

24-Month Reliability Outlook 2010-2012

Stakeholder Information Session

Wednesday, December 8, 2010

John Kehler, Steve Heidt and Jin Liang Han

- **Introductions**
- **Reliability**
- **System Performance**
 - Disturbances, Metrics and Constraint Events
- **Planning Standards, Criteria and Coordination Plan**
- **Regional Update**
 - Operations Planning & Transmission Development over the next 24 months
 - Imports / Exports, MATL
- **Summary**
- **Q&A**

Role of Alberta Electric System Operator (AESO)



- **System Operations**

- Direct the reliable operation of Alberta's power grid

- **Markets**

- Develop and operate Alberta's real-time wholesale energy market to facilitate fair, efficient and open competition

- **Transmission System Development**

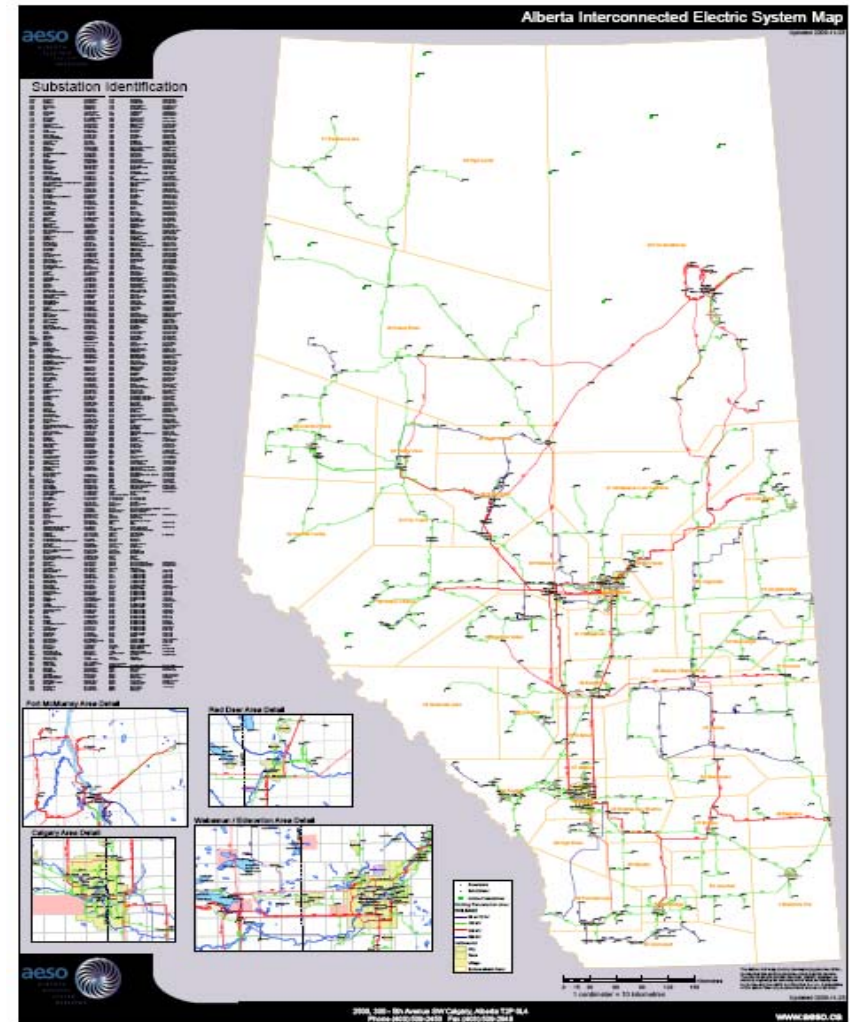
- Plan and develop Alberta's transmission system to ensure continued reliability and facilitate the competitive market and investment in new supply

- **Transmission System Access**

- Provide system access for both generation and load customers

The Alberta Grid

- 22,322 km transmission
- Single balancing area of 660,000 km²
- B.C. & Sask. Connections
- over 167 generating units
- 9,541 MW summer peak
- 10,236 MW system peak
- Over 200 market participants
- 12,915 MW internal capacity net to grid



- **For the next 2 years**
 - Provides a comprehensive assessment of the reliability of the electric system
 - Include details on each area, including transfer limits, and how the area will be operated for the next couple of years
 - Include transmission upgrades expected to be in service
 - Ensure stakeholders have a common understanding of transmission operating issues
- **Information beyond 2 years will be addressed in the Long-term Transmission System Plan to be filed with the AUC in June 2011**

“The System

- is controlled to stay within acceptable limits during normal conditions
- performs acceptably after credible contingencies
- limits the impact and scope of instability and cascading outages when they occur
- facilities are protected from unacceptable damage by operating them within facility ratings
- integrity can be restored promptly if it is lost, and
- has the ability to supply the aggregate electric power and energy requirements of the electricity consumers at all times, taking into account scheduled and reasonably expected unscheduled outages of system components”

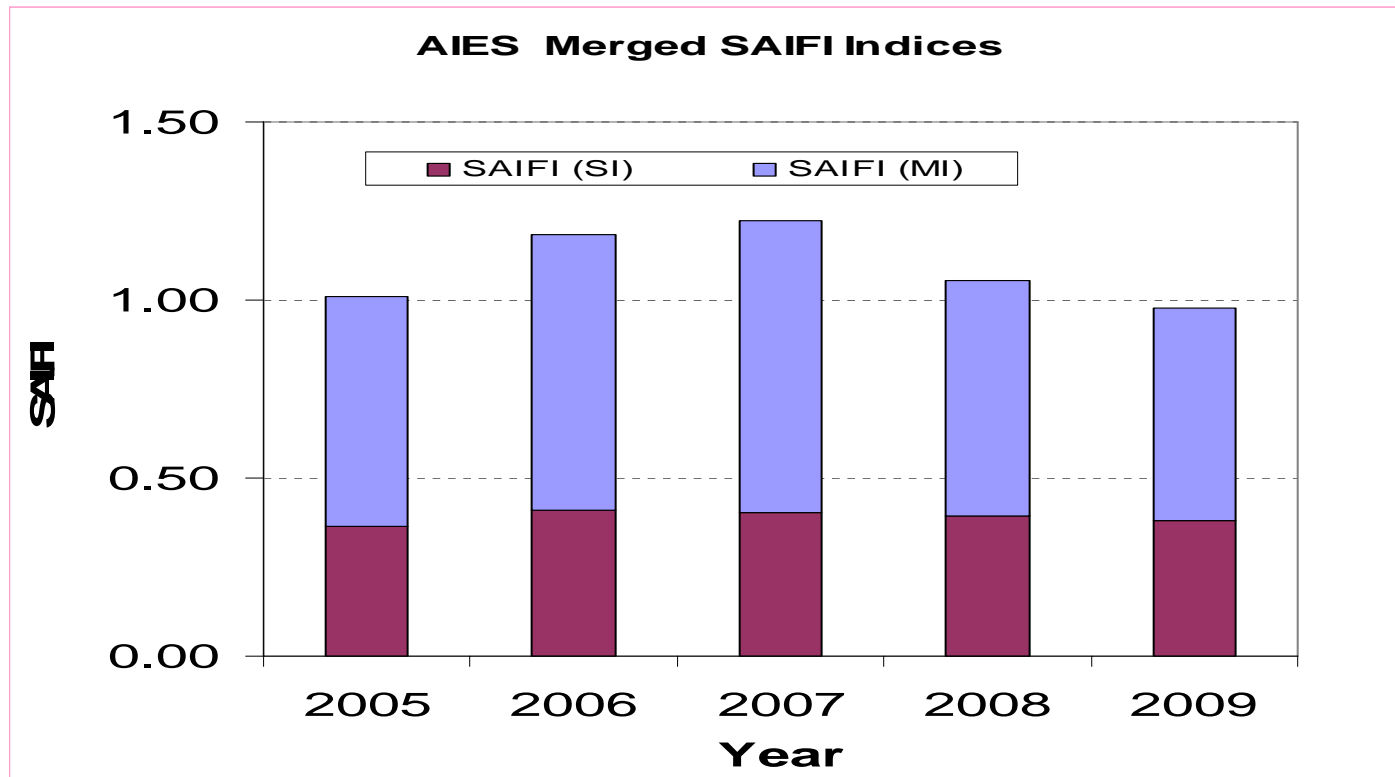
- **Performance can be assessed**
 - Statistics and benchmarking
 - Disturbance monitoring and investigations

Performance Metrics

Alberta System Average Interruption Frequency Index (SAIFI)



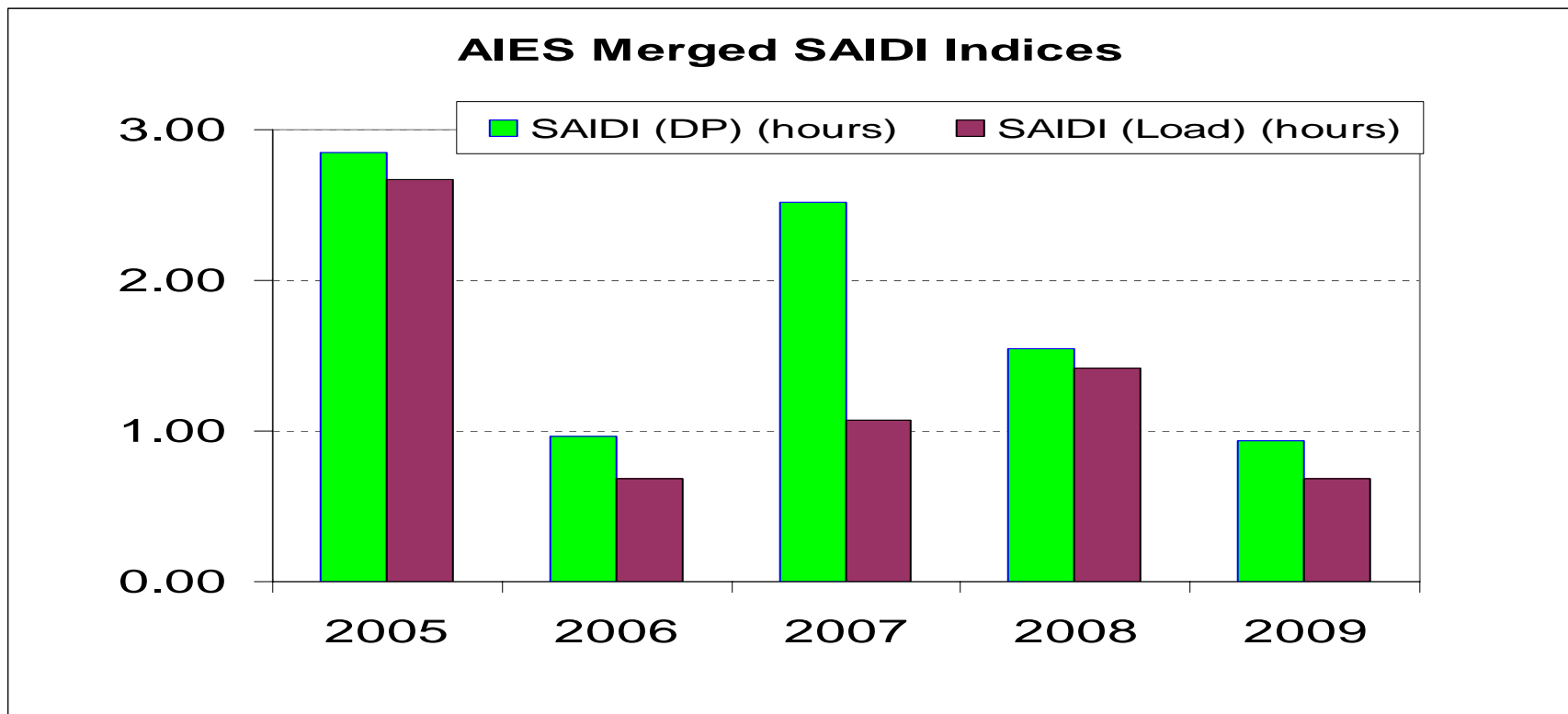
- Average number of interruptions delivery point or load customers experience per year
- Five year consolidated performance of all Alberta TFO system data



Performance Metrics

Alberta System Average Interruption Duration Index (SAIDI)

- Average duration of interruptions delivery point and load customers experience per year
- Five year consolidated performance of all Alberta TFO system data



Performance During Major System Disturbances

- **5 major disturbances in 2010 where over 300 MW of load was shed in each disturbance**
 - March 1 and June 30 – Initiating factor : human error
 - April 8 and 14 - Initiating factor: snow storms
 - April 14 storm was a rare event as snow and wind loading exceeded design capability of towers.
 - June 1 - Initiating factor: equipment problem
- **AIES performed as expected during the disturbances**
 - Cascading mitigated
 - Voltage and frequency stabilized

- **19 recommendations developed in the investigations and key areas were in respect of;**
 - Procedural matters
 - Root cause identification
 - Relay operation confirmation or modification
 - Restoring facility performance to AESO standards
 - Monitoring

Photos of the Damaged Towers – April 14, 2010

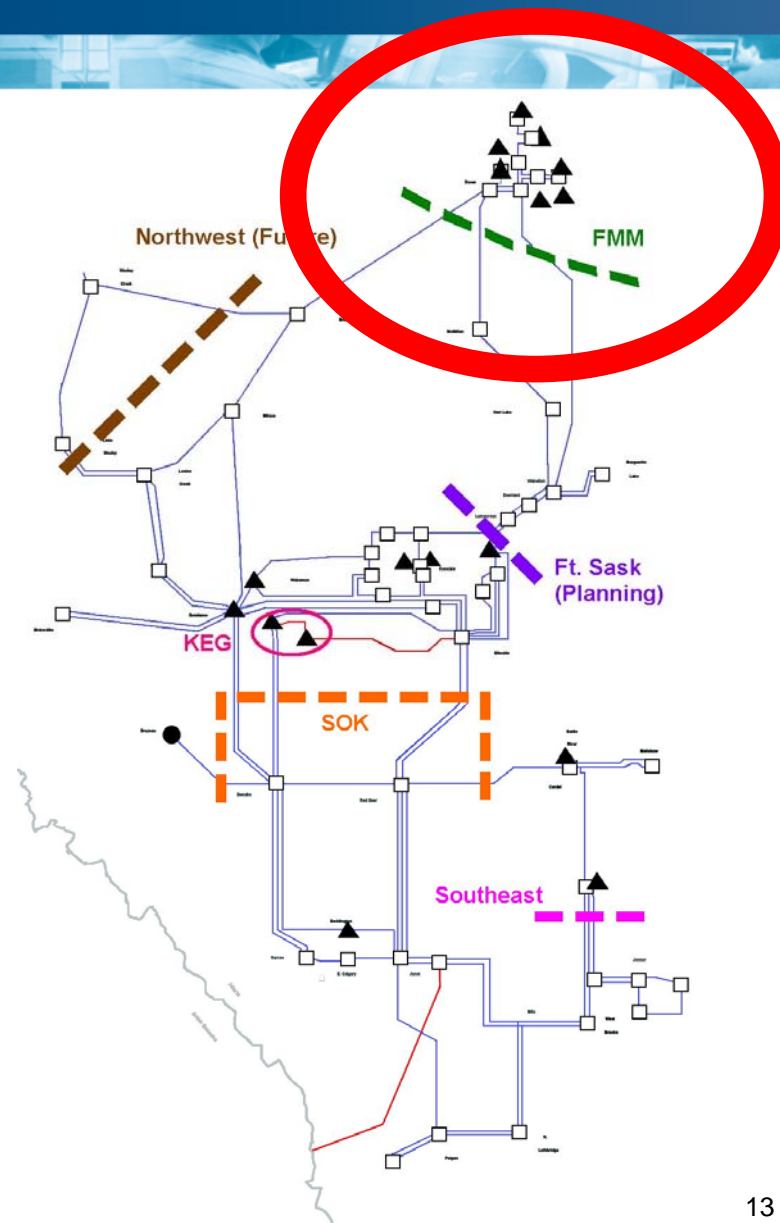
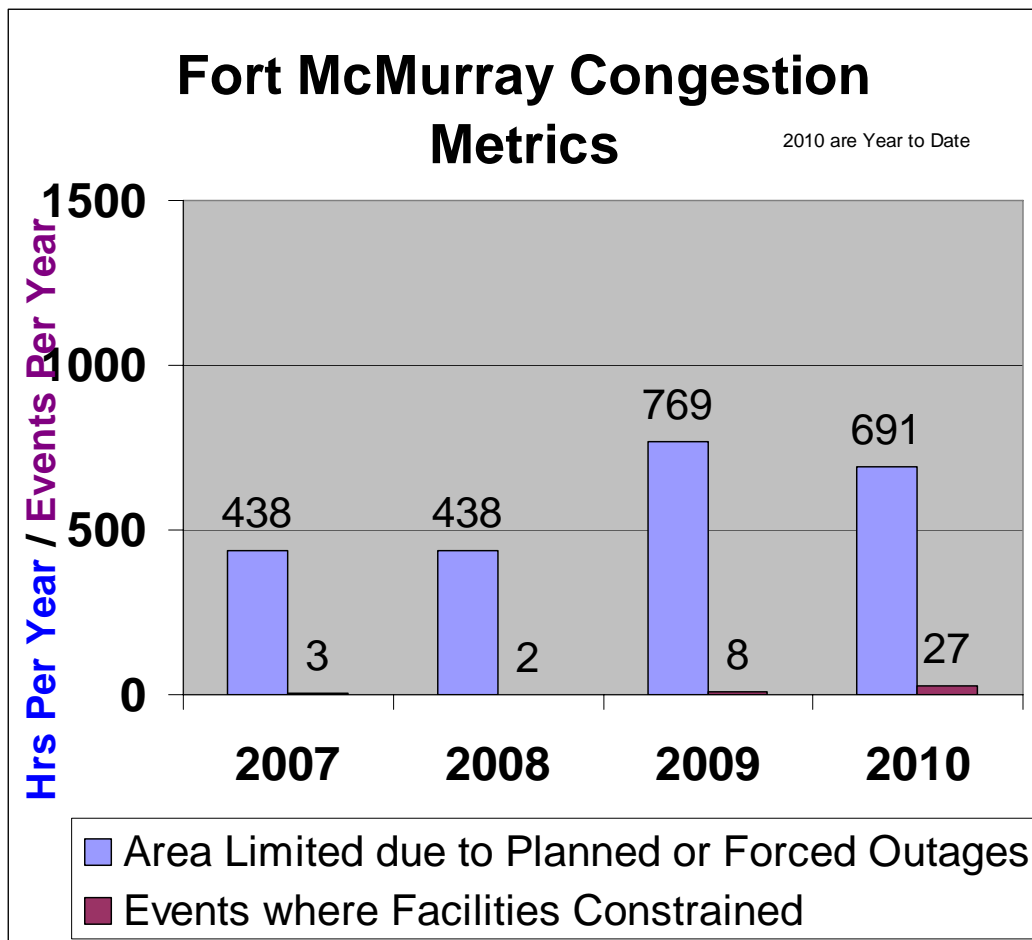


Storm conditions where snow and wind load exceeded the design capability of these towers

Courtesy of AltaLink

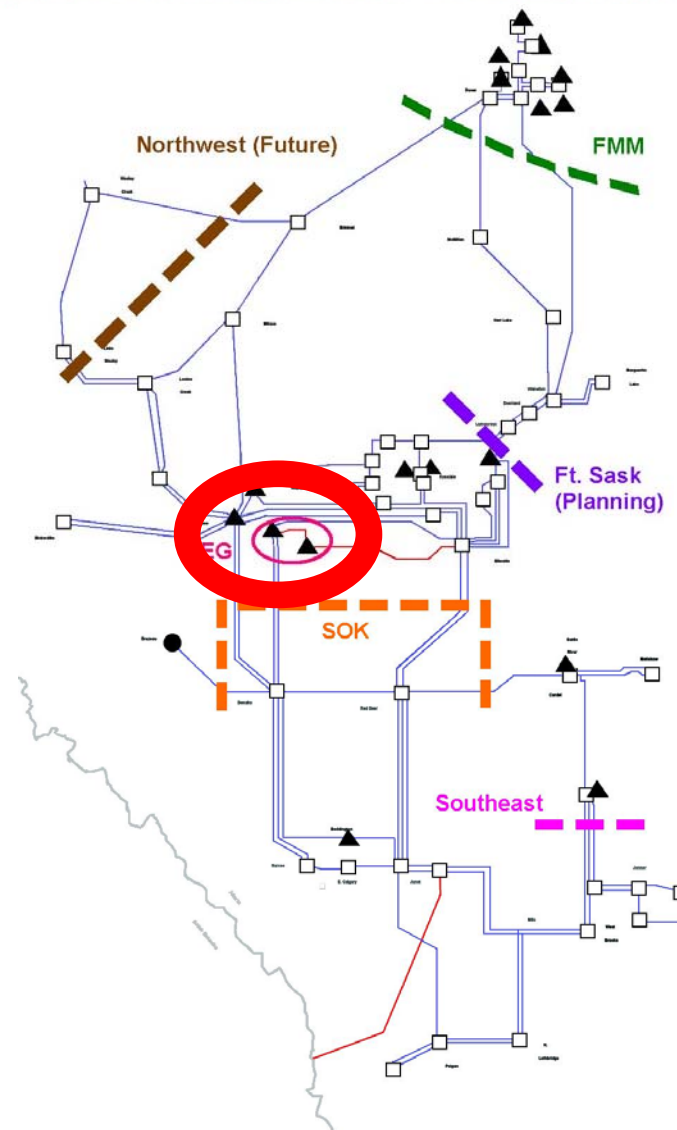
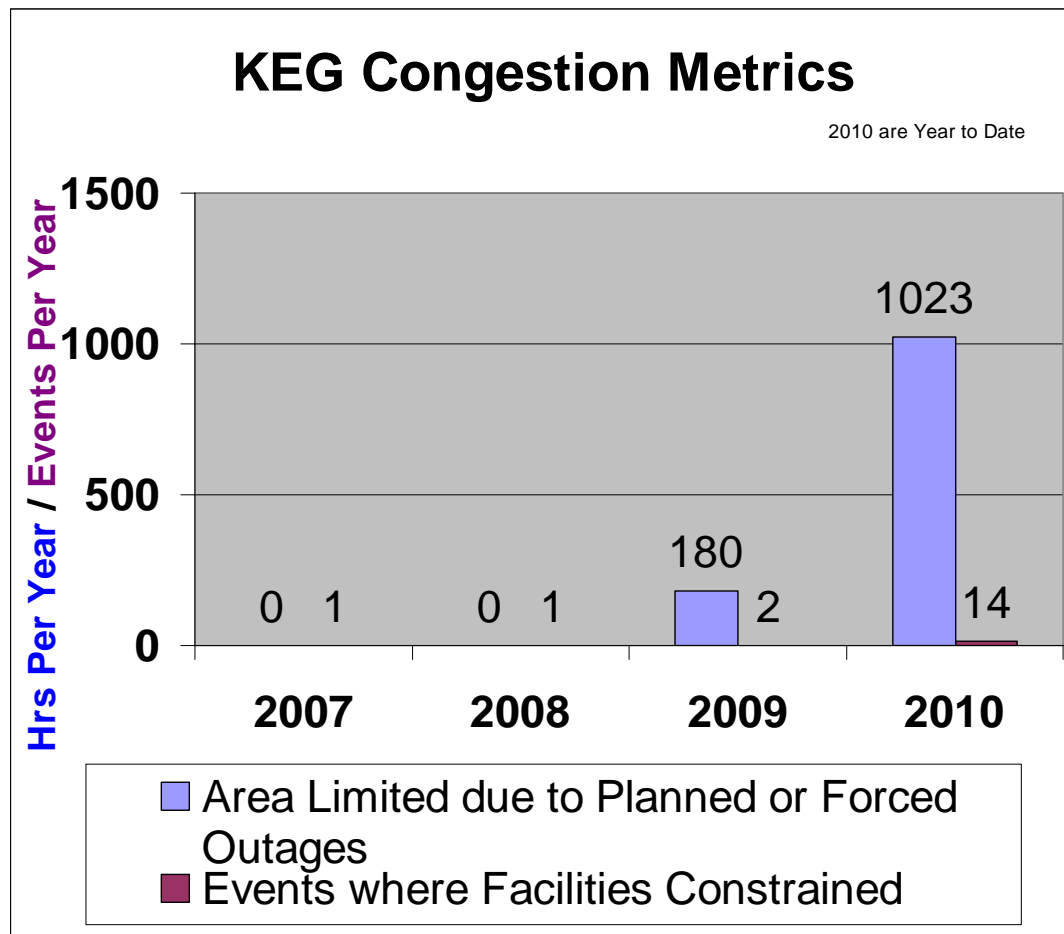
System Performance

Constraint History- Fort McMurray Cutplane



System Performance

Constraint History - KEG Area

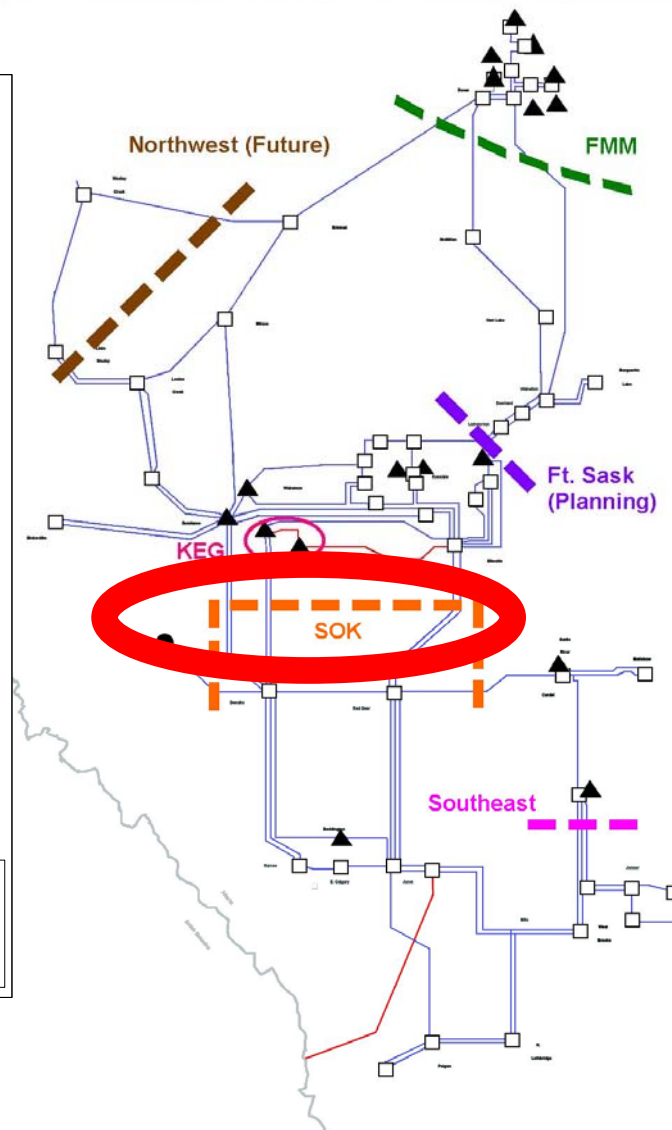
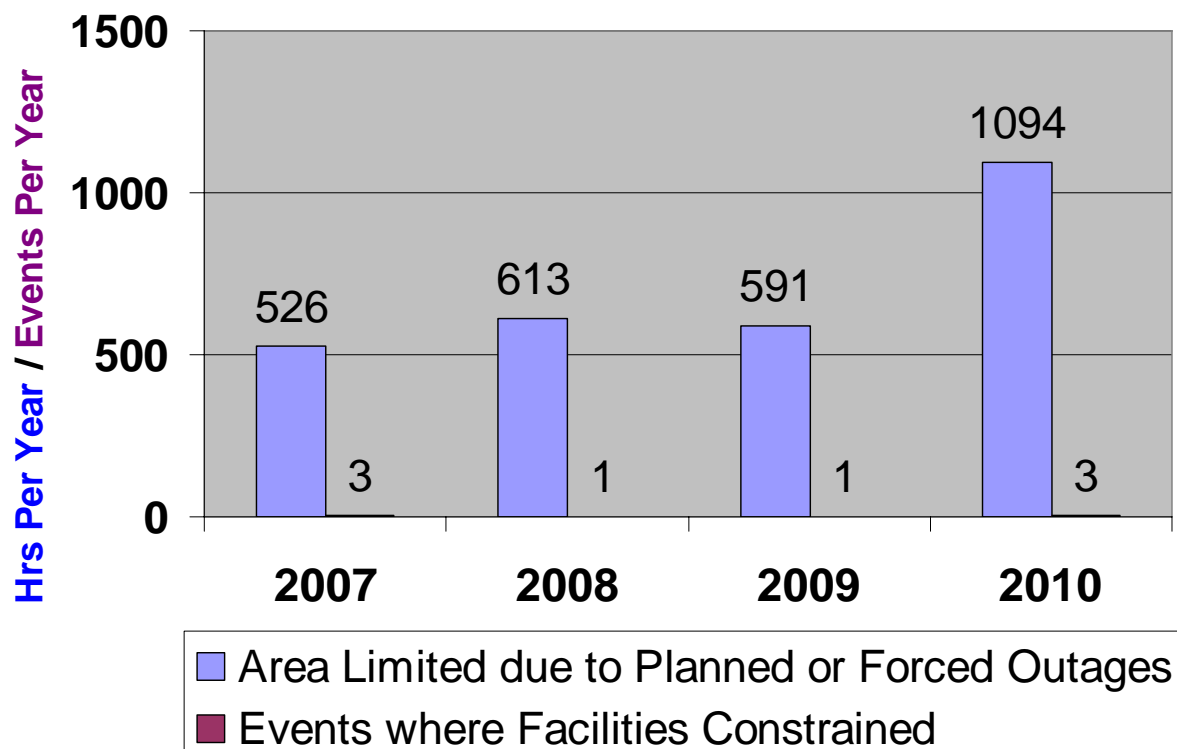


System Performance

Constraint History – South of KEG (SOK)

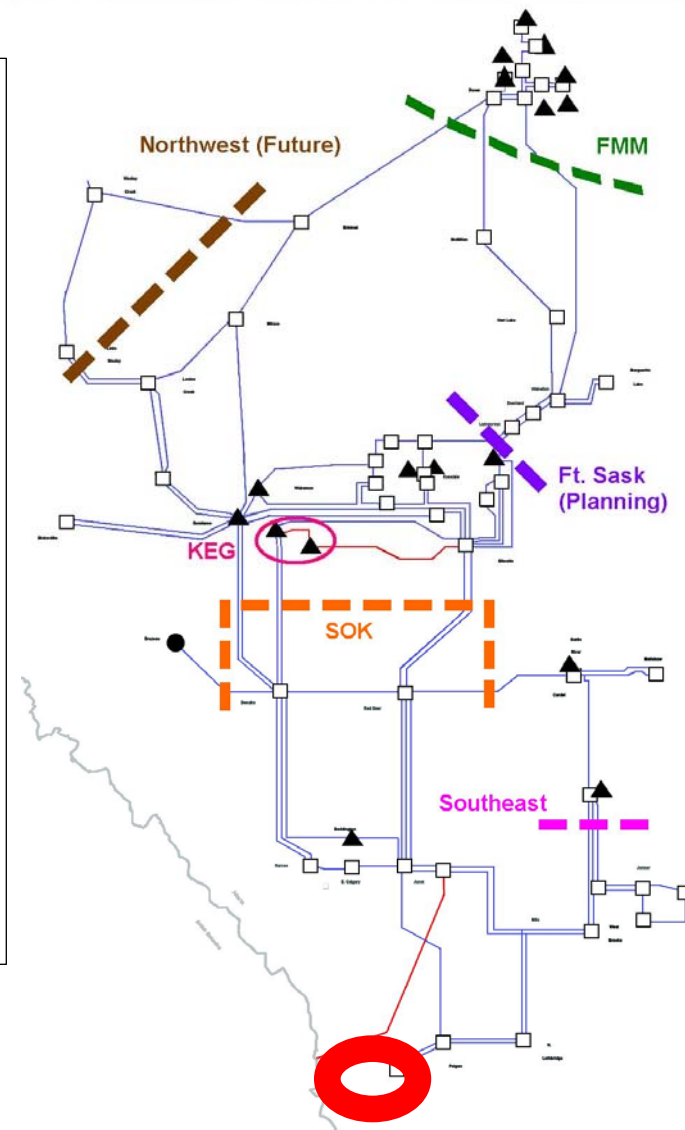
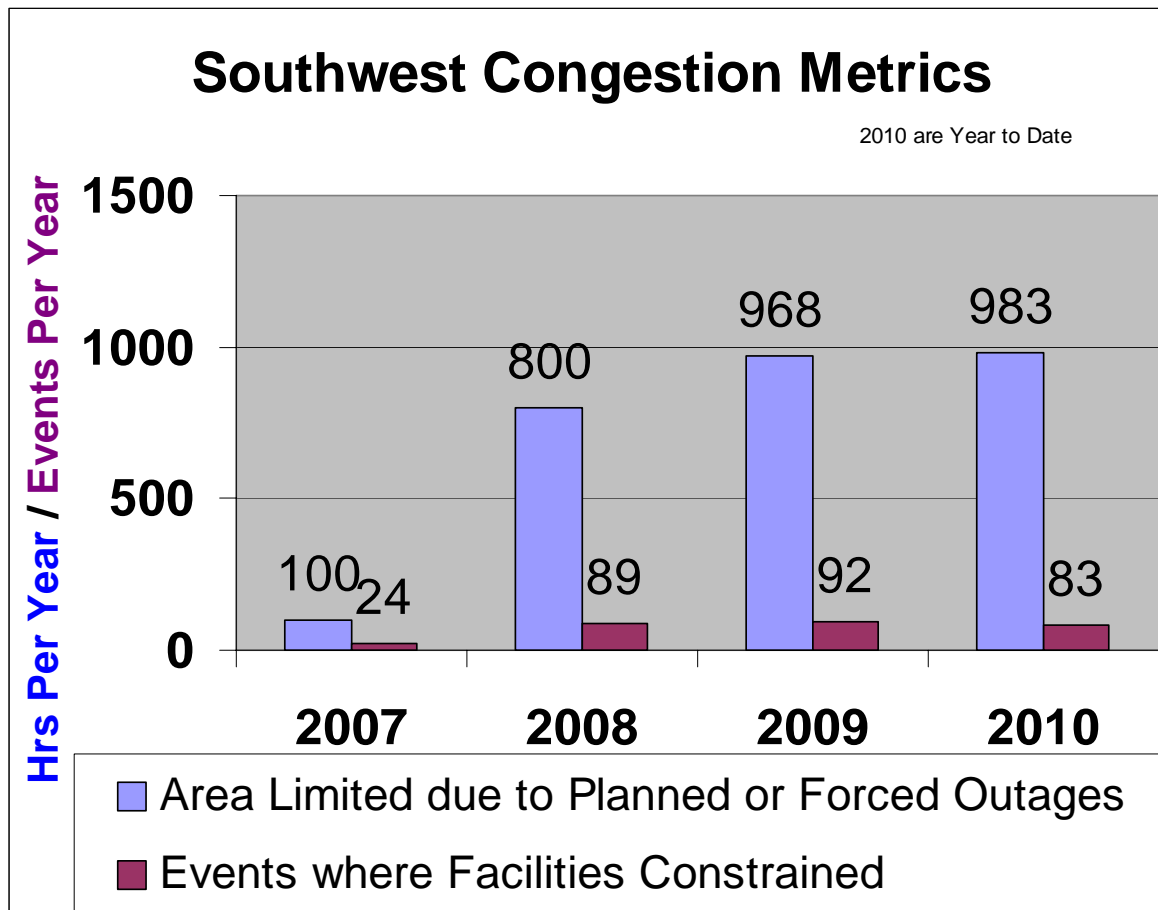
SOK Congestion Metrics

2010 are Year to Date



System Performance

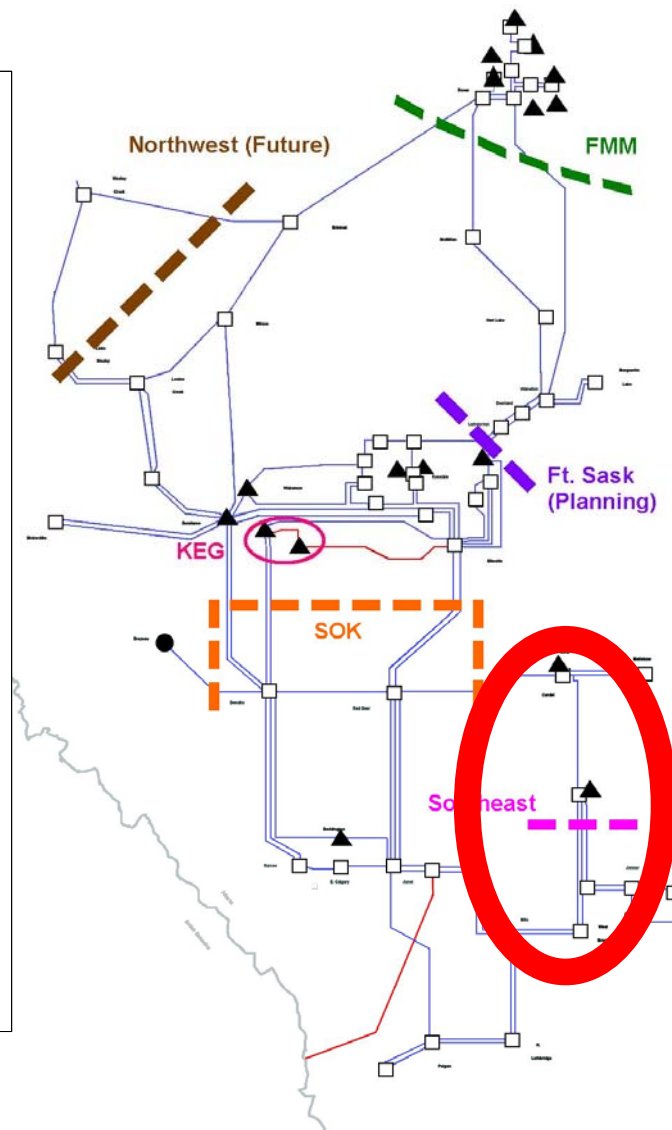
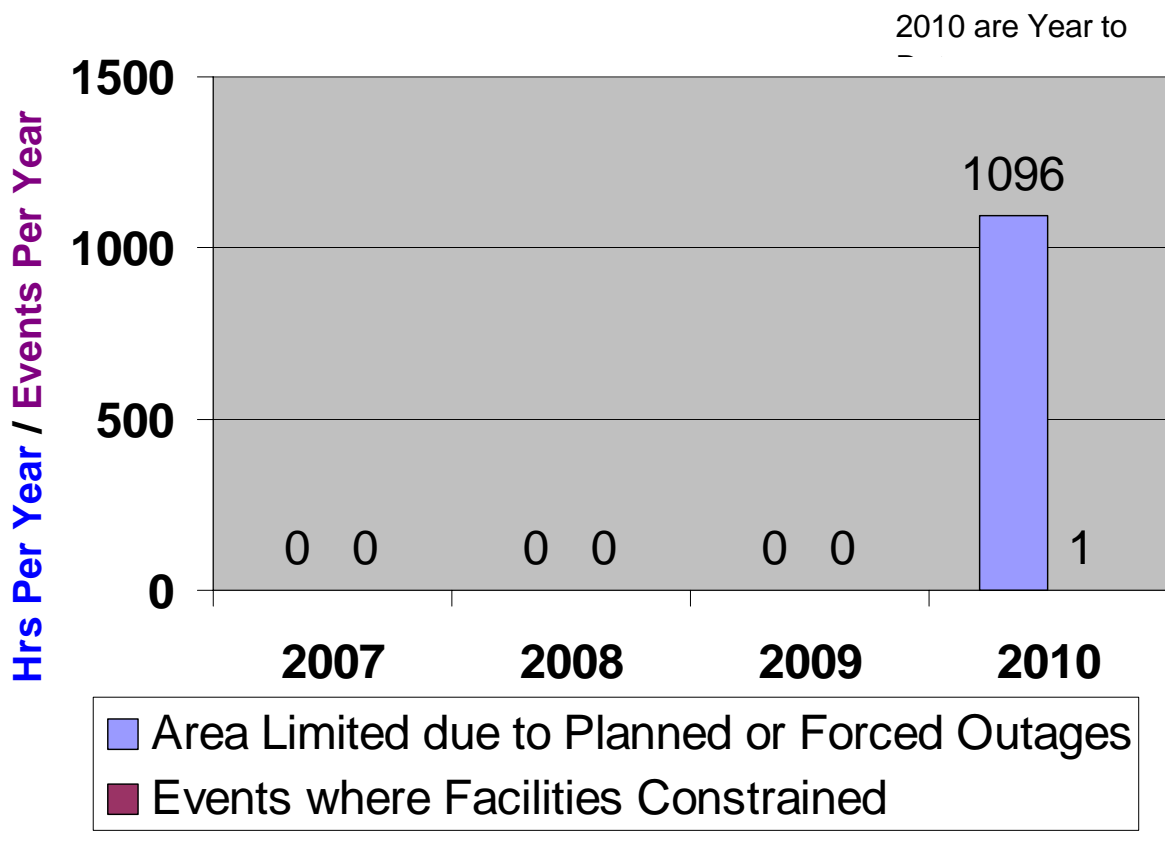
Constraint History - Southwest Area



System Performance

Constraint History - South East Area

South East Congestion Metrics



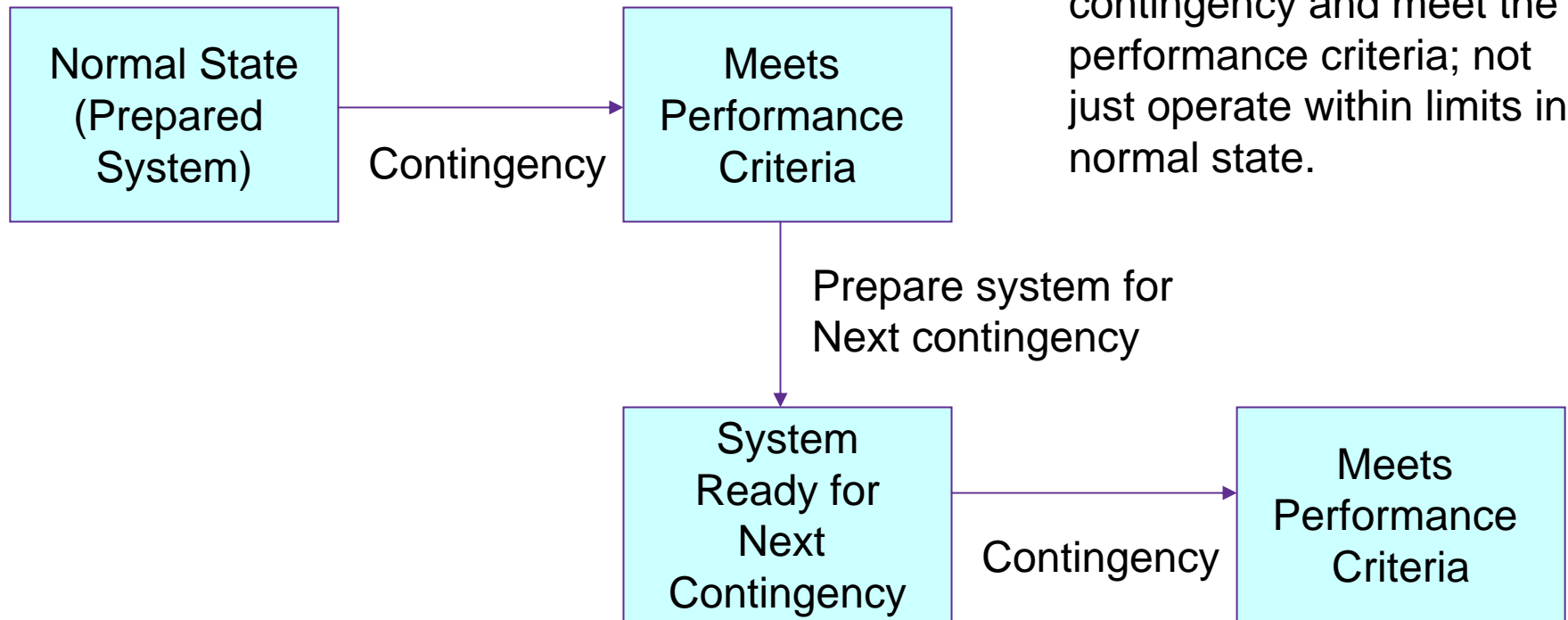
Planning Standards, Criteria and Coordination Plan

Steve Heidt

Alberta Reliability Standards - TPL

Alberta TPL Reliability Standards	
TPL-001-AB-0	System Performance Under Normal Conditions
TPL-002-AB-0	System Performance Following Loss of a Single Element
TPL-003-AB-0	System Performance Following Loss of Two or More Elements
TPL-004-AB-0	System Performance Following Extreme Events
Approved Sept 23, 2009	
Effective Sept 24, 2010	
Planning Assessments are in progress (R1)	
Corrective action plans to be developed and implemented in 2011 (R2)	

Preparing for Next Contingency



System in normal state must sustain next contingency and meet the performance criteria; not just operate within limits in normal state.

- **Each region or area is analyzed and studied considering:**
 - Current system (including known system additions)
 - Low and high loading levels
 - Low and high generation levels
- **Select contingencies to be studied**
 - Single circuit, common tower circuit, bus outages, breaker fail
- **Study objectives**
 - Determine the operating limits of the system
 - Look for constraints for the study period

- **Performance criteria (applied in system normal and following contingency situations)**
 - Thermal Limit – equipment normal or emergency rating are exceeded
 - Voltage Limit – bus voltage level or deviation is outside acceptable limits
 - Voltage Stability Limit – area load flow solves without required voltage support margin
 - Angular Stability Limit – area load flow solves in an unstable or oscillatory state

- **Objective is to maintain reliable operation during planned activities such as;**
 - transmission maintenance or construction outages and generator commissioning.
- **TFOs and GFOs are required to submit planned outages to the AESO**
- **AESO analyzes proposed outages**
- **AESO approves transmission outages and consults with owners where issues arise**
- **Approved transmission outages are published on our website**
- **On a week ahead basis, AESO performs operational studies considering:**
 - Outage schedules for each day
 - Short term load forecast and known generation status
- **Objective is to identify violations and implement necessary procedures**
- **In consultation with TFOs, AESO develops procedures for the real time operators to manage constraints as required**
- **Follow ISO Rule 5**
 - RELIABILITY ASSESSMENT AND SCHEDULED GENERATOR OUTAGE CANCELLATION

Transmission Planning Regions

- **System divided into five regions for study purposes**
- **Regional boundaries are revised to reflect synergies between planning areas for long term system planning**
- **Also evaluate bulk transfer capability between regions**



Regional Update

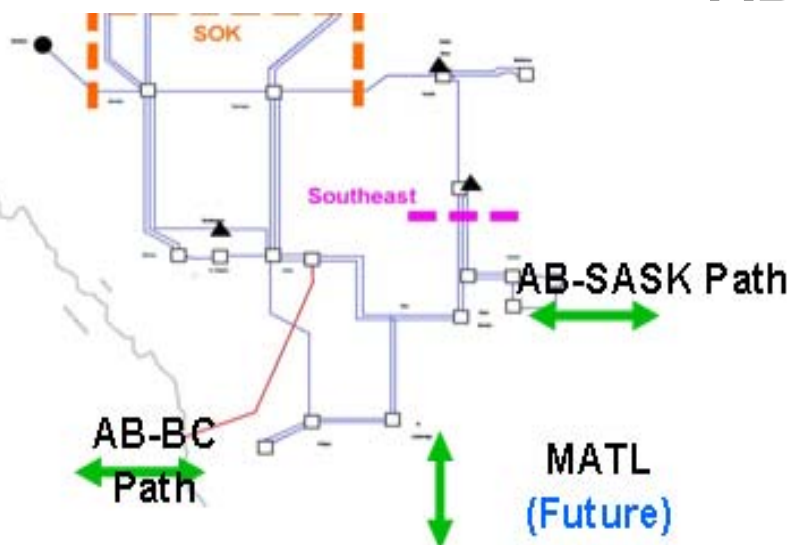
South / Central

OPERATIONS PLANNING AND TRANSMISSION DEVELOPMENT

Steve Heidt

AB-BC PATH

- One 500 kV and two 138 kV lines
- Transfer Capability
- Export 800 MW
- Import 780 MW
- Design and use of load shed programs are being reviewed
- OPP 304 & OPP 312

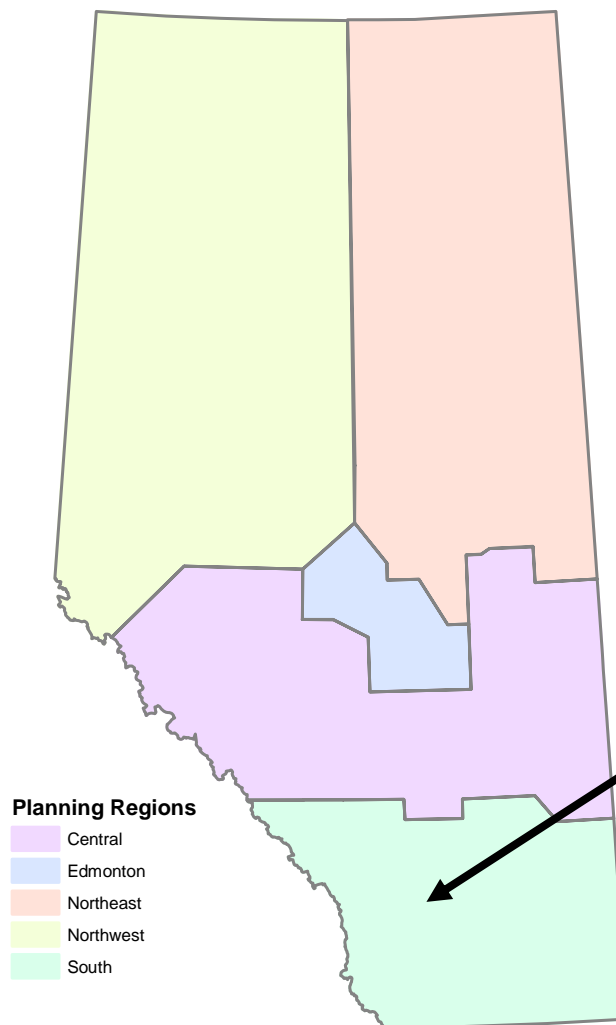


AB-SASK PATH

Back to back
AC/DC Converter
Intertie capability
is restored to 150
MW in both
directions
OPP 307

- **300 MW design capability**
- **ISD is Q3 2011**
- **Total Transfer Capability (TTC) limits for various operating conditions are being studied**

2010 Generation and Load - South

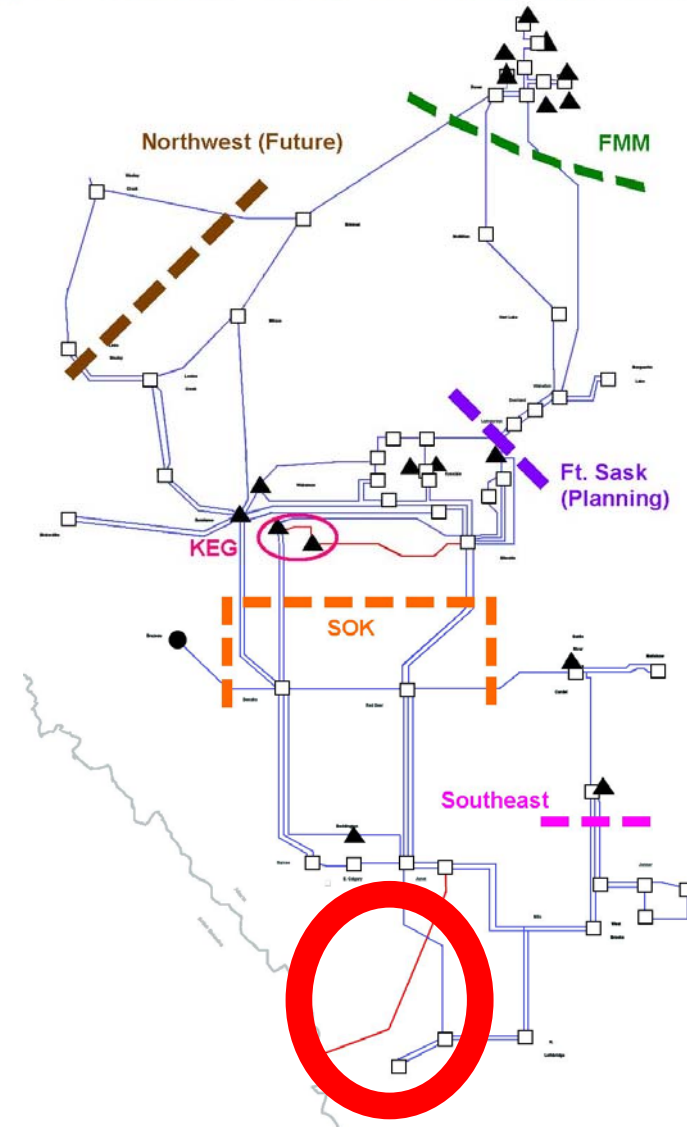


South Region		
2010 Generation Capacity	2,919	22.6%
2012 Generation Capacity	3,386	23.5%
2010 Load	2,925	29.8%
2012 Load	3,059	28.4%

- Coal and Gas
- Hydro and Wind

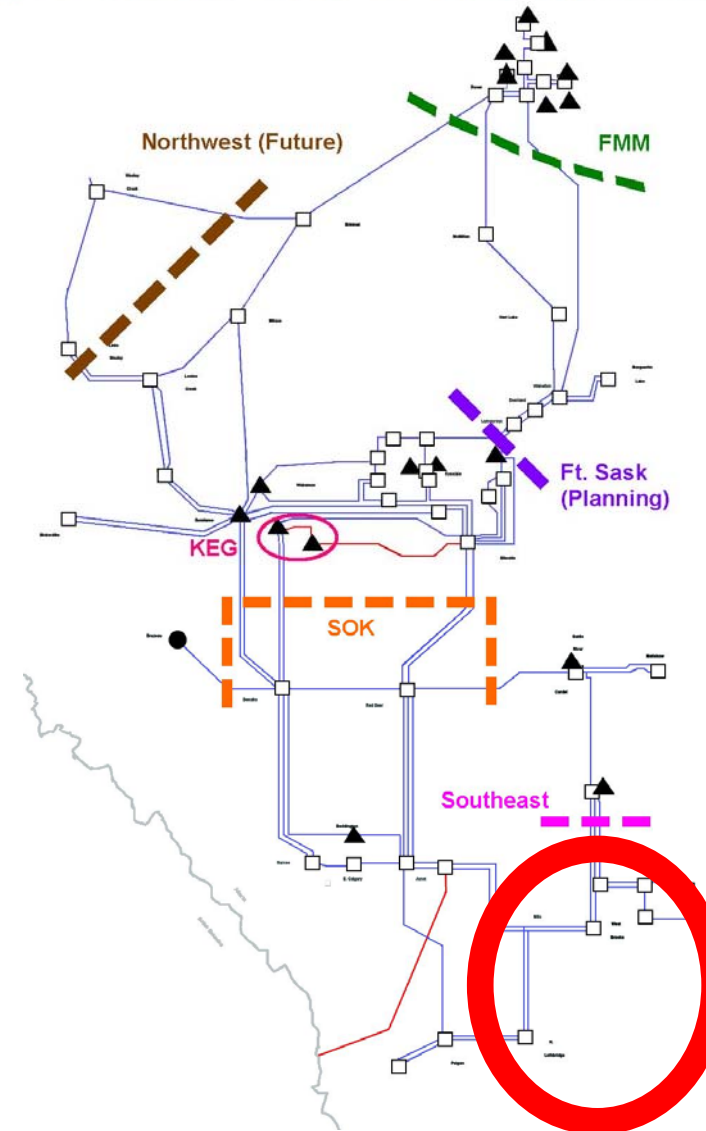
South Region - Southwest Area

- **Area Load = 109 MW (Lethbridge not included)**
 - 1.1% of provincial peak load
- **Area Generation = 664 MW (5.1%)**
- **Thermally limited area**
- **OPP 515**
- **Flow is out of the area; depends on wind generation**
- **SW 240 kV Transmission Project in service**
- **786L overloads will be mitigated by the phase shift transformer in 2011**
- **Remaining constraints will be mitigated by SATR related developments as these come on line in stages**
- **Expect frequency and MWh of wind generation curtailments will go down in the next 2 years**



South Region - Southeast Area

- **Area Load = 805 MW**
 - 8.2 % of provincial peak load
- **Area Generation = 1,180 MW (9.1%)**
- **Transmission consists of**
 - Two 240 kV three terminal lines
 - One 240 kV line heading north of Sheerness
- **Typical flow into the area**
 - The area is thermally, voltage limited, and angular stability limited



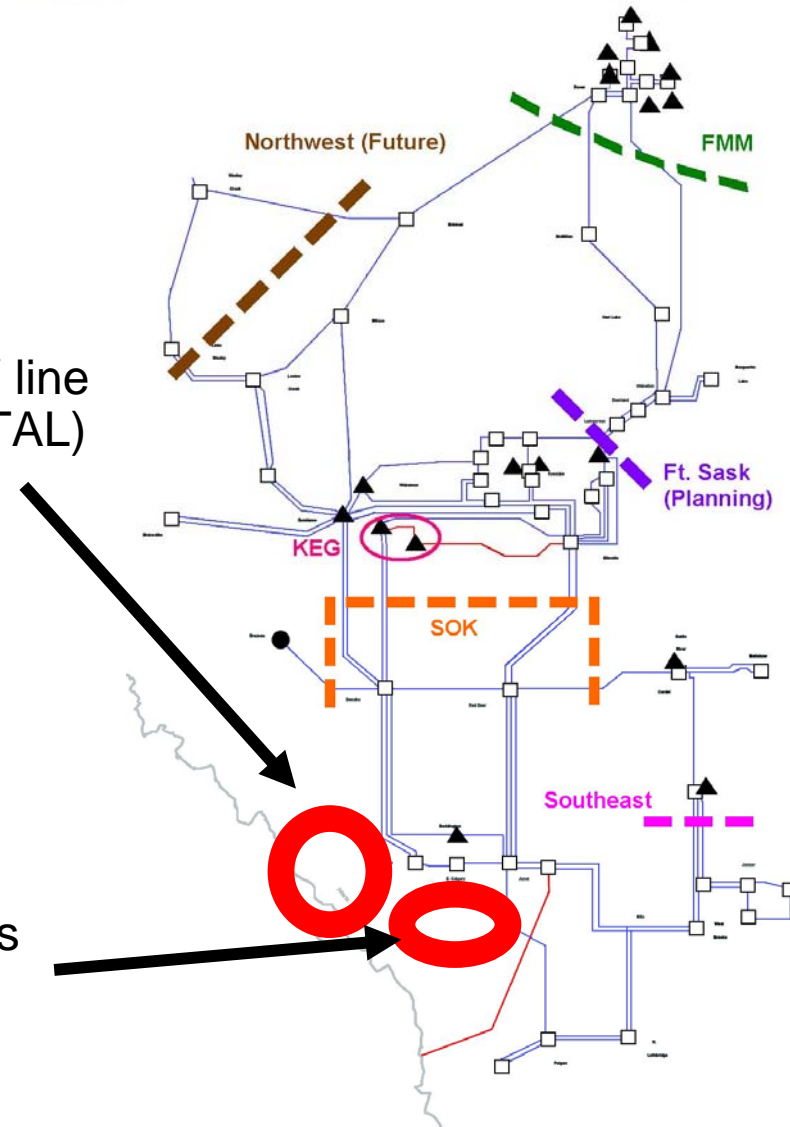
South Region - Seebe Area & South of Calgary

- **Seebe area**

- Area Load approximately 187 MW
- 1.9% of peak load
- Area Generation = 320 MW (2.5%)
- Transmission connected with three 138 kV line to Calgary and one 138 kV line to BC (NATAL)
- 138 kV system to the west is thermally constrained, depends on amount of hydro generation on-line

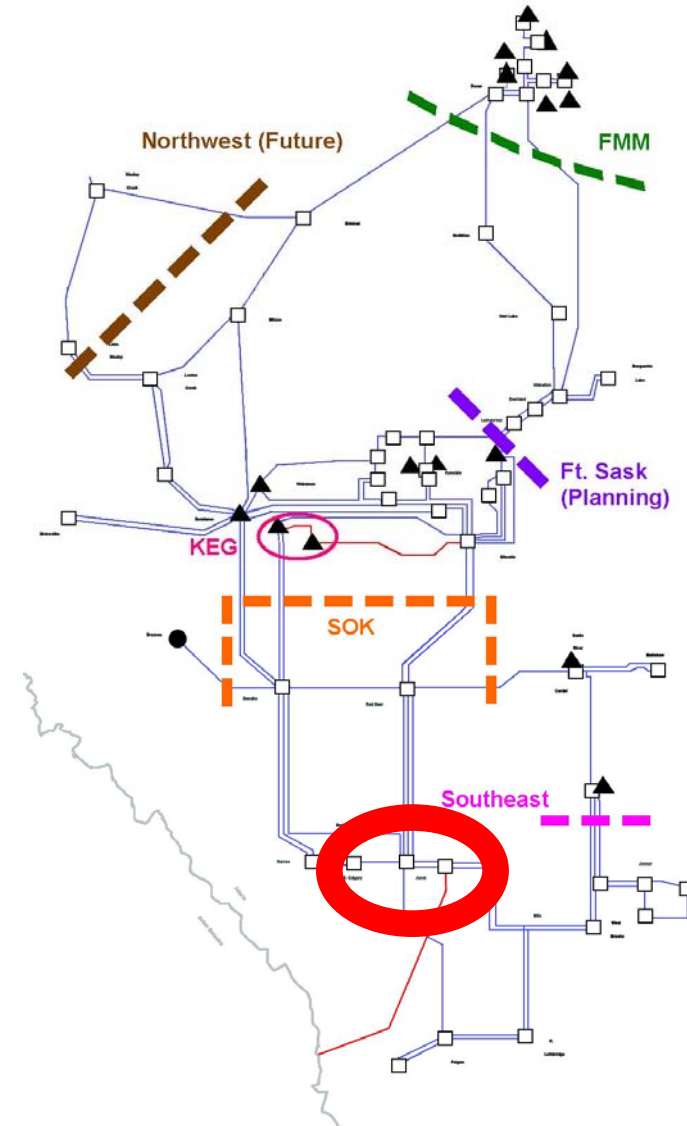
- **South of Calgary**

- 109 MW load
- 1.1% of peak, no generation
- 138 kV system east and south of Calgary is thermally and voltage constrained when operating with one line out of service



South Region Calgary and surrounding areas

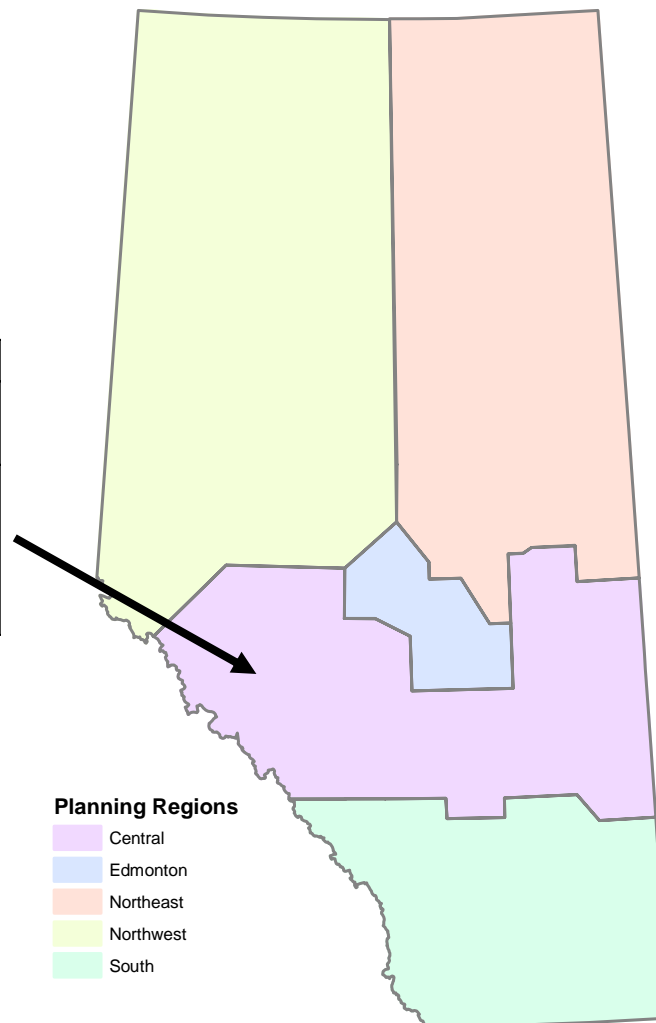
- Typically MW flow is into the area
- Area operation managed through specific limits
 - Path 1 limits
 - SOK limits
 - Dynamic VAr requirements and monitoring
- Under Voltage Load Shedding scheme
- Area Load = 1,716 MW
 - 17.5% of peak load
- Area Generation = 642 MW (5%)
- Downtown core and south is thermally constrained
 - Project in progress to address this constraint.
- AESO and ENMAX are creating development plans in the short and long term to address area reliability concerns



2010 Generation and Load – Central

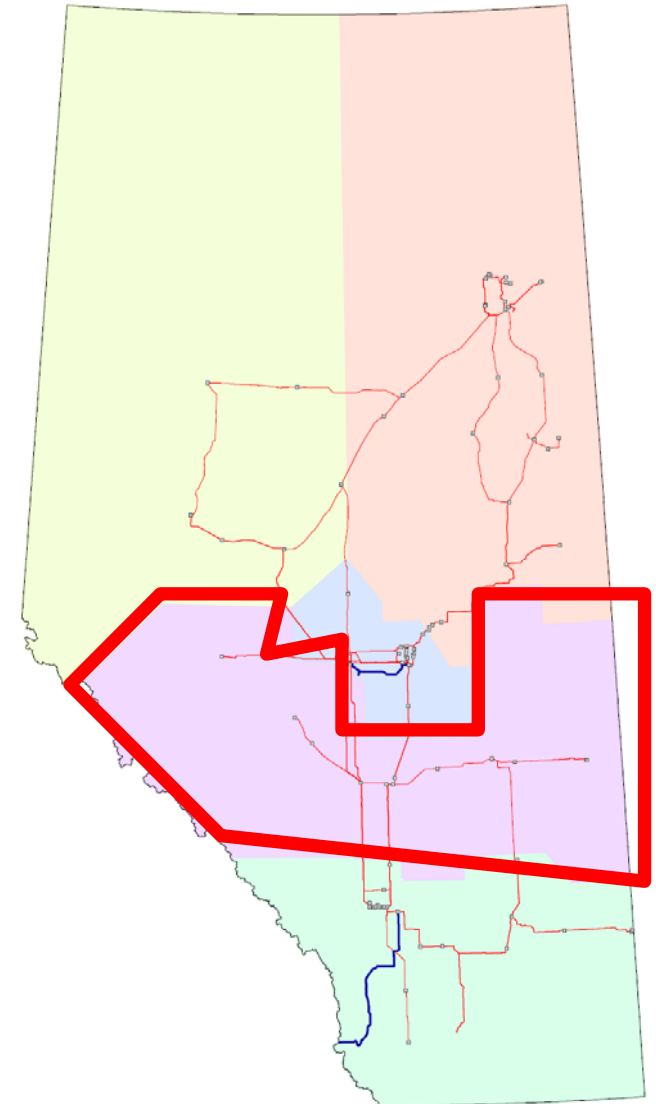
Central Region		
2010 Generation Capacity	1,740	13.5%
2012 Generation Capacity	2,150	14.9%
2010 Load	1,573	16.0%
2012 Load	1,683	15.6%

- Coal and Gas
- Hydro



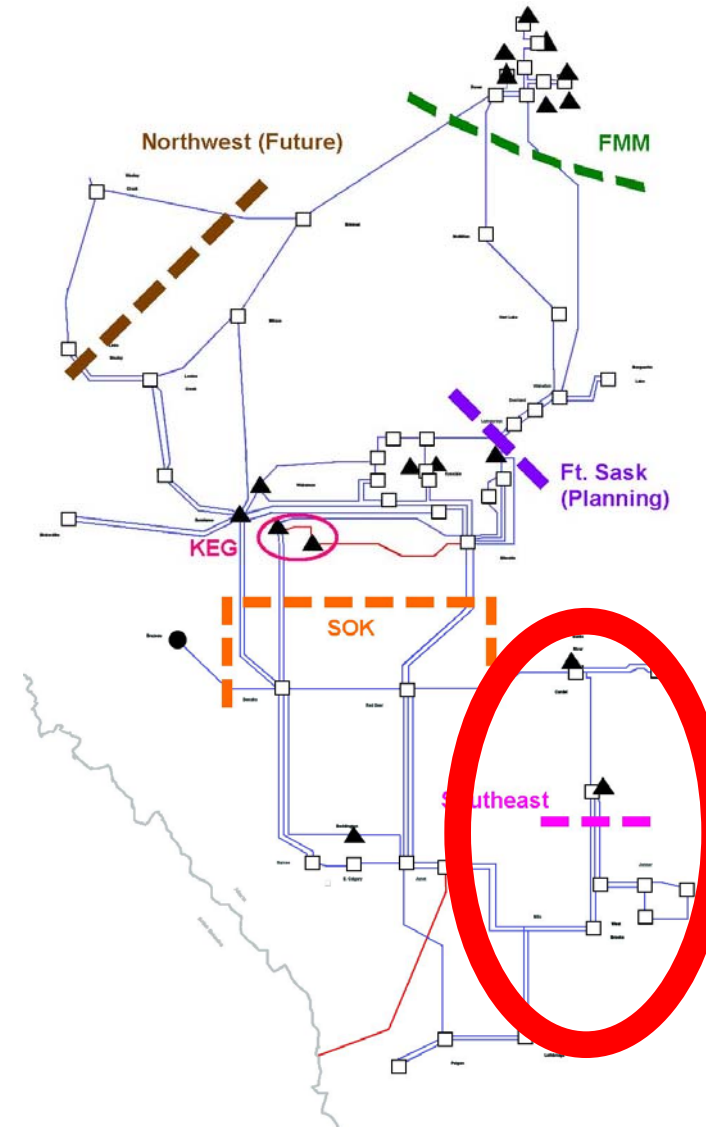
Central Region Update

- **Voltage and thermal constraints in the west and east area**
- **Yellowhead Development will mitigate west area constraints by 2012**
- **Hanna Development will meet Keystone pipeline load and mitigate other thermal and voltage constraints**
- **Red Deer area NID is planned for Q1 2011 to address voltage and thermal constraints in the area**



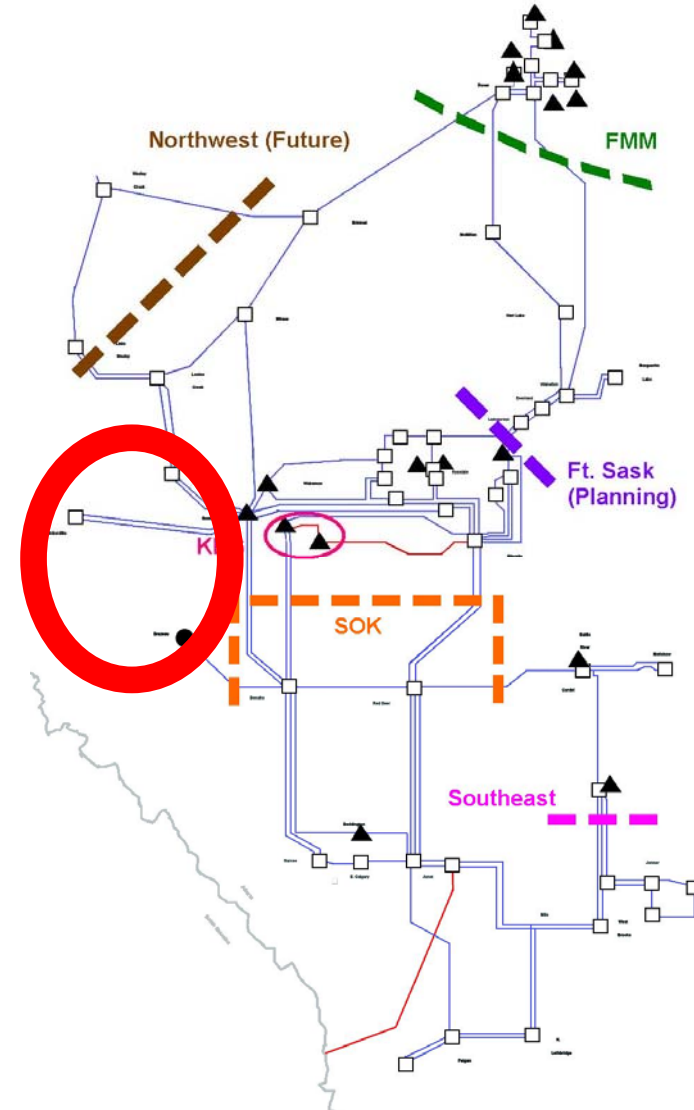
Central Region - Hanna Area

- **Southeast system is constrained by dynamic stability**
- **Options to increase the operating limit of south east are:**
 - Protection upgrade
 - Completion of Hanna Area Development
 - AESO operations studies to incorporate the new developments



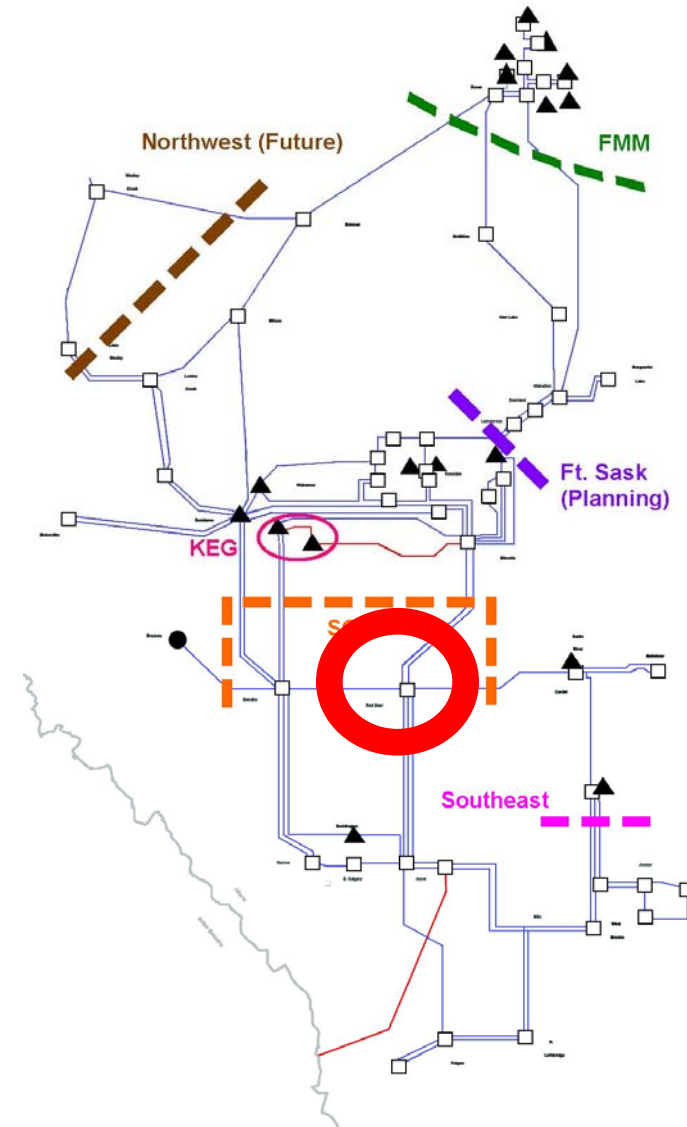
Central Region – Yellowhead Area

- **Brazeau area 138 kV system**
 - 430 MW of generation (3.3%)
 - 287 MW of load (2.9 % of peak)
 - Voltage limited during outage depending on load
 - Approved Yellowhead NID will mitigate area constraints
- **Area operation is managed through the outage coordination plans**



Central Region Joffre Area and Red Deer

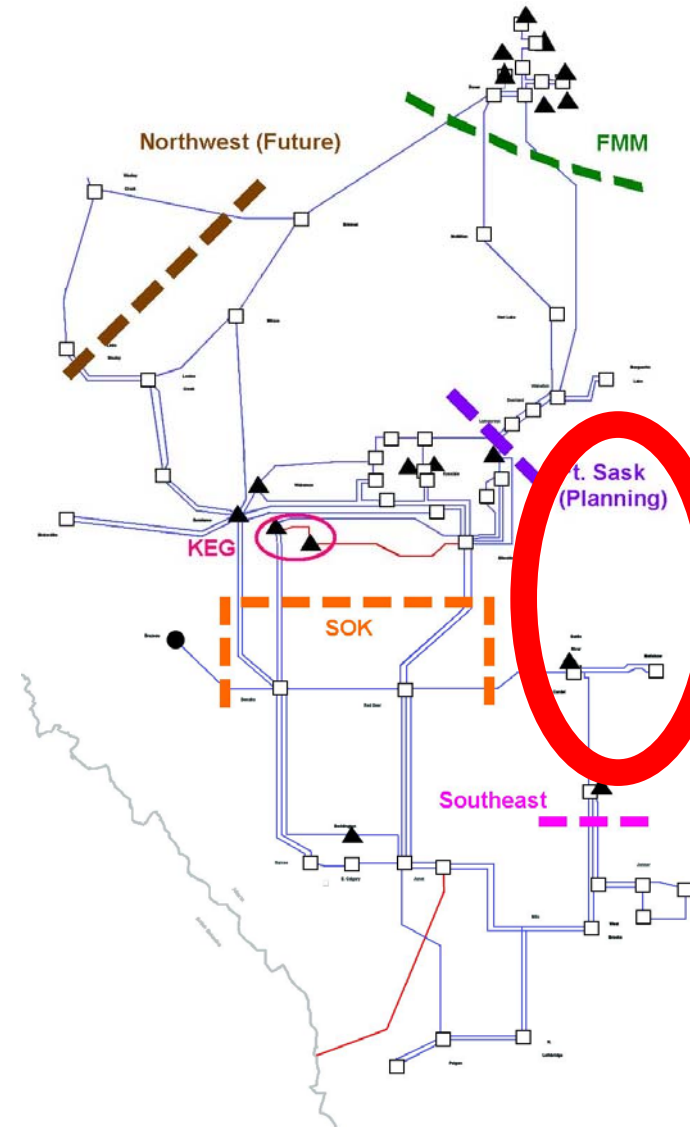
- **Area Load = 497 MW**
 - 5.1% of peak load
- **Area Generation = 474 MW (3.8%)**
- **Significant industrial load and base loaded co-generation**
- **Area interchange flows depends on generation status**
 - Thermally limited for outflow and voltage for inflow
 - Established in flow and out flow limits
 - Dependant on base loaded local generation to supply area load – area is monitored but not encroaching area limit
- **OPP 502**
- **NID planned to be filed in 2011**



Central Region – Central East

- **Central East**

- Generation 697 MW (5.4%)
- Load 654 MW; 6.7% of peak load
- Large geographic area that is has weak transmission support
- Voltage and thermal limitations during single element outage
- Experiencing future load growth relating to new pipeline operations
- Expect new 240 kV connections to Hardisty area and south of Monitor in the Hanna area to provide area reinforcement
- Area operation is managed through the weekly coordination plans
- Central East NID hearing complete in Nov 2010



Regional Update

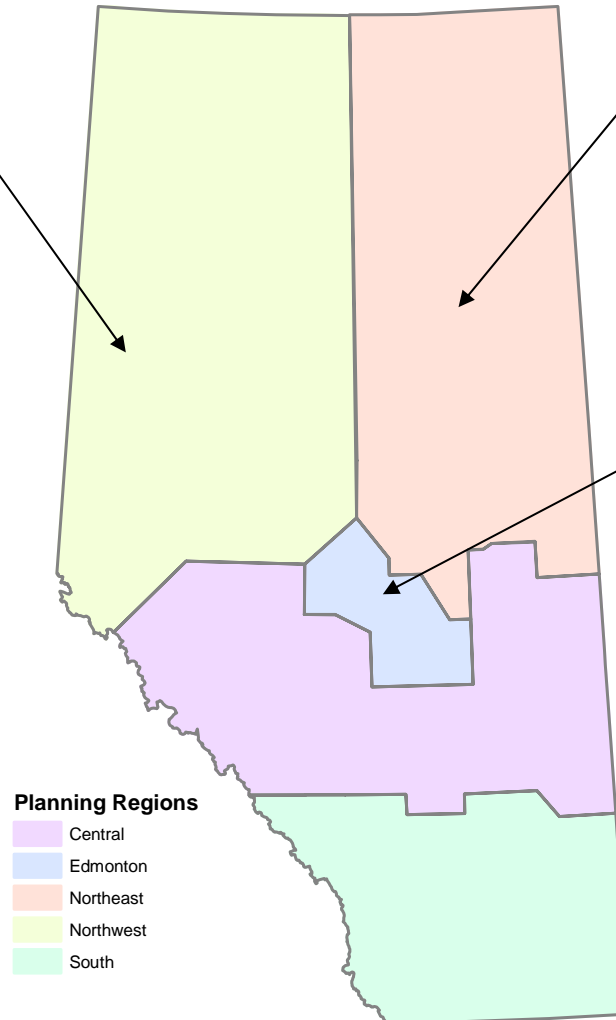
Northwest, Northeast and Edmonton
OPERATIONS PLANNING AND TRANSMISSION DEVELOPMENT

Jin Liang Han

Generation and Load - North Region

Northwest Region		
2010 Generation Capacity	798	6.2%
2012 Generation Capacity	798	5.5%
2010 Load	1,099	11.2%
2012 Load	1,165	10.8%

- Coal
- Gas
- Biomass



Planning Regions

- Central
- Edmonton
- Northeast
- Northwest
- South

Northeast Region		
2010 Generation Capacity	3,001	23.2%
2012 Generation Capacity	3,179	22%
2010 Load	2,197	22.4%
2012 Load	2,777	25.8%

- Gas
- Biomass

Edmonton Region		
2010 Generation Capacity	4,457	34.5%
2012 Generation Capacity	4,907	34%
2010 Load	2,013	20.5%
2012 Load	2,085	19.4%

- Coal and Gas

North - South Bulk Transmission (Edmonton to Calgary)

- **Six 240 kV lines**

- Wabamun Lake / Edmonton area to Red Deer area
- Red Deer area to Calgary area

- **Transfer limits (Operational Definition):**

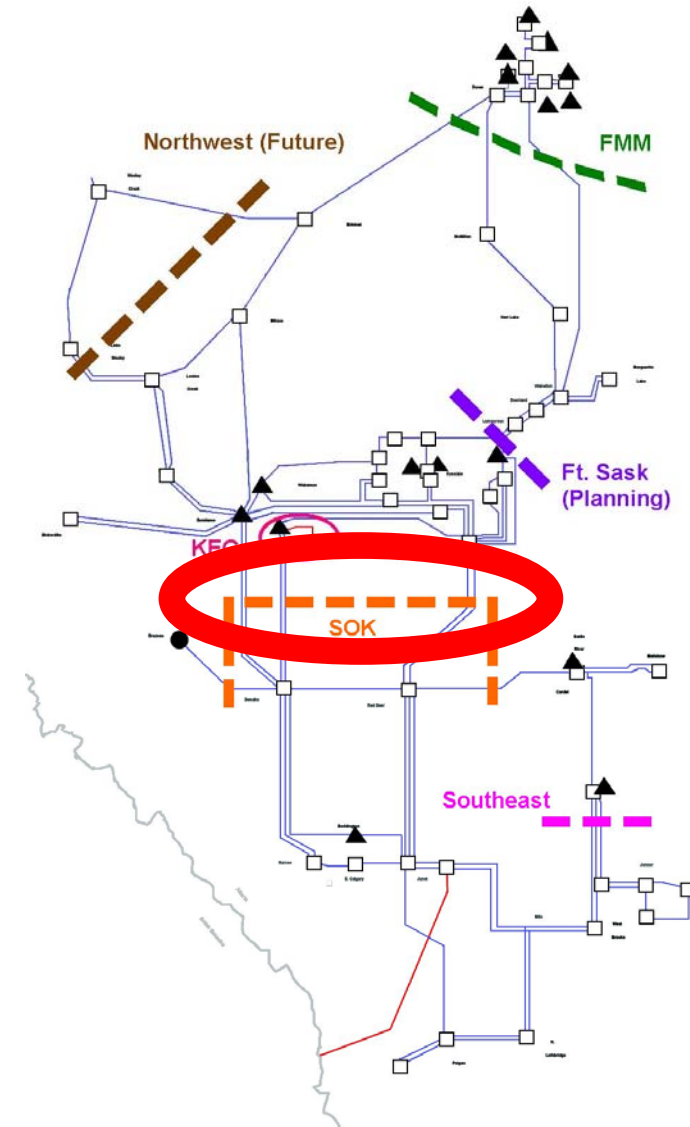
- Summer = 2,050 MW (2010)
- Winter = 2,150 MW (2010)
- Limitation angular stability and thermal (138 kV overloads)

- **Flows**

- Always north to south
- Maximum flow range 1,946 to 2,010 MW over three years
- 2010 Jan-Sep average was 1,242 MW

- **OPP 521**

- **No congestion expected in 2012 when system operating with normal SOK transfer limits**



Edmonton Region

- **Transmission system**

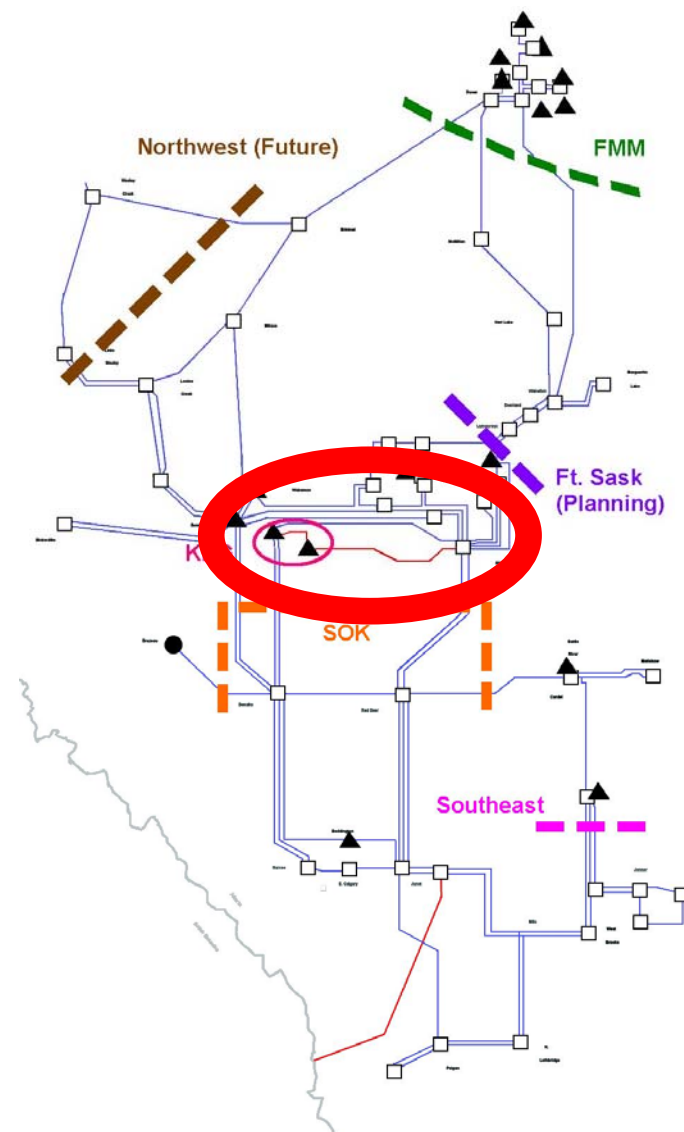
- Three 240 kV lines from Sundance plants to Edmonton area
- Two 500 kV and one 240 kV from KEG to Edmonton area
- Several 240 kV and 138 kV between Edmonton & Ft Sask

- **Largest flows west to east and south**

- **Bulk system is approaching capacity limit**

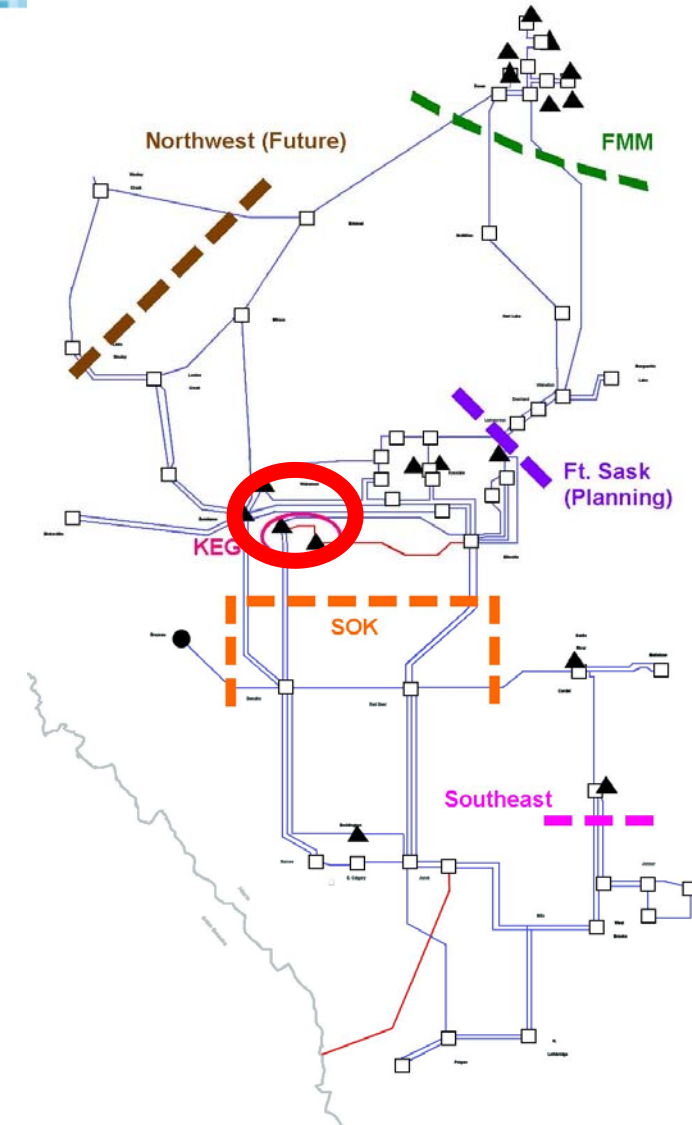
- **Limits are based on thermal, angular and voltage stability**

- **Wabamun 4 was decommissioned in 2010 (279 MW)**



Edmonton Region – Wabamun Area

- **2,010 MW of base loaded coal generation in KEG**
 - Keephills Plant 780 MW (6.0%)
 - Genesee Plant 1,230 MW (9.5%)
- **Sundance plant 2,151 MW (16.7%)**
- **Area load 178 MW (1.8% of peak)**
- **MW flows from west to east, northwest and south**
- **Transmission system operating at its limit**
- **Limits are based on thermal, angular and voltage stability**
- **One transmission facility outage requires significant generation curtailment**
- **OPP 517**
- **Keephills 3 interconnection and debottlenecking projects in progress**

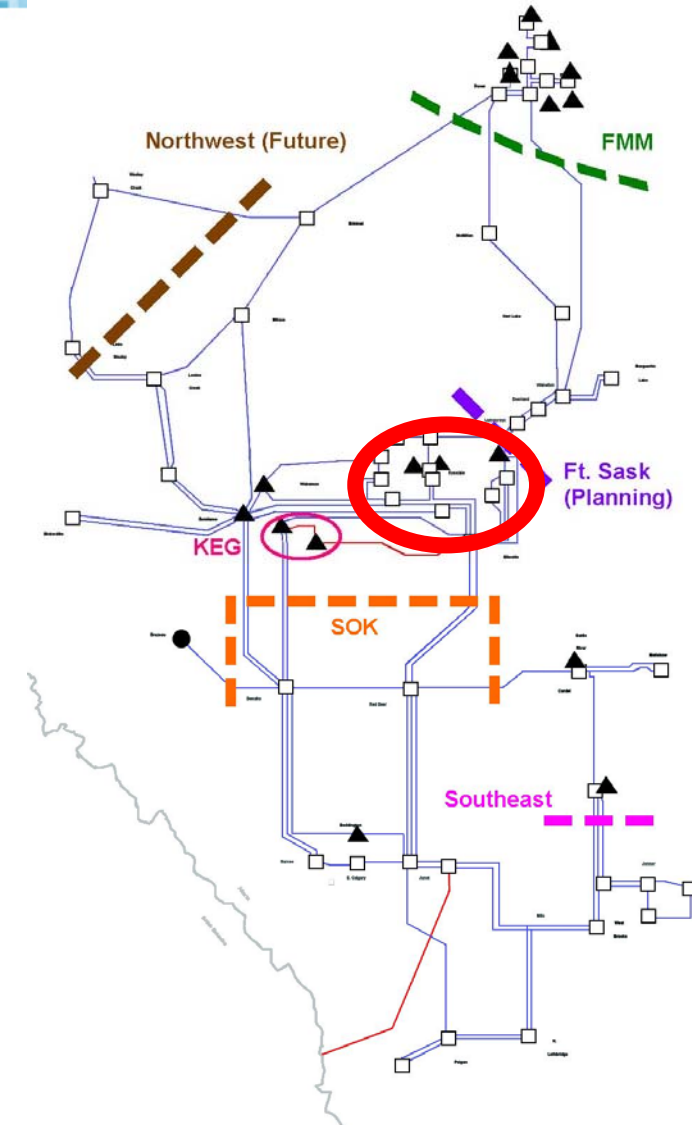


Edmonton Area Debottlenecking Project & KH3 Interconnection Update

- **Protection upgrades are almost complete**
- **500 kV and 240 kV upgrades and line configurations are in progress and will be complete in March 2012**
- **KH3 energization to the AIES grid will be in Q1 2011**
- **Congestion will continue to occur during construction phase**
- **Completion of the 240 kV line re-configurations and upgrades in March 2012 will:**
 - **Mitigate dynamic stability concerns in the area due to increased generation**
 - **Mitigate congestion in the KEG loop and system between Sundance Plant and Edmonton area**

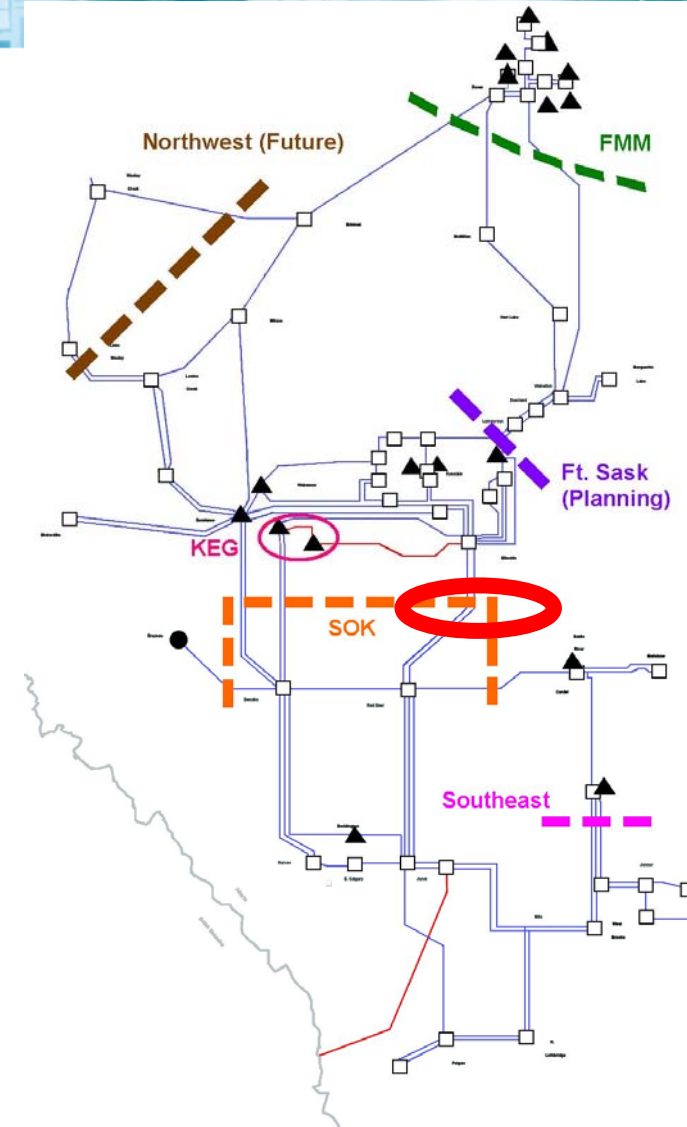
Edmonton Region City of Edmonton Area

- **Area Load approximately = 1,704 MW**
 - 17.4% of peak load
- **Area Generation = 289 MW (2.2%)**
- **Typical flows into the area from Wabamun area and northeast**
- **947L 240 kV line termination from Ellerslie to Clover Bar completed**
- **1202L upgraded to 500 kV**
- **Constraints may occur during construction outages relating to the debottlenecking project**



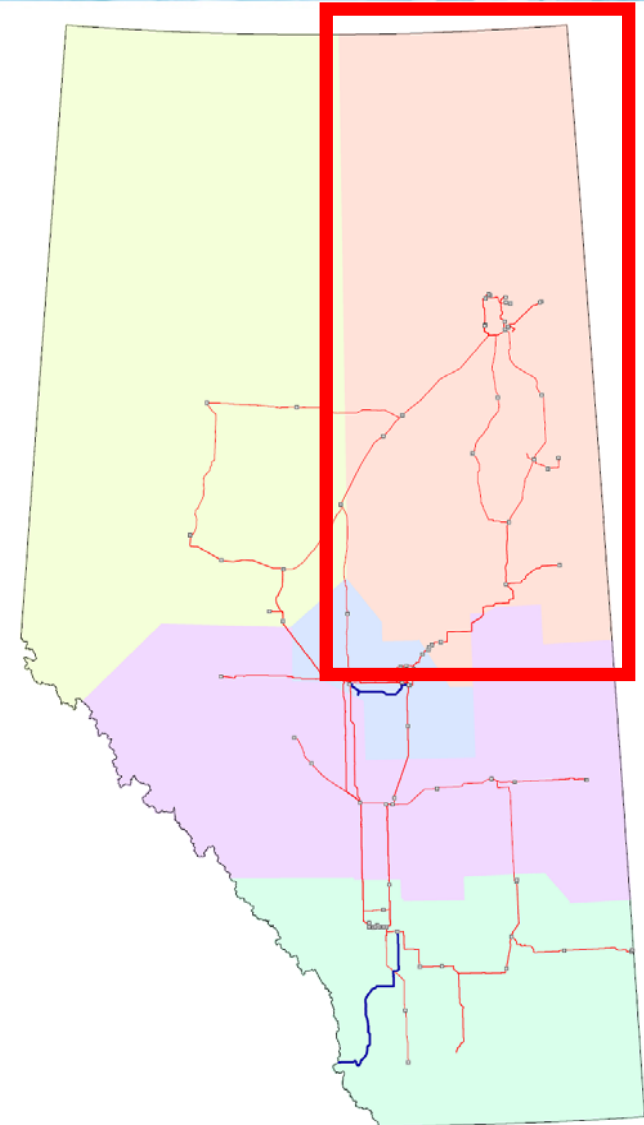
Edmonton Region 138 kV system around Edmonton

- **Area Load approximately = 131 MW**
 - 1.3% of peak load
- **Area interchange flow into area (no generation in area)**
- **East Edmonton to Nisku to Wabamun to North Calder 138 kV system is voltage and thermally constrained during outages**
- **Planned outages are managed via outage coordination plans**
- **Transmission reinforcements are necessary and are being planned**



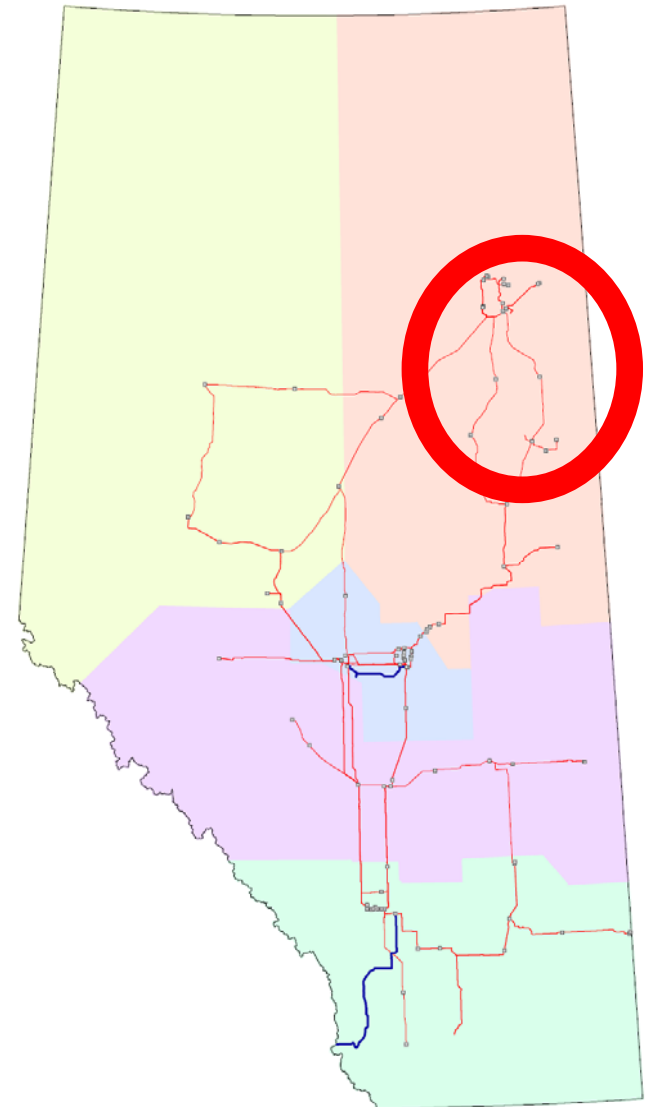
Northeast Region

- **Significant industrial load and base loaded co-generation**
- **Expect over 500 MW growth in load over the 2 years**



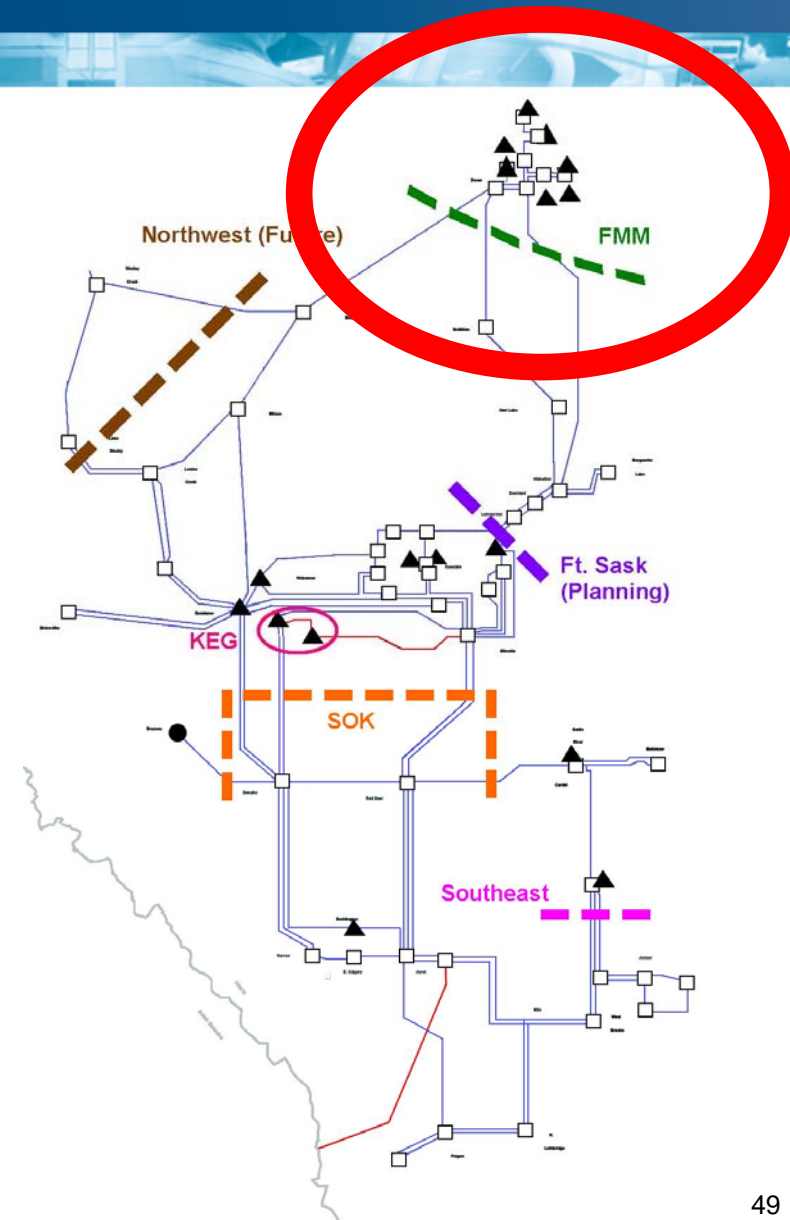
Northeast Region - Fort McMurray Area

- **Area Load = 1,171 MW (11.9% of peak)**
 - High growth expected for next two years
- **Area Generation = 1,852 MW (14.3%)**
- **The 240 kV and 144 kV systems are thermally and voltage constrained especially during outages**



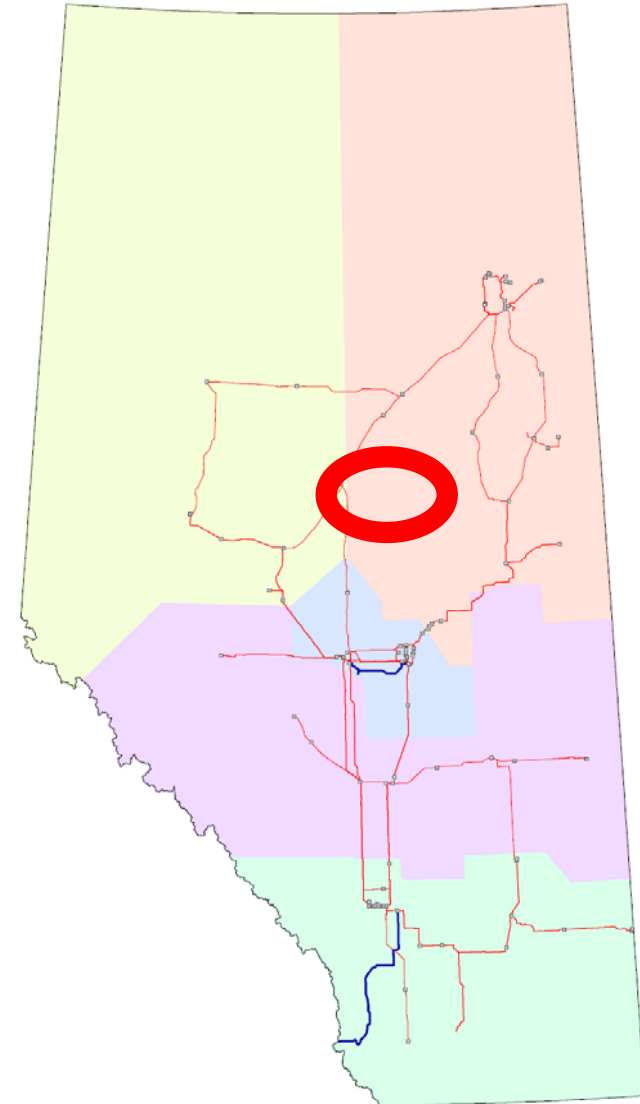
Northeast Region - Fort McMurray area

- **Three 240 kV lines define the FMM cutplane with limits as:**
 - 575 MW out and 300 MW in
- **OPP 505**
- **Congestion expected in 2012 with current transfer limits**
- **Transmission upgrades by 2012**
 - 260 MVAR capacitor banks
 - Will increase inflow and outflow limits
 - AESO studies will determine operating limits
 - Congestion expected to be mitigated with upgrades when system operating under normal conditions



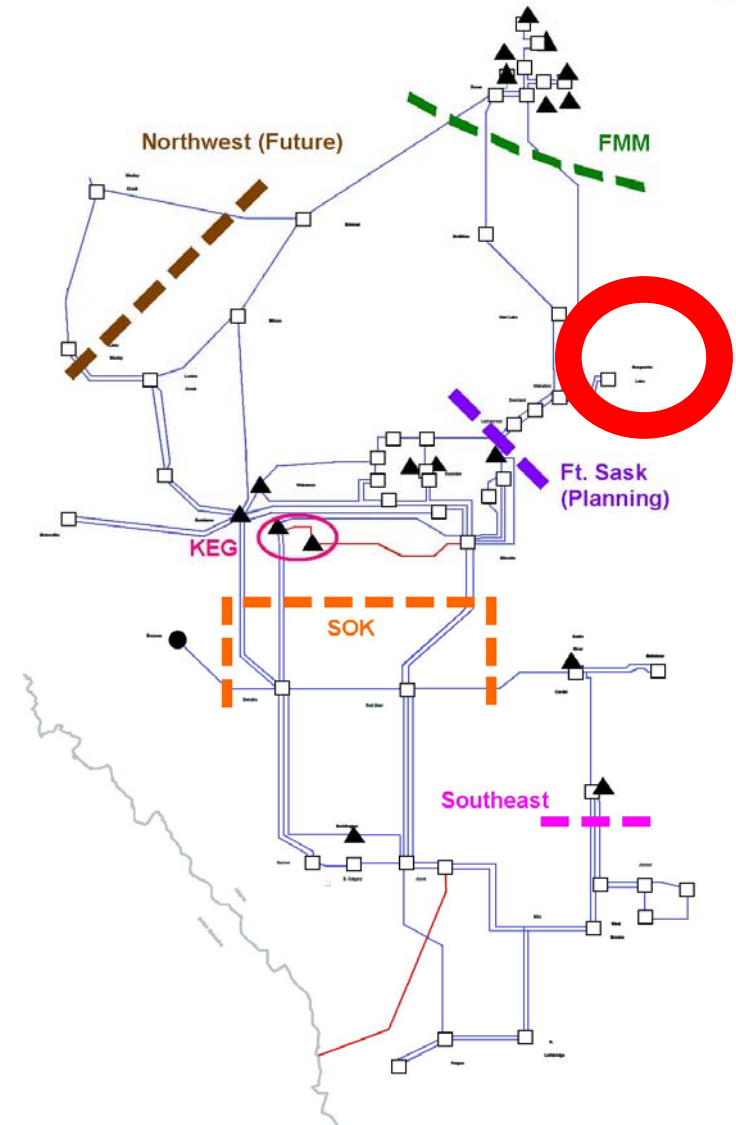
Northeast Region - Athabasca / Lac La Biche Area

- **Area Load approximately = 127 MW**
 - 1.3% of peak load
- **Area Generation = 117 MW (0.9%)**
- **Typical MW flow is into the area**
 - Area is voltage limited
 - Congestion may show up when operating under single element outage and is dependent on the area load
 - Planned outages managed via outage coordination plans



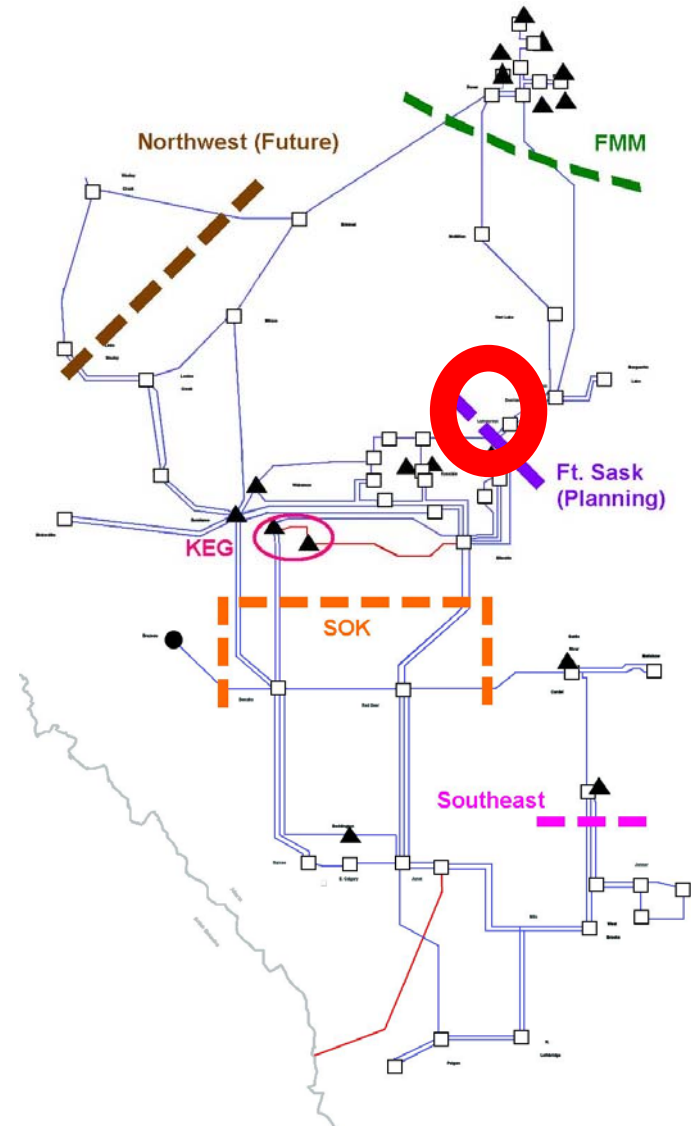
Northeast Region - Cold Lake Area

- **Area Load approximately = 336 MW**
 - 3.4% of peak load
- **Area Generation = 369 MW (2.9%)**
- **Typical MW flow is out of the area**
 - During light load periods the Cold Lake area is thermally constrained during outage conditions
 - RAS are applied to alleviate transmission line overloads following contingencies by running back and or tripping area generation
- **Expected load and generation increase in the area relating to oil sands and pipeline facilities**
- **OPP 508**



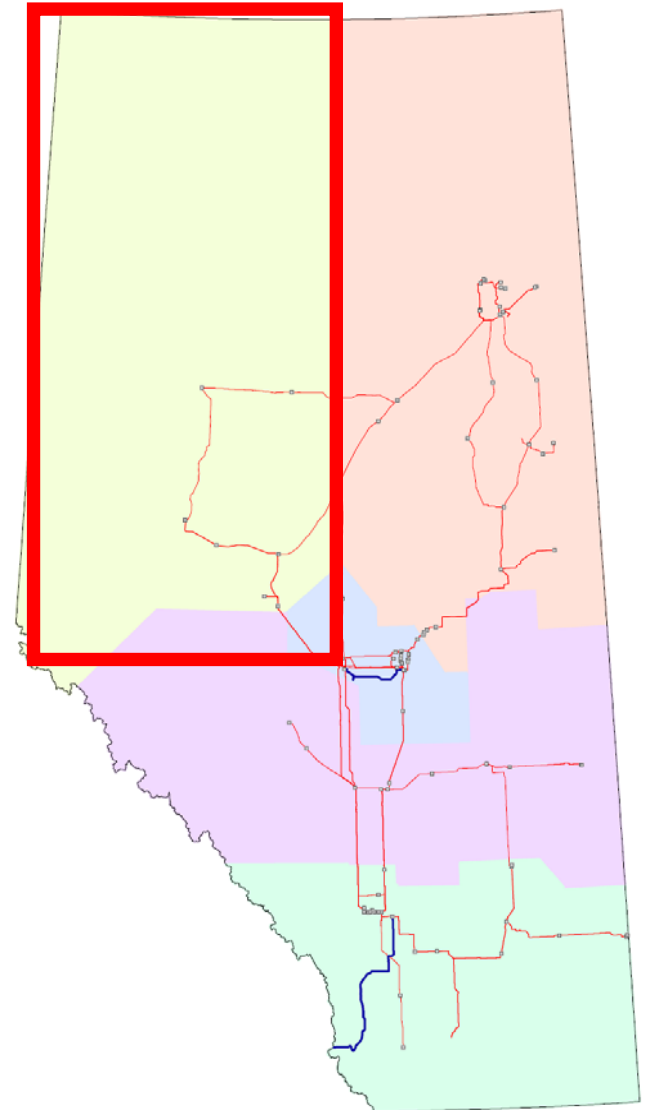
Northeast Region - Fort Saskatchewan Area

- **Area Load 563 MW (5.7% of peak)**
- **Area Generation 663 MW (5.1%)**
- **Significant industrial load and base loaded co-generation**
- **CTI upgrade (Heartland)**
 - Support local demand in the Heartland area
 - Accommodate growing demand in northeastern Alberta including Fort McMurray from oilsands development and pipelines
 - Support the backbone of the province's transmission system
 - New transmission will address bulk system future constraints
 - Facility application filed by TFOs in 2010



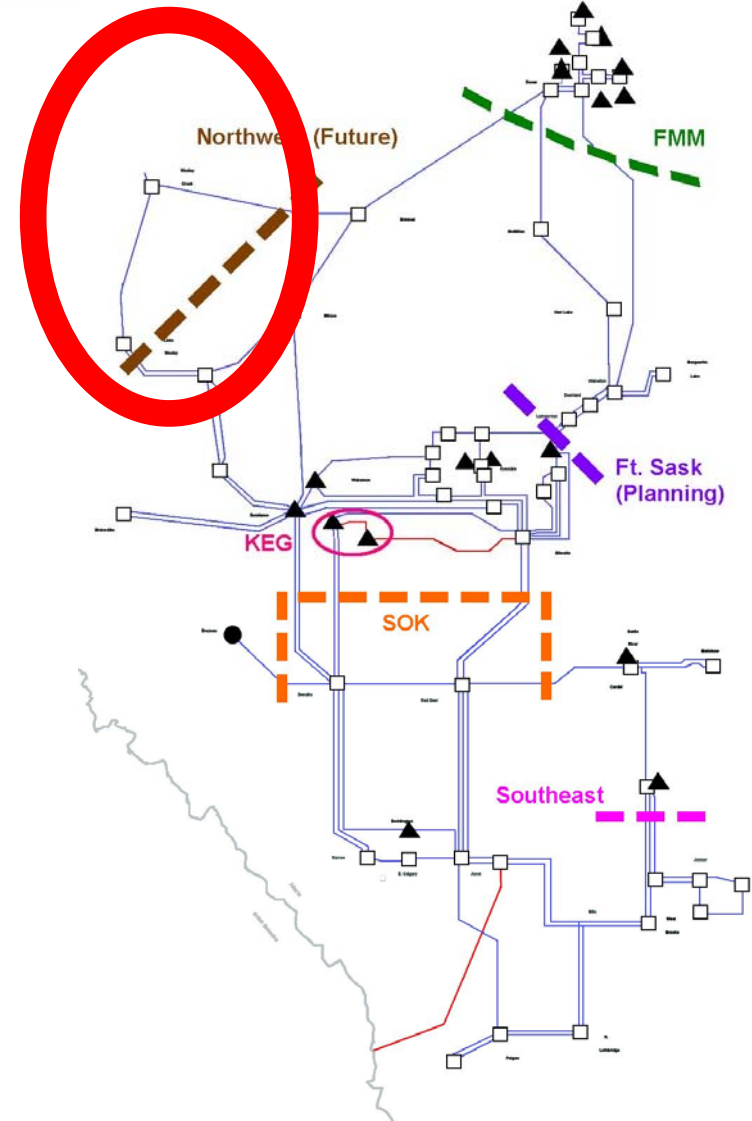
Northwest Region

- **Three 240 kV lines connect Wabamun Lake to the northwest**
 - Typical MW flow into the area ranges from 530 to 755 MW
- **Area Limitations:**
 - Voltage stability, angular stability and thermally constrained area
 - Region is dependant on local generation (TMR) to supply load



Northwest Region Updates

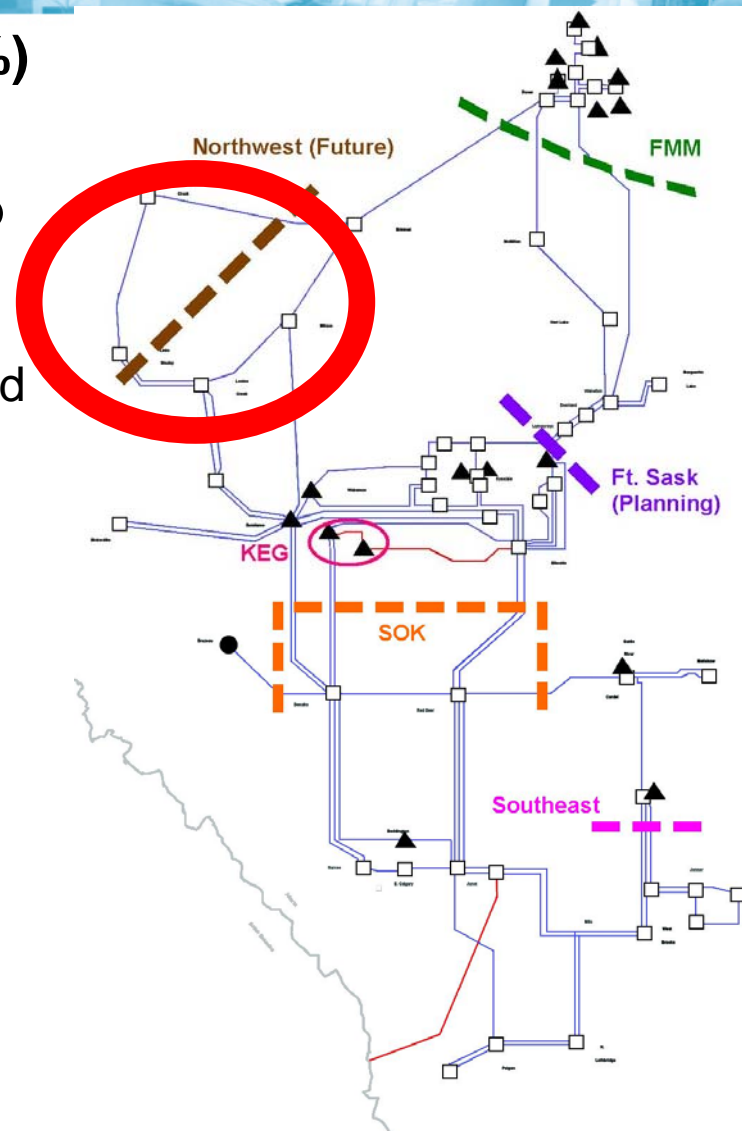
- **NW Transmission Development project in progress**
- **New 144 kV double circuit transmission lines from Wesley Creek 834s to Meikle 905s**
- **Planned completion by 2012**
 - Three 144 kV lines in Rainbow Lake area
 - One SVC, one sync condenser & one capacitor bank at a new substation



Northwest Region

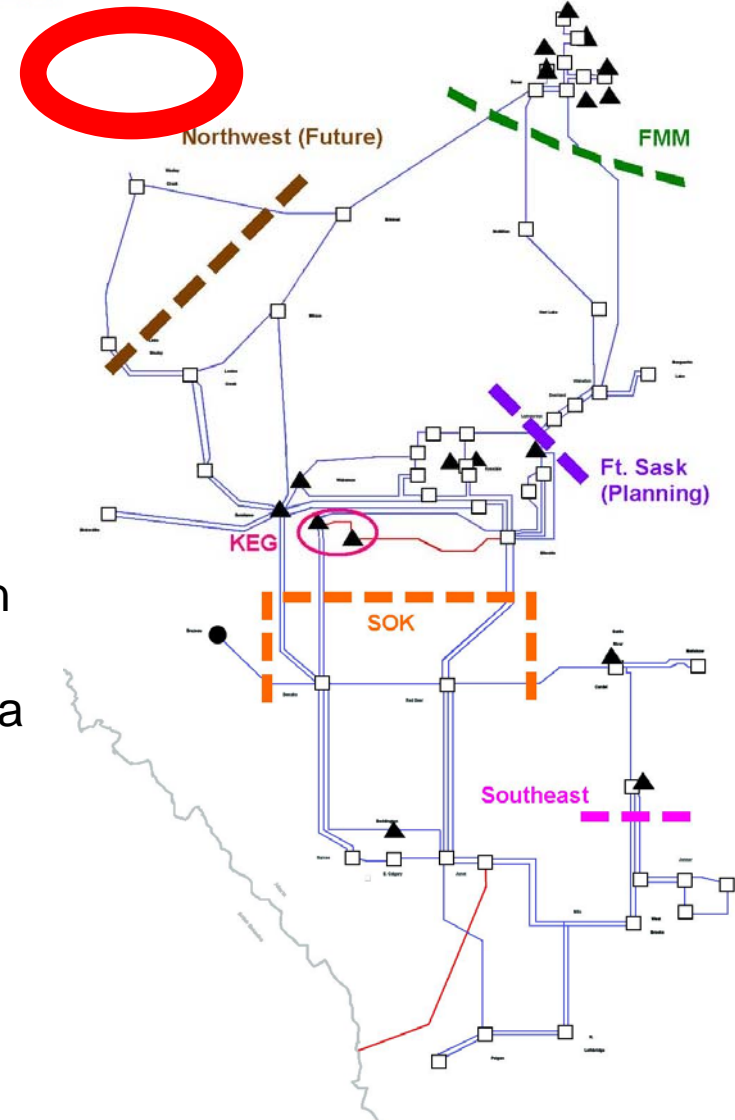
Northwest Area (excluding Rainbow)

- Area Load approximately = 959 MW (9.8 %)
- Area Generation = 564 MW (4.4%)
- Current system does not have capacity to support all area load, without local generation on line
 - Area is voltage stability, angular stability limited and thermally limited
- New +/- 100 MVAR SVC at Little Smoky
- OPP 501



Northwest Region Rainbow Area

- **Area Load approximately = 141 MW (1.4%)**
- **Area Generation = 234 MW (1.8%)**
- **Interconnected through one 144 kV transmission line**
- **Current system does not have capacity to support all area load**
 - Area is voltage stability limited
 - Requires minimum Rainbow area generation on-line 100% of the time
 - Under Voltage Load Shed (UVLS) in the area
- **OPP 501**



Transmission Must Run Update

John Kehler

Transmission-must-run

Northwest Rainbow Lake Area

Minimum = 65 MW

Increases approx 1 to 1 as load increase

Northwest Grande Prairie Area

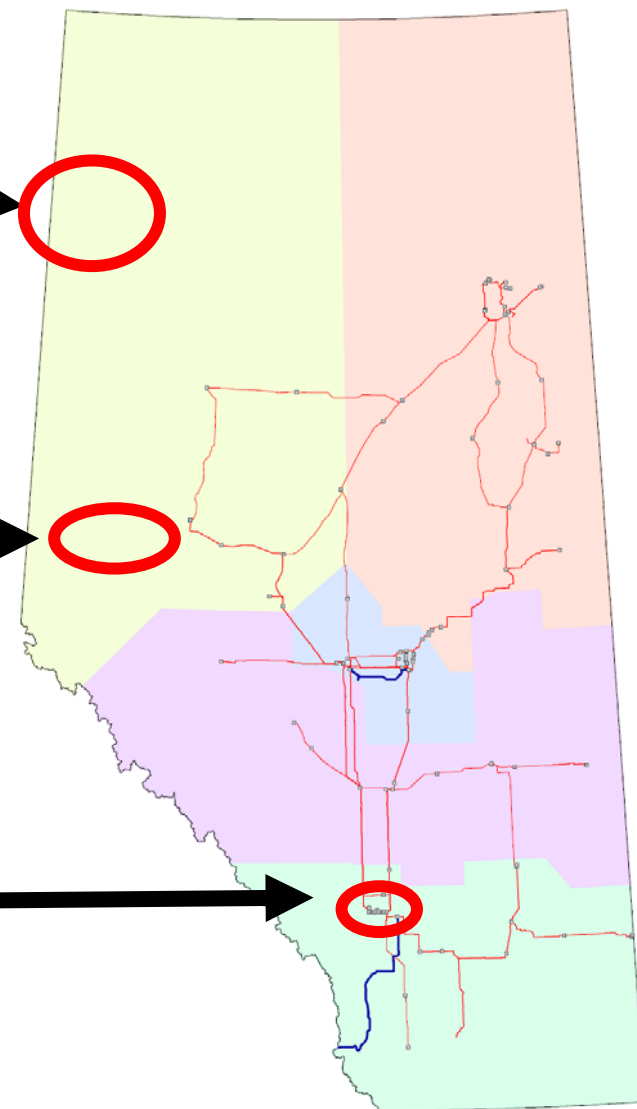
No TMR when NW area load = 785 MW

TMR MW is 1 to 1 as load increases over 785 MW*

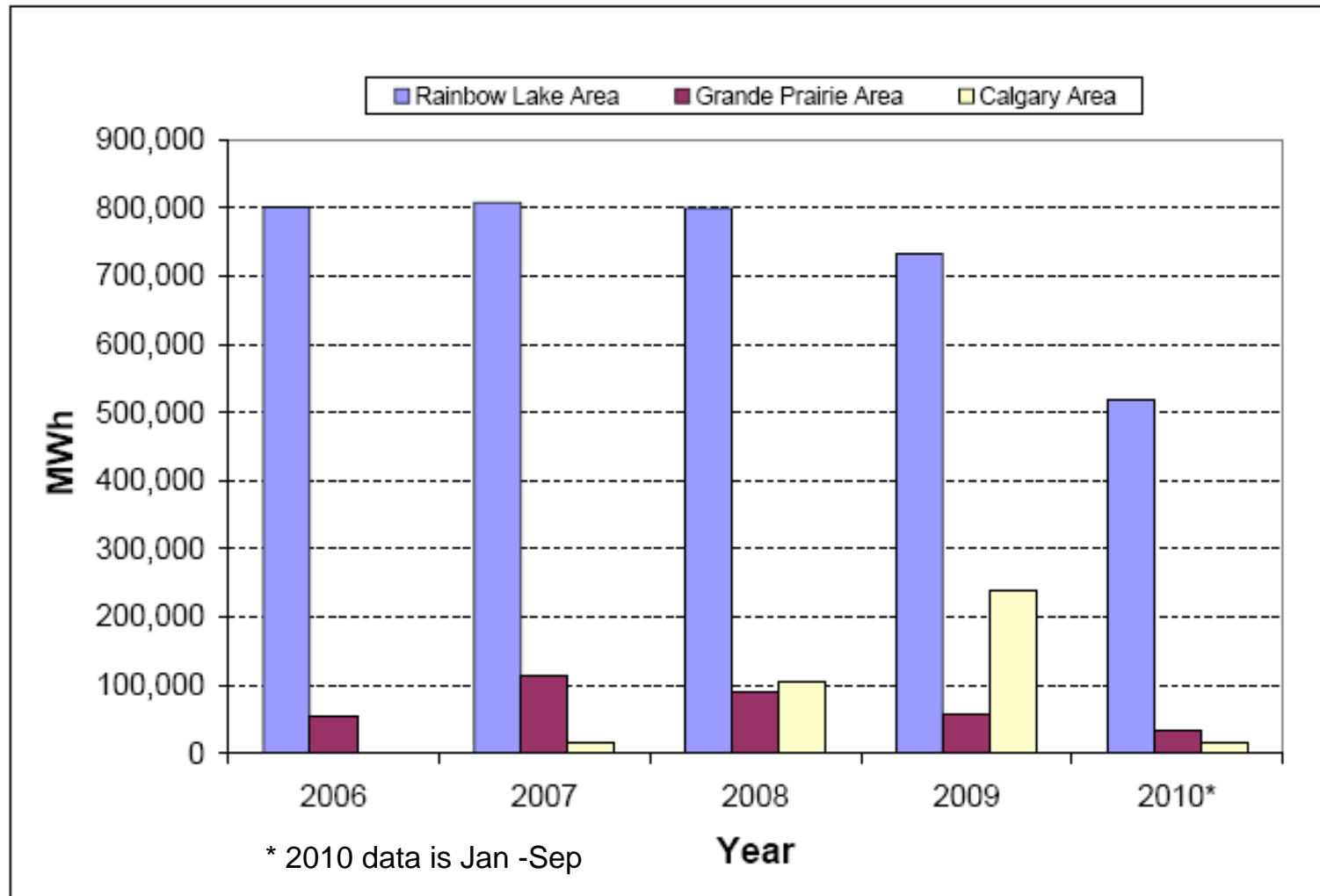
* This is after NW development in place

Calgary Area

Minimum = 125 MW when SVC out of service or congestion on SOK path



TMR MWh Usage History for Different Areas of Alberta



2010 – Completed Major Transmission Upgrades

- **240 kV extension in southwest**
- **Double circuit 144 kV lines in northwest**
- **Capacitor banks in northwest**
- **Two SVCs in northwest**
- **Re-termination of 947L between Ellerslie 89s and Clover Bar 987s**
- **1202 upgraded to 500 kV**
- **Southeast: 138 kV re-configuration**
- **Two 27 MVar capacitor banks at McNeil**
- **240/138 kV transformer capacity increase at West Brooks and North Lethbridge**



2010 to 2012 – Expected Major Projects

- **Capacitor banks (NW / NE)**
- **SVC (NW)**
- **144 kV lines in northwest**
- **Capacitor banks in northeast**
- **Yellowhead area developments in place**
- **Phase Shift Transformer at Keephills**
- **Phase Shift Transformer near Dover**
- **Keephills 3 interconnection**
- **The Montana Alberta tie line**
- **Re-configurations in the City of Calgary**
- **Hanna area transmission developments**
- **Central East transmission developments**



- **System is expected to be reliable over the next 24 months**
- **During normal system conditions;**
 - Future congestion will be infrequent and of short duration
 - Without planned transmission enhancements;
 - Future regional congestion will increase
 - May create reliability issues in the longer term
- **AESO actively manages planned outages via outage coordination plan**
- **Maintain emphasis on system analysis, operating procedures, tools, and training to preserve reliability and manage constraints as they occur**

QUESTIONS