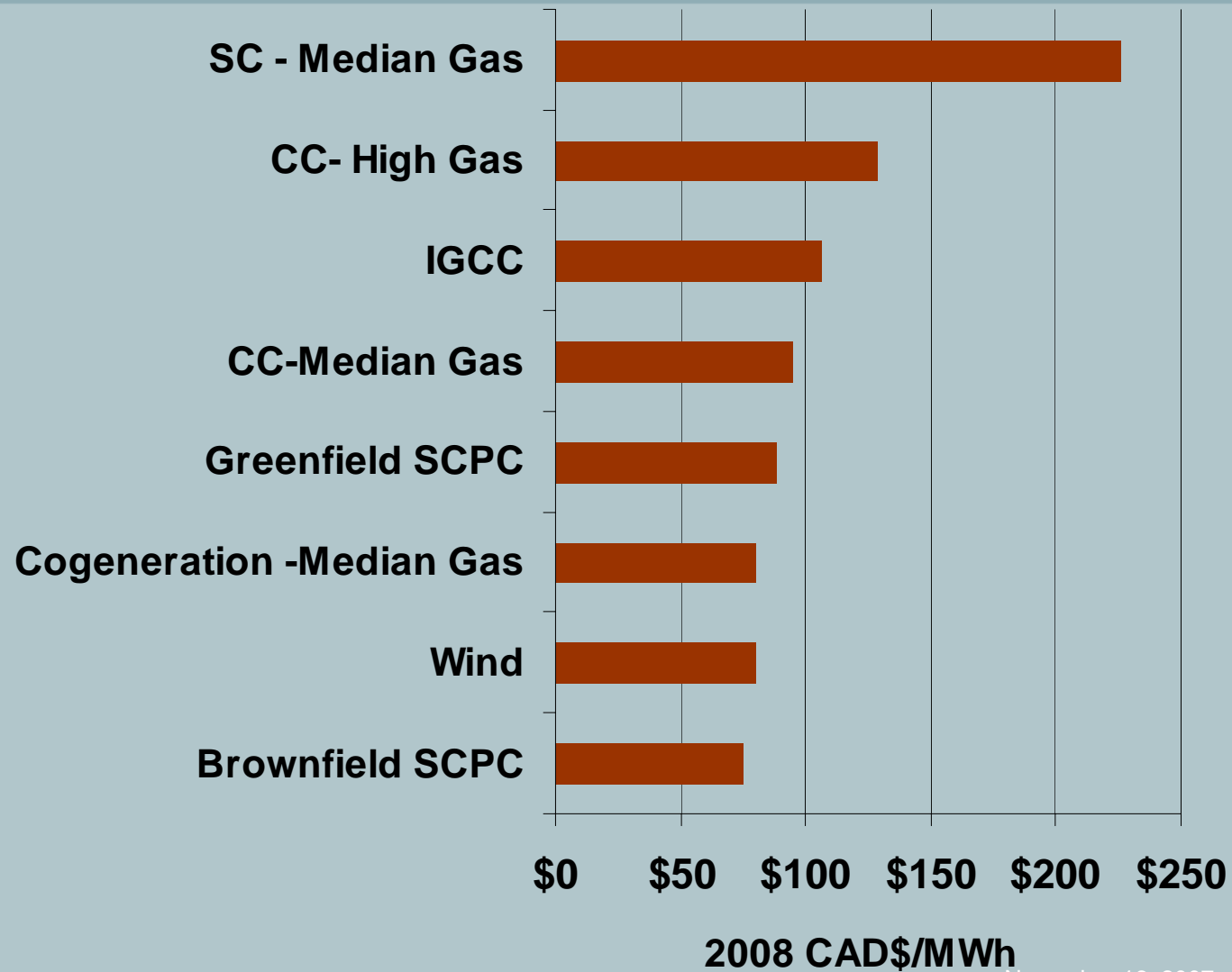
Intensity Reduction	Clean fuel standard for new projects, additional 2% annually thereafter
Enforcement Date	2010
Compliance Options	Abatement Federal offsets & trades Technology fund (\$15/tonne, \$20/tonne in 2013) Limited international trades (10%)
Technology Fund	Limited to 70% of compliance in 2010, 0% by 2018

Canadian Offset Price

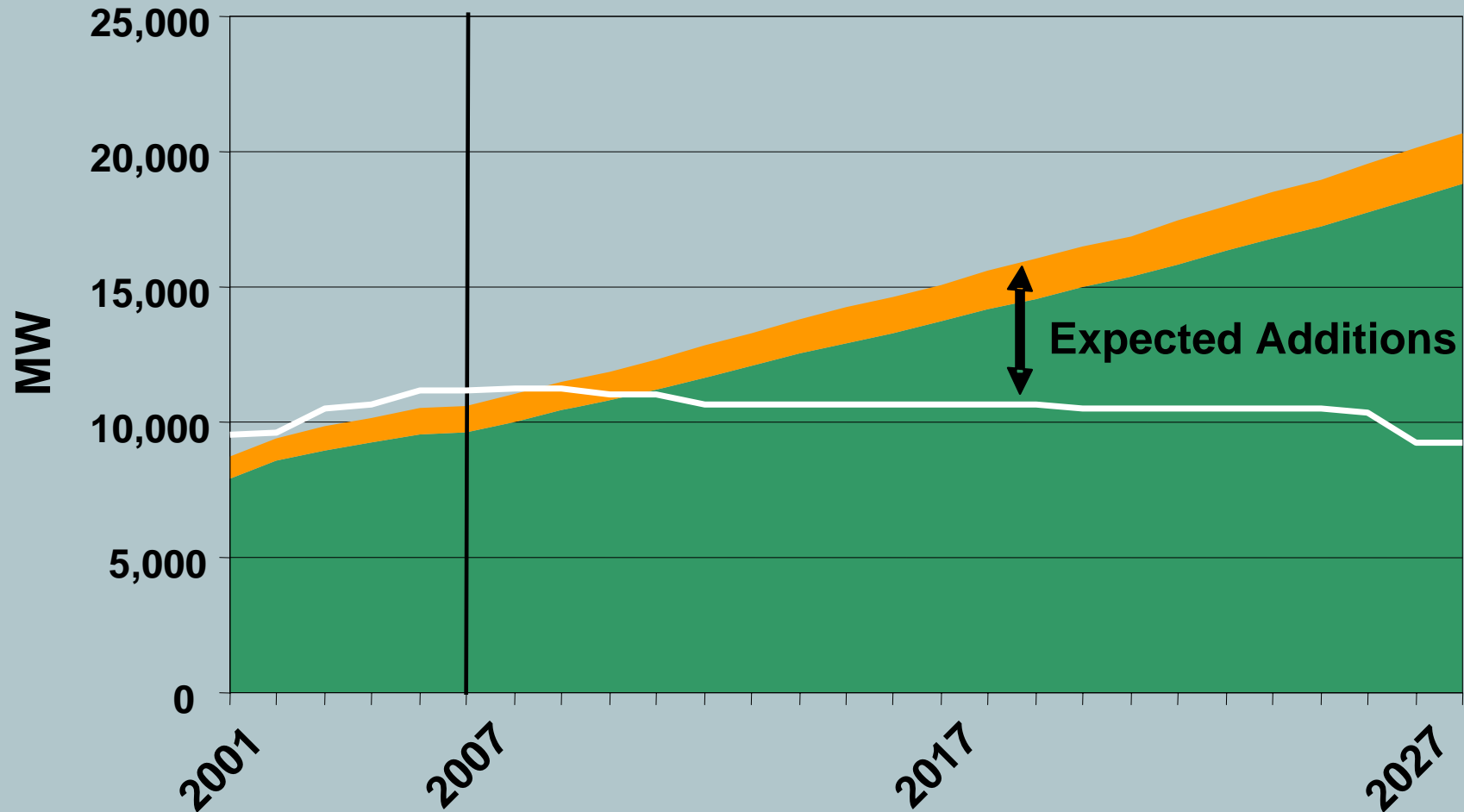
Year	Price/Tonne (2007 CAD\$)
2015	21.20
2016	23.77
2017	26.12
2018	29.50
2019	30.52
2020	31.00
2021	33.98
2022	40.10
2023	44.75
2024	47.48
2025	53.43
2026	59.37
2027	67.30
2028	69.67
2029	74.21
2030	78.50

November 16, 2007

Generation Economics



Expected Generation Additions



Expected Additions: **2017 - 5,000 MW** **2027 - 11,500 MW**

Generation Scenarios 2007-2017



- **Based on future expectations, existing generation technologies will continue to be developed**
 - SCPC remains an option under the Federal Air Emission Framework
 - Gas prices expected to support continued combined cycle development
- **Major additions are to come from the following existing technologies:**
 - Cogeneration
 - Combined Cycle
 - Simple Cycle
 - Supercritical Pulverized Coal Plants
 - Wind
- **Technology advancement will provide additional generation options later in the ten year timeframe**

10-year scenarios (MW)

Additions common to all



Keephills 3	450
Coal Upgrades	150
Simple Cycle	200
Hydro	100
Other small additions	100
Total Capacity Additions	1,000
50% Hydro Capacity Derate	-50
Total Effective Additions	950

10-year scenarios

2007-2017 Major Additions (MW)



Northern \longrightarrow Southern

Scenario	1	2	3	4	5
Genesee 4	450	450	450	450	
Keephills 4	450	450	450		450
HR Milner Expansion	450				
ENMAX 1200 MW			600	1,200	1,200
Cogeneration	1,760	2,260	1,760	1,760	1,760
Simple Cycle	600	600	400	300	
Wind (Installed)	(1,600)	(1,600)	(1,600)	(1,600)	(3,400)
Effective	320	320	320	320	680
Major Additions	4,030	4,080	3,980	4,030	4,090
Common Additions	950	950	950	950	950
Total Additions	4,980	5,030	4,930	4,980	5,040

Generation Scenarios 2017-2027



The 20 year scenarios are a high level outlook that allow for the development of conceptual transmission alternatives

Technology improvements and the value of GHG will be drivers for the development of projects such as:

- Integrated Gasification Combined Cycle
- Large Hydro
- Nuclear
- Oxy-fuel Combustion

As well as the continued addition of:

- Cogeneration
- Combined cycle
- Wind

20-year scenarios

2017-2027 Additions (MW)



Scenario		A	B
Battle River 6		450	450
Bow City			1000
IGCC		600	
Combined Cycle		500	500
Simple Cycle		300	300
Wind	(Installed)	(2,000)	(4,000)
	Effective	400	800
Hydro	(Installed)	(1,400)	(1,400)
	Effective	700	700
Nuclear		2,200	2,200
Cogeneration		1,400	600
2017-2027 Additions		6,550	6,550
2007-2017 Additions		5,000	5,000
Total 20 Year Additions		11,550	11,550

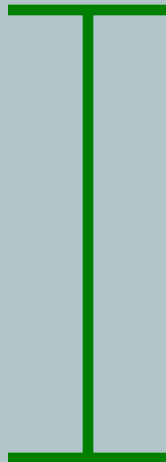
Alberta Generation Scenarios 2027



Five Scenarios



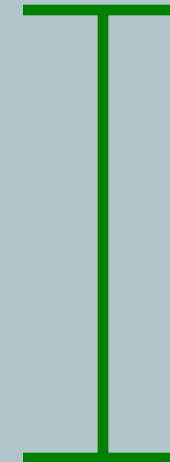
Northern Additions
9,200 MW Effective
(9,960 MW Installed)



Southern Additions
2,300 MW Effective
(5,200 MW Installed)



Northern Additions
6,500 MW Effective
(7,260 MW Installed)



Southern Additions
5,000 MW Effective
(11,000 MW Installed)

Long-Term Transmission System Planning Next Steps

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Next Steps



- **Comments on generation scenarios to AESO by November 30**
- **AESO will review all stakeholder feedback and respond**
 - **Timing dependent on scope and nature of stakeholder feedback**
- **Load forecast and generation scenarios will be used as input to transmission planning studies**
- **Stakeholder consultation scheduled for 2008 to review 20-year transmission planning studies and obtain stakeholder feedback**

Contact Information



**Please submit
your comments or questions
to AESO by November 30 to:**

karissa.ohsberg@aeso.ca