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ALBERTA ELECTRIC SYSTEM OPERATOR

AESO 2015 Long-term Transmission Plan

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The Alberta Electric System Operator (AESO) uses its comprehensive *2014 Long-term Outlook* (2014 LTO) as the key input for its *2015 Long-term Transmission Plan* (2015 LTP). The LTO was originally published in May 2014, and the AESO recognizes that the province's economic outlook has changed significantly since then. Current economic conditions have resulted in much slower provincial growth, and this downturn will be captured as part of the AESO's forthcoming *2016 Long-term Outlook*.

To present stakeholders with the most accurate assessment of the province's transmission needs, the AESO took the added step of testing the 2015 LTP's transmission plans against our 2014 Low-growth Scenario. This economic scenario is predicated on low oil prices and the deferment of large capital oilsands investments.

The projects outlined within the 2015 LTP are subject to change based on forecast, economic, legislative or regulatory changes. The AESO reconciles any future changes by adjusting transmission infrastructure planning as needed over time. Prior to advancing any proposed transmission infrastructure through the regulatory process, further study work is always undertaken to reaffirm whether or not the proposed infrastructure is still appropriate. Using both the 2014 LTO's Main Outlook and its 2014 Low-growth Scenario, the AESO is confident that it is providing stakeholders with a thorough and accurate assessment during this time of economic uncertainty.

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1.0 Executive summary

Executive summary

The 2015 Long-term Transmission Plan *(2015 LTP) describes how the Alberta Electric System Operator (AESO) plans to develop Alberta's electricity transmission system over the next 20 years.*

Electricity transmission infrastructure is essential to Alberta's economic growth and sustainability. The transmission projects described in this plan enable the economy by providing for the safe, reliable, efficient delivery of wholesale electricity where and when it is needed.

The AESO is the single largest source of transmission planning expertise in Alberta, with access to credible, accurate, real-time electricity information. The AESO uses this expertise and information to plan, reinforce and operate an efficient, reliable transmission system; one that Albertans can be confident in at all times.

The 2015 LTP is the AESO's current evaluation of Alberta's provincial transmission system. It is created to help satisfy the AESO's mandate to plan for a transmission system that is free of constraints, compliant with Alberta Reliability Standards, and operated in the public interest. The AESO's mandate is defined in the *Electric Utilities Act* and its regulations, and requires the AESO to assess both current and future needs of Alberta's interconnected electric system and plan for transmission construction in a timely manner.

The transmission upgrades identified in this plan are comprehensive and flexible, meeting statutory and legislative requirements including all provisions within the province's *Electric Utilities Act* and *Transmission Regulation*.

Load and generation forecasts are contained within this plan, along with other information required to understand both Alberta's electricity transmission infrastructure needs and the AESO's plans for addressing those needs. The sections within the 2015 LTP include the AESO's forecasting and planning processes, along with forecasting results drawn from the AESO *2014 Long-term Outlook* (2014 LTO) and any relevant updates to the forecast. Transmission study results and plans comprise a major part of the 2015 LTP, and include bulk and regional system overviews, relevant tables, and maps.

> Through this plan, Albertans will have an electrical grid they can count on, new load and generators can connect in timely fashion, the wholesale electricity market will continue to be enabled, and investment in new generation will be secured through efficient electricity transmission.

Regional planning sections incorporate key information such as technology, planning timeframes, project staging, and present details in three specific time intervals; near-term (to 2020), medium-term (to 2025) and long-term (to 2035).

The AESO's long-term transmission plans are created to be flexible. This allows for adjustments that may result from changes in project development and the variability of industries and business cycles. Alberta's economy is a key factor, impacting both short-term and long-term planning. For example, changes in the price of oil, or the rate at which renewable energy is integrated, may have an impact on Alberta's short-term growth outlook and prompt the need for increased focus on how future transmission development is affected.

Transmission system development requires a significant amount of lead time and is subject to regulatory, environmental and stakeholder review. Once completed, transmission infrastructure is expected to provide a service life of 40 years or longer and be able to accommodate near-term and long-term needs. In addition to planning challenges, implementation is influenced by other factors ranging from environmental concerns and landowner impacts, to cost and availability of labour and materials.

The AESO establishes milestones where appropriate, segmenting project development into distinct stages, consulting with stakeholders and facilitating efficient regulatory coordination. At all times, Alberta's economy and business climate are monitored and analyzed, and the AESO adjusts its planning as appropriate based on any number of aspects.

This long-term plan will be updated again within two years to capture and adapt to changes in forecasts, government policy, industry and technology, and overall economic conditions. Through this plan, Albertans will have an electrical grid they can count on, new load and generators can connect in timely fashion, the wholesale electricity market will continue to be enabled, and investment in new generation will be secured through efficient electricity transmission.

ASSUMPTIONS AND INPUTS

The 2015 LTP is based on the AESO's forecast of load and generation as documented in the 2014 LTO. The 2014 LTO is a detailed forecast with corresponding scenarios based on provincial economic growth outlooks, commodity price expectations, economic evaluations, applicable policy considerations, and customer connection requests. The information within the 2014 LTO was validated in the AESO's *Long-term Outlook Validation*, issued in December 2014.

The AESO's Main Outlook, the primary forecast within the 2014 LTO, indicates that Alberta's economy will continue to be driven by oilsands investment and associated development over the long term. The AESO's 2014 LTO indicates that the provincial economy is expected to grow at a rate of 2.4 per cent annually until 2035. This growth is reflected in the AESO's total electricity energy forecast. Across the industrial sector, including oilsands, the AESO expects overall Alberta Internal Load (AIL) growth to be 2.5 per cent annually until 2035. The AIL peak is also expected to grow at the same rate over that time period.

The AESO develops load and generation forecasts using additional input and analysis derived from third-party experts. These include The Conference Board of Canada, the Canadian Association of Petroleum Producers and IHS Global Insights. The latest customer connection requests are also taken into account. At time of publication, the AESO is managing over 208 connection requests for load and generation facilities.

In light of the economic slowdown that followed the publishing of the AESO's 2014 LTO, the 2015 LTP considers the Low-growth Scenario to inform planning considerations for the transmission system for all near-term projects and for some medium-term projects.

The AESO anticipates that generation investment will keep pace with predicted load growth. Investment in future generation supply is determined by market participants, who assume the risks and rewards associated with building generation facilities. Opportunities for future generation will be primarily driven by two factors; the need to serve increasing provincial load, and the planned retirement of coal generation facilities. Moving through the 20-year forecast period, it is expected that the province's generation mix will shift from coal to natural gas including combined-cycle generation and cogeneration. The growth in wind generation and small-scale renewables is expected to continue, and there is also potential for future hydro generation. Alberta currently has the third largest installed wind generation capacity in Canada.

In addition to the 2014 LTO's Main Outlook, the AESO developed three forecast scenarios that accompany it. These scenarios provide the AESO with a comprehensive understanding of how economic shifts or environmental policy changes may have an impact on the electricity industry.

One of those scenarios—the Low-growth Scenario, in which the AESO models its planning based on the assumption that growth in oilsands development is limited and provincial economic growth is strongly reduced—is given additional emphasis in this long-term plan.

In light of the economic slowdown that followed the publishing of the AESO's 2014 LTO, the 2015 LTP considers the Low-growth Scenario to inform planning considerations for the transmission system for all near-term projects and for some medium-term projects. This approach demonstrates the AESO's commitment to providing industry and stakeholders with the most accurate analysis of the future of the provincial transmission system.

More on the AESO's 2014 LTO, and its Low-growth Scenario, can be found in the forecasting section of the LTP.

KEY HIGHLIGHTS

- Provides a high-level summary of transmission infrastructure solutions over a 20-year planning horizon.
- Assumes provincial economic growth in the long term will continue to drive load growth and customer connection requests.
- Applies heightened attention to the changing economy and measures planning through the 2014 LTO's Main Outlook and Low-growth Scenario.
- Contains 17 transmission projects[1] proposed out to 2020, representing approximately $2.5 billion. These projects still require regulatory approval.
- Under the AESO's Low-growth Scenario, 11 projects are proposed out to 2020 at a projected cost of $800 million. Projects under this scenario would also still require regulatory approval.

REGIONAL HIGHLIGHTS

The regional highlights below are based on the Main Outlook. In the Low-growth Scenario many of the transmission projects are deferred for several years. The impacts of the Low-growth Scenario on transmission plans are discussed in each regional transmission plan section.

- **South Planning Region**—The Southern Alberta Transmission Reinforcement, intended to provide access for major development of wind generation in the southern part of the province, is underway. In the future, some local area 138 kV enhancements are expected to be required to meet load growth.
- **Calgary Planning Region**—Load growth is driving the need to expand transmission capacity in downtown Calgary. As well, growth around the city, coupled with aging 69 kV systems, is driving the need for local area 138 kV enhancements. Load growth is also driving the need for 138 kV enhancements in and around Airdrie.
- **Central Planning Region**—Forecast pipeline load increases in the central east area, as well as potential wind generation, are expected to drive the need for 240 kV enhancements, and oilsands load in the Cold Lake area is expected to drive local 138 kV enhancements. The rest of the Central Planning Region is not expected to see load or generation increases that will drive new transmission enhancements.
- **Northwest Planning Region**—Large generation development and oilsands load growth near Peace River is expected to result in the need for 240 kV and 138 kV enhancements. Continued strong load growth in and around the Grande Prairie and Fox Creek areas requires the development of a 240 kV supply to those areas. Load growth and the potential for major generation development in the Grande Cache area is expected to drive 240 kV and 138 kV enhancements in that area.
- **Northeast Planning Region**—Several oilsands developments in the vicinity of Fort McMurray may drive major 240 kV and 138 kV enhancements; however, given the economic uncertainty of these developments, timelines for some transmission projects remain fluid pending more information. The Athabasca area north of Edmonton is likely to see increased pipeline load, driving the need for some 138 kV enhancements. Oil refinery expansion in the Fort Saskatchewan area is expected to drive the need for 240 kV and 138 kV enhancements in that area.
- **Edmonton Planning Region**—Load growth in and around Edmonton will require 240 kV and 138 kV enhancements. In the City of Edmonton, some new 240 kV developments are required to replace parts of the aging 72 kV system, which are reaching the limit of their capability to supply the city's load.

[1] Projects consist of a number of components within a geographic area that may vary and are subject to adjustment throughout the planning and regulatory processes.

2.0 Background

Background

The Alberta Electric System Operator (AESO) is a not-for-profit corporation mandated by legislation to act in the public interest and is not to own any transmission, distribution or generation assets.

The AESO is mandated through legislation to operate the Alberta Interconnected Electric System (AIES) in a safe, reliable and economic manner, and plan a transmission system that meets electricity demand today and in the future. It is governed by an independent board comprising up to nine individuals appointed by the Minister of Energy. Through the principles of sound governance, the AESO balances the diverse interests of a wide range of stakeholders while fulfilling its mandate.

The key duties and responsibilities of the AESO are dictated by the *Electric Utilities Act* (EUA) and the *Transmission Regulation* (T-Reg) and include, without limitation, the following:

- Determine the future requirements of the AIES, develop transmission plans over near-term, medium-term and long-term planning horizons that identify transmission system enhancements needed to meet those requirements, and make arrangements to implement those enhancements as necessary.
- Prepare and maintain a transmission system that anticipates, for at least 20 years forward, system conditions and requirements. The system must be planned to accommodate future growth, which requires the AESO to take a long-term view while adjusting for short-term changes and focusing on system requirements that meet the long-term vision for electrical infrastructure.
- Ensure the safe, reliable and economic operation of the AIES.
- Operate the power pool and facilitate the electricity market in a manner that is fair, efficient and openly competitive.
- Provide transmission access service consistent with an approved transmission tariff.
- Manage and recover the costs associated with line losses and ancillary services.
- Conduct a fair and open competitive process to determine the successful proponent who will develop, design, build, finance, own, operate, and maintain identified major transmission infrastructure in Alberta.

The AESO is required to update its long-term transmission plan at least every 24 months, and file it for information with the Minister of Energy and the Alberta Utilities Commission (AUC).

The AESO's planning team consists of numerous transmission planning engineers and economists. Prior to drafting a long-term transmission plan, this group of experts analyzes electricity consumption patterns in every area of the province and integrates data from multiple sources to determine where electricity demand is likely to grow. In addition, they anticipate the type and location of generation required to meet that demand across a range of scenarios, ultimately determining the type of additional transmission infrastructure required. Research to determine future load patterns includes analyzing historical energy consumption patterns of the industrial, oilsands, residential, farm, and commercial sectors. The AESO also studies oilsands development, industrial processes, cogeneration requirements and other end-use requirements. All of this information is further examined within the context of feedback provided through customer, stakeholder, market participant and public consultation.

The *2015 Long-term Transmission Plan* (2015 LTP) takes into account technical considerations, reliability standards and operating and planning criteria that provide for system reliability and a well functioning market. There are key project milestones that are fundamental to planned projects, including planned need dates.

> The AESO is required to update its long-term transmission plan at least every 24 months, and file it for information with the Minister of Energy and the Alberta Utilities Commission (AUC).

OBJECTIVES

The primary purpose of the 2015 LTP is to identify appropriate transmission infrastructure that can accommodate long-term growth and help secure Alberta's economic future. Early planning and implementation of these projects helps reduce uncertainty regarding transmission access for both generators and load customers, and supports an unconstrained, competitive market.

The AESO draws its long-term planning objectives from the T-Reg.

In Section 10(1), the T-Reg provides that the AESO must undertake the following:

> "(a) prepare and maintain a transmission system plan that projects, for at least the next 20 years,
> (i) the forecast load on the interconnected electric system, including exports of electricity,
> (ii) the anticipated generation capacity, including appropriate reserves and imports of electricity required to meet the forecast load,
> (iii) the timing and location of future generation additions, including areas of renewable or low emission generation,
> (iv) the transmission facilities required to meet the forecast load, imports and exports of electricity and anticipated generation capacity, including appropriate reserves and facilities to serve areas of renewable or low emission generation, in a timely and efficient way,
> (v) the transmission facilities required to provide for the efficient and reliable access to jurisdictions outside of Alberta,
> (vi) other matters related to the items described in subclasses (i) to (v) that the ISO [Independent System Operator] considers appropriate."

As well, certain forecasting obligations of the AESO are set out through Section 8 of the T-Reg.

Per Section 8, in forecasting the needs of Albertans, the AESO:

> "(a) must anticipate future demand for electricity, generation capacity and appropriate reserves required to meet the forecast load so that transmission facilities can be planned to be available in a timely manner to accommodate the forecast load and new generation capacity,
> (b) must make assumptions about future load growth, the timing and location of future generation additions, including areas of renewable or low emission generation, and other related assumptions to support transmission system planning,
> (c) must make an assessment of the transmission facilities required to provide for the efficient and reliable access to jurisdictions outside Alberta, and
> (d) may, if the ISO considers it necessary to do so, make an assessment of the contribution of a proposed transmission facility to any of the following:
> (i) improving transmission system reliability;
> (ii) a robust competitive market;
> (iii) improving transmission system efficiency;
> (iv) improving operational flexibility;
> (v) maintaining options for long-term development of the transmission system."

The T-Reg provides the AESO with authority to propose a "non-wires solution" to alleviate transmission constraints. Non-wires solutions are typically implemented only until a transmission solution can alleviate the constraints. The 2015 LTP approaches all non-wires solutions as temporary mitigation measures. This includes market and operational products and services such as transmission must-run and remedial action schemes. The addition of transmission infrastructure in certain areas is expected to reduce the need for these products and services over time.

STAKEHOLDER CONSULTATION AND ENGAGEMENT

The AESO carries out stakeholder consultation throughout Alberta regarding proposals to develop the transmission system. The consultation process provides the AESO with a broad perspective and valuable input that is used to test the reasonableness of the forecast and transmission planning results.

Long-term planning consultation involves a wide variety of stakeholders, who generally fall into the following categories:

- Market participants
- Industry groups
- Connection customers
- Distribution facility owners
- Transmission facility owners
- Elected and administrative government officials (local, municipal and provincial)

Engagement opportunities with other stakeholders such as landowners are available during the Needs Identification Document (NID) notification process. The AESO also conducts stakeholder engagement regarding changes to market rules and the ISO tariff. Stakeholder experience and expertise help improve the quality and implementation of the AESO's decisions.

ECONOMIC, SOCIAL AND ENVIRONMENTAL CONSIDERATIONS

Public safety is a vital consideration in the planning, design, construction, location and operation of transmission infrastructure, and the AESO considers this in the early stages of planning. Economic, social and environmental impact assessments are included as part of NID filings, and are evaluated within an AUC hearing process.

While the AESO is not directly responsible for siting and routing of transmission development, a process that falls to transmission facility owners (TFOs) and the AUC, it does consider a variety of potential impacts. These include agricultural, residential and visual impacts, and environmental concerns.

The AESO is required by Section 16.1 of the EUA, when carrying out its mandate, to act in accordance with applicable *Alberta Land Stewardship Act* (ALSA) regional plans. The AESO participates in ALSA regional planning activities as part of its transmission planning, and takes the objectives and outcomes of applicable regional plans into account.

TRANSMISSION AND ALBERTA'S WHOLESALE ELECTRICITY MARKET

The transmission system is planned to both ensure reliability of the system and facilitate Alberta's wholesale electricity market. Alberta's market is a real-time, energy-only equilibrium market, or power pool, meaning that suppliers are paid one single, hourly pool price only for the energy they deliver. The single pool-price model requires effective price signals to facilitate long-term investment in generation.

The T-Reg asserts an unconstrained transmission system as critical to maintaining an effective, efficient electricity market for all. An effective electricity market provides consumer choice, incents both generators and load to build facilities in Alberta, and provides import and export opportunities from and to other electricity markets. The AESO plans for an unconstrained transmission system in order to best serve both consumers and generators, and to connect new and varying generation fuel types wherever they wish to locate.

To support an evolving competitive market for electricity while responding to economic growth, the AESO focuses on the following wholesale electricity market priorities:

- Creation of market-based products to help restore the capability of interties to rated capacities
- Development of demand participation products
- Development of framework details for participation of interties in the Alberta market, including tariff design, capacity allocation rules, and design to consider integration of future interties and merchant lines
- Implementation of congestion management rules and procedures to address real-time constraints
- Provision of consistent and transparent system access business practices and connection process for a variety of generation and load types

The AESO looks long-term at the grid and market, identifying technological advances that can affect market and grid operations. One current example is the AESO's Energy Storage Initiative, which identifies ways in which energy storage facilities can be connected to the grid and integrated into the market. This will allow the electricity market and transmission system to accommodate a greater amount of renewable energy, while ensuring the continued safe, reliable and economic operation of our interconnected electric system.

By facilitating Alberta's competitive wholesale electricity market, and enabling a predictable market structure with reliable price signals to producers, consumers and investors, the AESO helps ensure an adequate electricity supply for years to come.

Historic and recent market performance is provided in the AESO's ***Annual Market Statistics Reports***

ANCILLARY SERVICES

When the system experiences constraints or operational disturbances, the AESO employs a variety of solutions that includes ancillary services and operational procedures. The 2015 LTP seeks to reduce the dependency on, and costs of, ancillary services by removing system constraints. The procurement and use of ancillary services supports a safe, reliable transmission system that is responsive to customer connection needs.

Some of the ancillary services used to support reliability are:

- **Transmission Must-run Service**—A generator is required to be online and operating at specific levels in parts of the system where local transmission capacity is insufficient to meet local demand, effectively acting as a temporary substitute for adequate transmission.
- **Regulating Reserve**—Available generator output that is dispatchable and responsive to automatic generation control, providing the power needed to address the lag period between balancing supply and demand. This allows generators to catch up to increasing or decreasing load.
- **Contingency Reserve**—Available output from a generator that can be dispatched, or load that can be reduced, to restore the electricity supply/demand balance following a contingency or unforeseen event on the system. Contingency reserve can be further categorized as either spinning reserve (immediate generator or load response) or supplemental reserve (10-minute response from generator or load).
- **Black Start Service**—Generators able to start their own generation facility with no outside power source and are called upon, in the event of a system-wide blackout, to re-energize the transmission system by providing start-up power to generators who cannot self-start.
- **Load Shed Service for import (LSSi)**—Supplied by electricity customers (load) who have agreed to instantly reduce demand in the event of an unexpected loss of imports that threatens the system's electricity supply/demand balance.

TRANSMISSION CONSTRAINTS MANAGEMENT (TCM)

Transmission constraints occur when electricity flow from one part of the system to another is limited, or normal dispatch of the energy market merit order is altered. Transmission constraints may restrict market participants' access to the market and therefore may affect market prices.

The T-Reg[2] directs the AESO to "make rules and establish practices respecting the operation of the transmission system and the management of constraints that may occur from time to time."

In planning studies, reliability criteria are applied to generation and load scenarios in order to identify both actual and potential constraints and provide warnings of real-time potential or actual constraints. During day-to-day operation of the AIES if AESO monitoring and control systems detect performance issues, System Controllers must mitigate them according to market rules and using established protocols and procedures such as remedial action schemes and transmission must-run service.

TCM Rule Update

In November 2014, the AESO submitted a compliance filing to revise the TCM Rule in accordance with the process and directions set out in AUC Decision 2013-135. In April 2015, the AUC approved the filing, addressing how the AESO mitigates transmission constraints in real time. The effective date of the revised TCM Rule is conditional on the AESO completing IT system changes required to provide market participants with information on the location of transmission constraints and the cost of resolving them. The necessary IT changes are expected to be complete by the end of 2015.

AESO SYSTEM OPERATIONS

AESO Operations employs a team of highly trained System Controllers and engineers who ensure safe and reliable operation of the power system at all times.

AESO Operations engineers conduct both near-term and long-term operational planning assessments to develop operational procedures and strategies as the AIES continues to grow and evolve. Operations engineers also develop plans to enable components of the interconnected electric system to be taken out of service for maintenance and repair while maintaining reliability and ensuring continuity of service to load and generators.

AESO System Controllers use sophisticated data-capture and analysis tools to monitor, analyze and operate the AIES in real time. Dedicated control systems provide visibility of system conditions and allow for continuous analysis of the transmission system so that when there is potential for a component of the transmission system to become overloaded or fail, contingency plans are in place to allow continued reliable operation. Besides balancing supply and demand in real time, System Controllers oversee the execution of planned outages of components of the transmission system.

The AESO also develops detailed plans and procedures to restore the electric system in the event of a partial or total system blackout. In the event of a major electrical service disruption, AESO System Controllers collaborate with Alberta TFOs and neighbouring jurisdictions to restore power as quickly as possible. To prepare for these scenarios, the AESO conducts comprehensive annual training exercises with various partners including generation, transmission and distribution owners to prepare the AESO and the industry to effectively restore the system in the event of a partial or total blackout in Alberta.

[2] T-Reg s.17

The AESO has initiated a number of projects in recent years to enhance its ability to efficiently and effectively operate the transmission system, some of which are ongoing. These include a significant upgrade to the Energy Management System, design and construction of a new backup System Coordination Centre, assumption of reliability coordinator functions within Alberta from the Western Electricity Coordinating Council's jurisdiction, and new market rules that better facilitate the dispatch of wind-generated electricity.

AESO TARIFF

The AESO provides system access service under rates, terms and conditions set out in the ISO tariff [3]. Under Section 30 of the EUA, the AESO applies to the AUC for approval of the ISO tariff. The AESO also files for approval of tariff updates, deferral account reconciliations and other amendments to the tariff when appropriate.

All electricity consumers in the province pay a share of the rates approved to be charged for system access service. That share is included in transmission charges that are part of the delivery charges on all consumers' bills (industrial, commercial, farm, and residential).

The rates approved for system access service include payments the AESO makes to TFOs for the use of their facilities. The total cost of transmission facilities must be approved by the AUC before being recovered over the life of the facilities. Transmission facilities, once built, typically provide long service lives of 40 or more years. The impact of 2015 LTP projects on system access service rates will occur gradually as those projects are approved, constructed and energized, and will be spread over many years.

In some cases, new transmission projects will replace older facilities, providing additional capacity that allows flexibility in operation, increases efficiency, and reduces system losses and their associated costs. As well, a reduction in system constraints will better facilitate the efficient operation of the competitive market for generation.

[3] www.aeso.ca/downloads/AESO_2014_ISO_Tariff_(2015-07-01).pdf

3.0 Forecasting

Forecasting

The transmission planning recommendations outlined within the 2015 Long-term Transmission Plan (2015 LTP) are evaluated using the AESO 2014 Long-term Outlook (2014 LTO) as a key input.

Published in May 2014, the 2014 LTO was prepared following significant consultation with industry experts, load and generation entities, policy makers and distribution facility owners. It includes views on Alberta's expected economic growth, anticipated demand and energy requirements over the next 20 years, and the projected generation capacity needed to meet those requirements.

The 2014 LTO includes a Main Outlook and three comprehensive scenarios used to analyze impacts to load and generation development due to changes to major forecast drivers and assumptions:

- The Low-growth Scenario was developed in the event oilsands and overall economic growth is strongly reduced
- The Environmental Shift Scenario was developed in case strong environmental policy supporting oilsands development is implemented
- The Energy Transformation Scenario was developed in case strong environmental policy limits oilsands and associated industrial growth

As part of an ongoing process to monitor and assess the provincial economy, the AESO verified in December 2014 that the Main Outlook in the 2014 LTO continues to be a credible and reasonable forecast. The *2014 Long-term Outlook Validation* confirmed expectations that despite the low price of oil in the short term, global demand for crude oil is expected to grow in the long term, driving investment in the oilsands and strong provincial economic growth. This long-term growth will continue to drive energy and load growth in Alberta.

The AESO recognizes that Alberta's economy has changed significantly since publishing the 2014 LTO and has carefully analyzed key economic indicators since the price of oil started to decline in June 2014. While the Main Outlook remains the appropriate forecast for the 20-year timeframe, both the Main Outlook and the Low-growth Scenario need to be considered in any analysis of transmission projects in the near term and some projects in the medium term.

The AESO will continue to monitor the economic outlook and assess impacts to the electricity industry as it develops the next long-term outlook, expected to be published in Q1 2016.

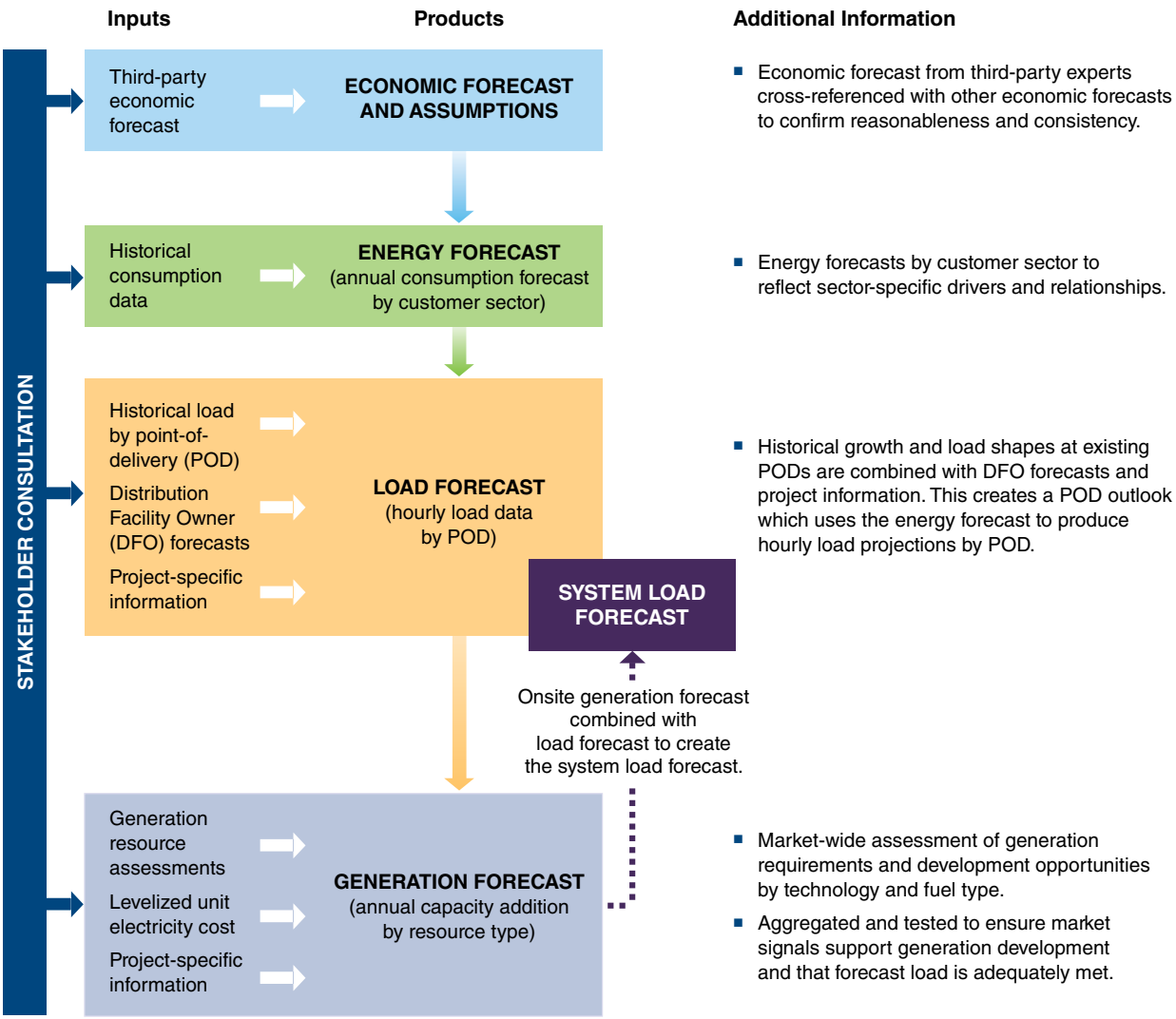
FORECAST PROCESS

Establishing a credible load forecast is the first step in determining the need for future transmission facilities. In creating an energy load forecast, the AESO considers a variety of economic indicators including provincial gross domestic product, population growth, and oilsands production as well as seasonal weather impacts. Expected long-term trends are also incorporated, along with project-specific proposals of new capacity and the proposed location of such facilities.

Forecast load is compared against currently installed generation and expected future retirements to determine the amount of incremental generation additions needed to reliably serve growing demand. Generation technologies and costs are studied to assess what resources are expected to be developed in response to future electricity load. Using the assumptions created through this process, the existing transmission system is assessed under different load conditions (winter peak, summer peak and summer light) as well as varying generation and intertie conditions.

Alberta has a large interconnected system, and the location of either new load or generation can create consequences in other parts of the system. The AESO addresses this by running numerous planning scenarios, sensitivities and stress tests.

3.0–1: Forecasting process



OTHER FORECAST CONSIDERATIONS

Policy and regulation

The electricity industry is affected by federal and provincial environmental regulations which are subject to change. The 2014 LTO alternate scenarios help provide flexibility to evaluate the impact of potential new government initiatives, regulations and policies on the transmission system. Existing policy and regulations are key drivers in the determination of forecasts, transmission plans, market dynamics and system operations. It is recognized, however, that significant changes to policies and regulations could have a large impact on load, generation and the economy in Alberta and, therefore, on the AESO's forecast and its plans.

Oilsands forecasting and development

For forecasting and planning purposes, the AESO carefully examines the economic drivers specific to Alberta's five customer sectors: industrial (without oilsands), oilsands, residential, commercial, and farm. The AESO separates the oilsands sector from the rest of the industrial sector due to its importance to the Alberta economy and its unique electricity needs. Environmental considerations, market accessibility, slowing of global oil demand and other factors possibly limiting oilsands development are also examined.

Establishing a credible load forecast is the first step in determining the need for future transmission facilities.

OVERALL FORECAST RESULTS

Economic and load growth

The AESO acknowledges that new economic data continues to become available subsequent to the publishing of the 2014 LTO. Continued slowing of the economy and the uncertainty associated with it will likely result in different load, generation and economic growth amounts than originally forecast. The transmission plans within the 2015 LTP, while based on 2014 LTO forecast results, allow for any planning adaptation that may be needed to develop appropriate transmission infrastructure within the planning horizon.

The 2014 LTO assumes that, throughout the forecast, global demand for crude oil will support investment in the oilsands, which will also drive strong provincial economic growth. This economic outlook is verified against other third-party forecasts, including those by The Conference Board of Canada and the Canadian Association of Petroleum Producers.

Growth in some cases may be hindered by influences such as slower population growth and an aging population which may influence income and spending patterns, and restrain growth of the labour force. Despite impacts such as these, real gross domestic product growth is expected to rise by 2.1 per cent annually between 2018 and 2035, easing to 1.8 per cent in the later years of the forecast.

Oilsands production, expected to grow at 4.5 per cent annually over the next 20 years, will have secondary and tertiary effects across the province. The non-oilsands industrial sector, which will be required to provide necessities such as construction materials, chemicals, metals, and machinery, is forecast to grow at 2 per cent annually over the same forecast period. Oilsands and industrial expansion will drive job creation, in turn driving immigration to Alberta and, subsequently, demand for goods and services. The resulting increased business activity will spur residential and commercial demand, particularly in urban centres. These effects combine to increase demand growth.

Residential electricity use is expected to grow by 1.6 per cent annually over the next two decades, with commercial electricity consumption expected to grow at 2.2 per cent annually. While overall Alberta Internal Load (AIL) is forecast to grow at 2.5 per cent annually, it is expected to be less strong in the latter half of the 20-year forecast, due in part to uncertainty surrounding long-term oilsands development. Similar to AIL energy, AIL peak is forecast to grow at 2.5 per cent annually. System load, excluding load served by onsite generation, is expected to grow at 2.3 per cent annually over the next 20 years.

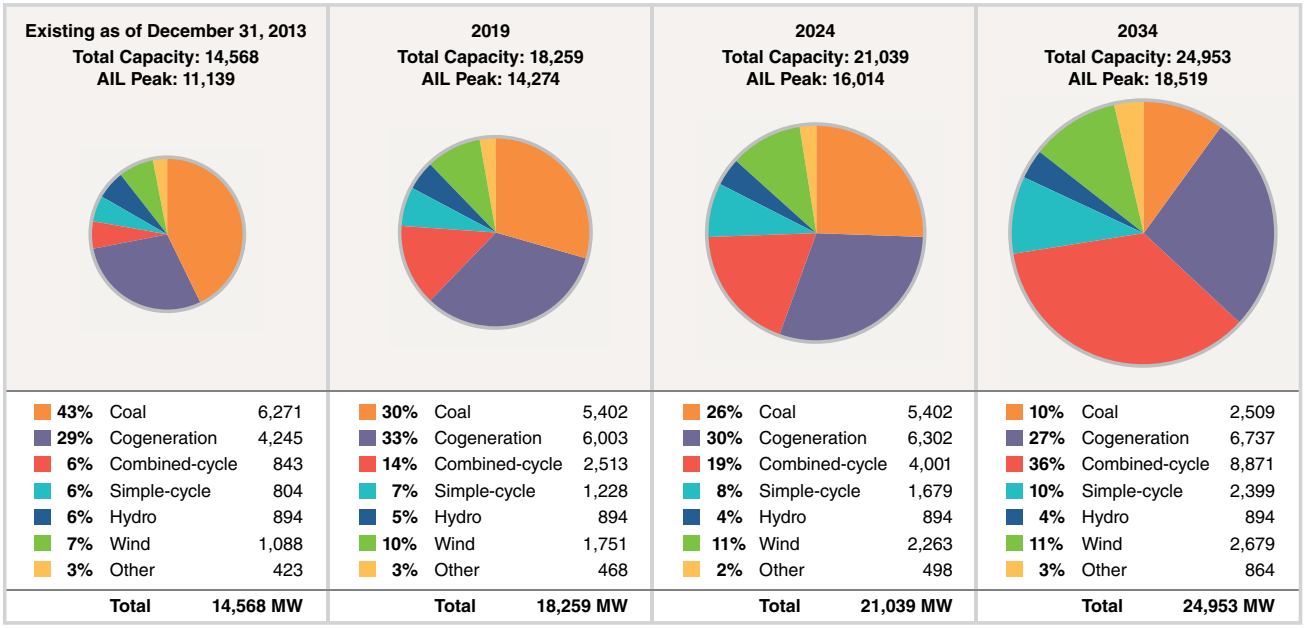
Generation development

Generation development is expected to be strong over the 20-year forecast period, a result of AIL growth and the retirement of large coal facilities. In developing the generation forecast, the AESO assesses various technology types, and studies location, fuel availability, current developments, relative levelized costs and policy impacts. Economically, combined-cycle generation emerges as the lowest-cost technology with wind energy coming in at the second lowest. Technologies such as cogeneration will see further development as many industrial applications are well positioned to take advantage of the benefits of captured heat.

In the first half of the 20-year forecast, cogeneration and combined-cycle are expected to be the most adopted forms of generation. The first 10 years will also see development of wind facilities and simple-cycle generation.

In the second half of the forecast period, large additions of gas generation are expected in response to further retirement of coal units and load growth. Cogeneration development is expected to slow, reflecting slower overall oilsands growth. Wind generation is expected to see little growth in the latter part of the forecast period as the economics remain challenging and existing policy does not provide strong incentives. Other generation technologies will continue to be added during the last 10 years of the planning horizon, but at reduced levels.

3.0–2: 2014 LTO Generation capacity mix comparison (Main Outlook)



Existing as of December 31, 2013			2019			2024			2034		
43%	Coal	6,271	**30%**	Coal	5,402	**26%**	Coal	5,402	**10%**	Coal	2,509
29%	Cogeneration	4,245	**33%**	Cogeneration	6,003	**30%**	Cogeneration	6,302	**27%**	Cogeneration	6,737
6%	Combined-cycle	843	**14%**	Combined-cycle	2,513	**19%**	Combined-cycle	4,001	**36%**	Combined-cycle	8,871
6%	Simple-cycle	804	**7%**	Simple-cycle	1,228	**8%**	Simple-cycle	1,679	**10%**	Simple-cycle	2,399
6%	Hydro	894	**5%**	Hydro	894	**4%**	Hydro	894	**4%**	Hydro	894
7%	Wind	1,088	**10%**	Wind	1,751	**11%**	Wind	2,263	**11%**	Wind	2,679
3%	Other	423	**3%**	Other	468	**2%**	Other	498	**3%**	Other	864
	Total	**14,568 MW**		**Total**	**18,259 MW**		**Total**	**21,039 MW**		**Total**	**24,953 MW**

Low-growth Scenario

The 2015 LTP was created following significant consideration of the 2014 LTO's Low-growth Scenario. The Low-growth Scenario was developed by contracting The Conference Board of Canada to test its economic models in a manner that slows oilsands development and growth. The economic data created through this process was then used in the AESO's forecast models to test the impact of reduced oilsands and economic growth.

In this model, real gross domestic product growth is reduced to 1.5 per cent in the Low-growth Scenario. The impact on load growth is most notable in the Northeast Planning Region of the province, where the bulk of the oilsands sector is located. There, load growth is expected to be 1.4 per cent in the Low-growth Scenario, compared to 3.4 per cent in the Main Outlook. As provincial load growth decreases, so does generation growth, particularly cogeneration associated with the oilsands sector.

3.0–3: Provincial demand

	Main Outlook	Low-growth Scenario
5-year horizon	14,274 MW	12,000 MW
10-year horizon	16,014 MW	12,689 MW
20-year horizon	18,519 MW	13,504 MW

3.0–4: Installed generating capacity

	Main Outlook	Low-growth Scenario
5-year horizon	18,259 MW	15,608 MW
10-year horizon	21,039 MW	16,560 MW
20-year horizon	24,953 MW	18,146 MW

Any shifts in forecast load and demand results affect transmission planning, and alternatives that reflect the Low-growth Scenario are noted within the transmission planning and development section of the 2015 LTP.

More details regarding all AESO scenarios, including the Low-growth Scenario, can be found within the ***2014 LTO***

4.0 Transmission planning and development

Transmission planning and development

The planning process relies on a number of key inputs, forecasts and assumptions. The AESO examines load growth and potential generation development and retirements, North American reliability criteria and standards, government policy and regulation, infrastructure life-cycle requirements, operational requirements, capital costs, and environmental and social considerations.

The AESO's transmission planning process is based on detailed engineering evaluations of the transmission system over a 20-year planning horizon. It is a continuous process, involving frequent evaluation of assumptions and proposed transmission solutions.

The transmission planning process involves three major steps:

- Need assessment
- Alternative development and screening
- Selection of the preferred alternative

The three-step planning process begins with need assessment; determining the need for transmission under scenarios identified in load and generation forecasts. After identifying the need, the AESO establishes and screens several transmission alternatives to meet those needs. The AESO then identifies the alternatives, from which plans are developed to meet the needs detailed within its forecast scenarios.

It is important to note that need dates (the time at which studies indicate existing transmission infrastructure will experience issues warranting upgrades) are differentiated from in-service dates (the time at which an approved element of transmission is expected to be in service). Operational measures are used in real time to support the Alberta Interconnected Electric System (AIES) between need date and in-service date.

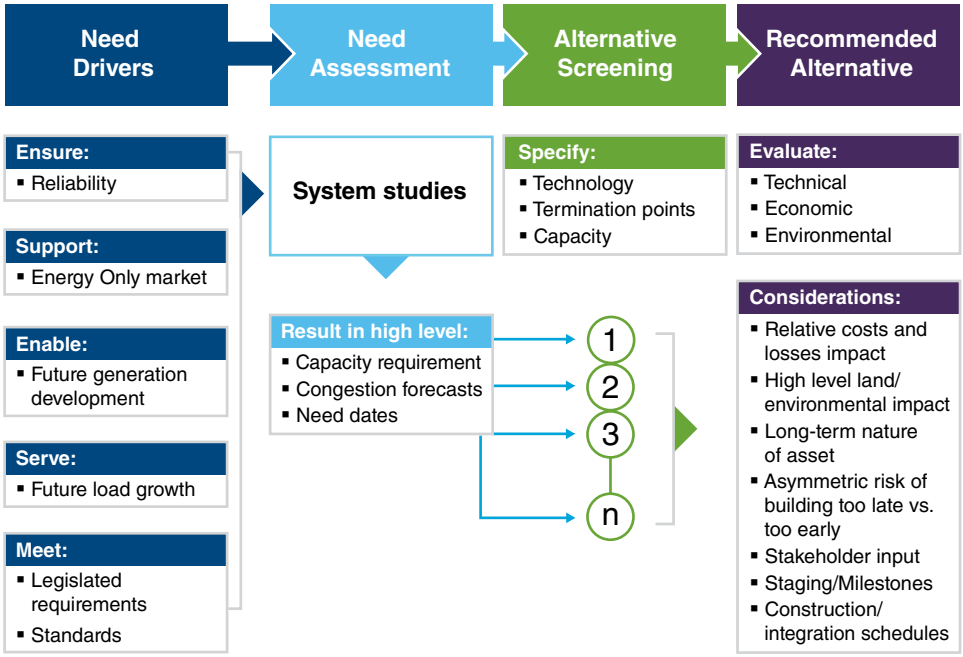
As new information becomes available, the size, scope and timing of transmission developments may evolve. The AESO continually studies the transmission system and assesses the latest information available to ensure the right Needs Identification Documents (NIDs) are being advanced at the right time.

4.0–1: AESO's 24-month planning process

Specific factors and assumptions considered in development of the 2015 LTP include the following:

- Continued strong Alberta load growth, as identified in the AESO's *2014 Long-term Outlook* (2014 LTO)
- Continued development and diversity of generation facilities and fuel types including connection requests
- Coal plant retirements due to federal environmental policy
- The need to satisfy Alberta Reliability Standards (ARS)
- Maintaining options for long-term development of the transmission system
- Improving operational flexibility and system efficiency
- Previously planned and approved inter-regional bulk system projects with consideration of in-service dates
- When required, interim non-wires solutions, operational protocols and market products that support transmission infrastructure
- Interties
- High-level land impact assessments and environmental considerations

4.0–2: Transmission system planning components



NEED ASSESSMENT

The need for transmission infrastructure must be identified well in advance of when it is actually required as projects typically take five to seven years to complete. Determining need early helps ensure transmission facilities are available in time to accommodate forecast load and generation requests. The AESO's forecast provides guidance on the magnitude, type, location and timing of anticipated development in load and generation. These elements help determine required transmission system enhancements and their respective need dates.

A particularly important step in the transmission planning process is the identification of future Alberta Reliability Standards (ARS) violations and system performance issues under forecast loading. Location and magnitude of new load is a primary driver in the need for transmission system expansion, and a key factor in determining the need and timing of future transmission system enhancements. Assessments of thermal loading and voltage and dynamic stability are performed, and ARS requirements are tested to verify that the alternatives developed are technically feasible. Another important consideration is the need to increase transfer capability between regions, which is often the basis for large bulk system expansions.

In addition to reliability assessments, the AESO also examines factors such as whether facilities are reaching end of useful life, and characteristics such as line losses. In some cases, there is an opportunity to consider higher capacity or higher voltage facilities, or to reconfigure the system and, in general, increase overall efficiency.

Uncertainty around the timing and location of future generation developments is also a primary consideration. By using scenarios outlined within the 2014 LTO, the AESO is able to consider the implications of this uncertainty in a controlled and deliberate manner. Scenario development allows the AESO to create plans that accommodate a range of potential future conditions, as opposed to a single future trajectory. The use of scenarios also enables a more complete assessment of risks and the identification of unique details that help facilitate future planning adjustments if new information emerges.

ALTERNATIVE DEVELOPMENT AND SCREENING

After determining the need for transmission enhancements, the AESO develops alternatives to meet those needs. Similar to the need assessment phase, this is done by assessing thermal loading and voltage and dynamic stability, and by testing ARS requirements to verify that the alternatives developed are technically feasible. Along with reliability evaluations, the AESO considers existing system facilities, technology risks, project staging, high-level capital and operating costs, alignment with legislation and policy, land use, and stakeholder input. Alternatives may include reconfiguring parts of the system, changing voltage, and using new transmission technologies.

Once multiple alternatives are developed, they are screened. A final set of alternatives is then created for the development of transmission plans suited to each scenario. The transmission development concepts created are subjected to further assessments to identify recommended transmission system plans.

SELECTION OF THE PREFERRED ALTERNATIVE

In this stage, a number of studies are carried out on the set of final alternatives. These studies may include additional thermal loading, voltage performance, and dynamic stability analyses. In addition, cost estimates are also developed and losses for each alternative are determined. A high-level land impact assessment is also carried out to compare the alternatives on this basis. The alternatives are then ranked technically, economically, and on their social and environmental impact. Based on all these factors, a preferred alternative is selected.

Location and magnitude of new load is a primary driver in the need for transmission system expansion, and a key factor in determining the need and timing of future transmission system enhancements.

MILESTONES: ROLE AND DEVELOPMENT

When future transmission system expansions or enhancements are expected, the AESO may identify project milestones to facilitate their construction. The use of milestones as a project development tool helps manage the uncertainty associated with changing economic and market conditions, and assists in the continued evaluation and timing of transmission projects. As conditions change, the AESO continually monitors market conditions, reports on changes, revises and updates system studies, and amends anticipated in-service dates.

As part of the milestone development process, the AESO conducts the following analyses and assessments:

- **Technical analysis**—This is to ensure compliance with ARS. The analysis is based on thermal loading, voltage stability, dynamic stability analysis, and system operating limits.
- **Market impact evaluation**—This includes assessment of transmission system access for incremental generation and load, and assessment of the potential for transmission congestion under varying normal and abnormal operating conditions. Market impact evaluation includes assessment of system operating limits, which serves as a measurement of congestion requiring generating units to be run out-of-merit.
- **Development risk analysis**—This involves assessment of development risks due to externalities including those related to regulatory processes, unanticipated siting issues and possible delays in related projects. Material and labour availability can also have an impact on project development.
- **Market participant connection monitoring**—The AESO identifies suitable generation and load project milestones that trigger transmission construction and assure alignment between generation and load projects and related transmission projects. There are numerous milestone dates in generation or major load project scheduling, including provincial and federal environmental impact assessment approvals, awarding of contractor and engineering contracts, order and delivery of major equipment, ground breaking and site mobilization, and routing of construction power to the site.

Monitoring of milestones

The AESO expects that project development is proactive, with transmission development being completed at the right time for the right need. Generation and major load projects are monitored to determine when they have reached milestones that trigger the construction of recommended transmission system facilities.

The most prominent project drivers are customer connection requests, system capability deficiencies, operating limit restrictions and system reliability concerns. There are several common elements related to these drivers that are addressed. They include reduction/removal of constraints, voltage fluctuation, frequency excursion, thermal line loading, reduced line losses, reduced dependency on non-wires short-term solutions, and the ability to fulfil load and generation requests.

INTERTIES

As part of the North American electricity grid, transmission interties connect Alberta to neighbouring systems and are an essential part of a reliable transmission system and competitive electricity market. They provide the ability to import power when economically viable and are an additional source of supply. Interties also allow for export of power to other jurisdictions. Alberta has been a net importer of electricity since 2001.

The *Transmission Regulation* (T-Reg)[4] directs the AESO to "prepare a plan and make arrangements to restore each intertie that existed on August 12, 2004 to, or near to, its path rating." Work on the intertie restoration initiative has progressed significantly since the publication of the 2013 LTP.

Achievements include:

- Increasing the summer and winter transfer limits on the BC intertie
- Completing operational studies and a joint study with BC Hydro to identify reinforcements required to accommodate the uncongested flow of energy across the BC intertie
- Completing a Load Shed Service for imports (LSSi) study to review volumes required to mitigate intertie trips
- Successful completion of a Request for Proposal process to contract with providers of LSSi services on a three-year contract basis
- Completion of Foothills Area Transmission Development – East (FATD) transmission upgrades in the Calgary area which will reduce constraints that impact intertie flows

4.0–3: WECC Path Ratings

WECC Path	Interconnecting Jurisdictions	Description	Transfer Limits
Path 1	▪ Alberta – British Columbia	▪ Consists of 3 lines: – Langdon-Cranbrook 500 kV – Pocaterra-Fording Coal tap 138 kV – Coleman-Natal 138 kV	▪ AB to BC – 1,000 MW ▪ BC to AB – 1,200 MW
Path 2	▪ Alberta – Saskatchewan	▪ Consists of McNeil back-to-back DC converter station operated at 42.2 kV	▪ AB to SK – 150 MW ▪ SK to AB – 150 MW
Path 83 MATL	▪ Alberta – Montana	▪ Consists of MATL 230 kV merchant line connecting MATL substation near Lethbridge, AB to Marias-Great Falls substation near Great Falls, MT	▪ AB to MT – 325 MW ▪ MT to AB – 300 MW

[4] T-Reg s.16(1)

TELECOMMUNICATION NETWORK DEVELOPMENT

The reliable, efficient and safe operation of Alberta's transmission system relies on a province-wide, utility-owned-and-operated telecommunication network. The sophisticated telecommunication infrastructure overlaying the transmission system is vital to monitoring and operating the AIES, protecting transmission lines, and all reporting functions. A variety of factors are considered in planning the development of the telecommunication network. Generally, this follows the transmission planning process and is therefore also reliant on Alberta load and growth forecasting. Changes in future load and generation facilities can impact the requirements for the telecommunication network.

The ability to handle future telecommunication network growth requires a long-term planning horizon and the network put in place today must be able to accommodate growth in network traffic. Further to that, reliable telecommunications facilities are essential in order to enable system operation during emergency conditions.

Telecommunication costs typically account for three to six per cent of transmission system upgrade or expansion costs. The projects proposed in the 2015 LTP already have telecommunication costs embedded within their project cost estimates. Over time, as proposed transmission upgrades or enhancements are put into place, the Alberta utility telecommunication network will be enhanced accordingly.

TRANSMISSION PLANNING AND THE LOW-GROWTH SCENARIO

The AESO's transmission plans are based on the Main Outlook of the *2014 Long-term Outlook* (2014 LTO), which asserts that oilsands development will continue to drive electricity demand over the next 20 years. However, the current period of sustained low oil prices has prompted increased scrutiny of transmission plans for the province that may be impacted if low oil prices persist.

The Low-growth Scenario discussed in the 2014 LTO indicates that some oilsands developers would respond to sustained low oil prices by deferring large capital investments in new projects or in the expansion of existing ones. These investment deferrals would result in lower growth in electricity demand and generation over the next three to seven years. In turn, the need for transmission development would also be affected. The manner in which the Low-growth Scenario would affect the AESO's transmission plans (i.e., which transmission developments can be deferred or cancelled) is outlined in the following regional transmission planning sections.

> The manner in which the Low-growth Scenario would affect the AESO's transmission plans is outlined in the following regional transmission planning sections.

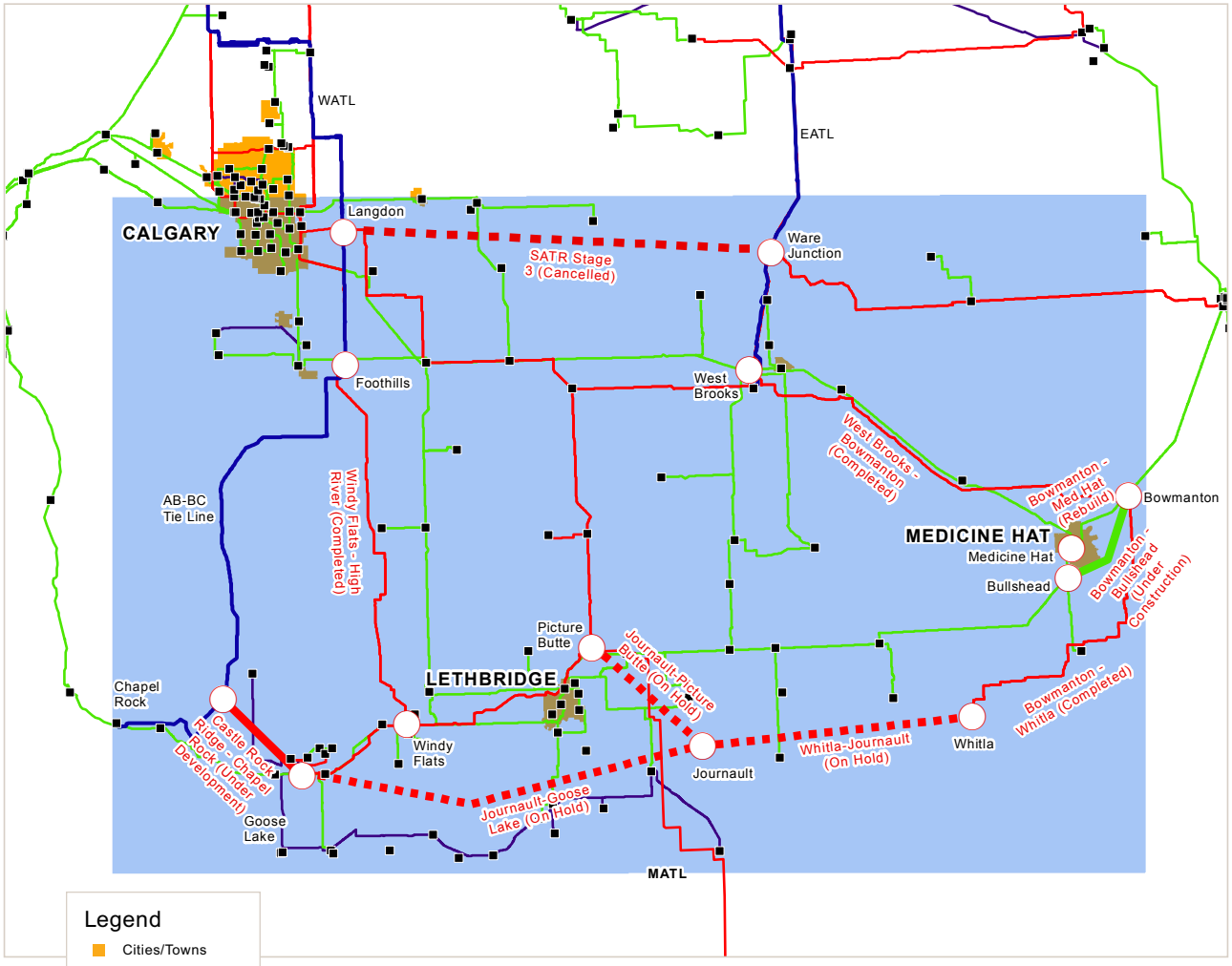
BULK SYSTEM OVERVIEW

The bulk transmission system consists of integrated transmission lines and substations that deliver electric power from generating facilities to load centres. The bulk system also delivers power to and from neighbouring jurisdictions, and interconnects regional transmission infrastructure.

Southern Alberta Transmission Reinforcement

The Southern Alberta Transmission Reinforcement project (SATR) is a 240 kV looped system comprising several components and is designed primarily to accommodate generation in southern Alberta. The plan was originally intended to be implemented in three stages. Stage 1 is complete; some projects within Stage 2 have been deferred and Stage 3 has been cancelled. EATL will provide the functionality that Stage 3 was intended to provide. To date, SATR has significantly increased transmission capacity for new generation in the south. In the time since SATR was approved, 557 MW of new generation has been connected in the south.

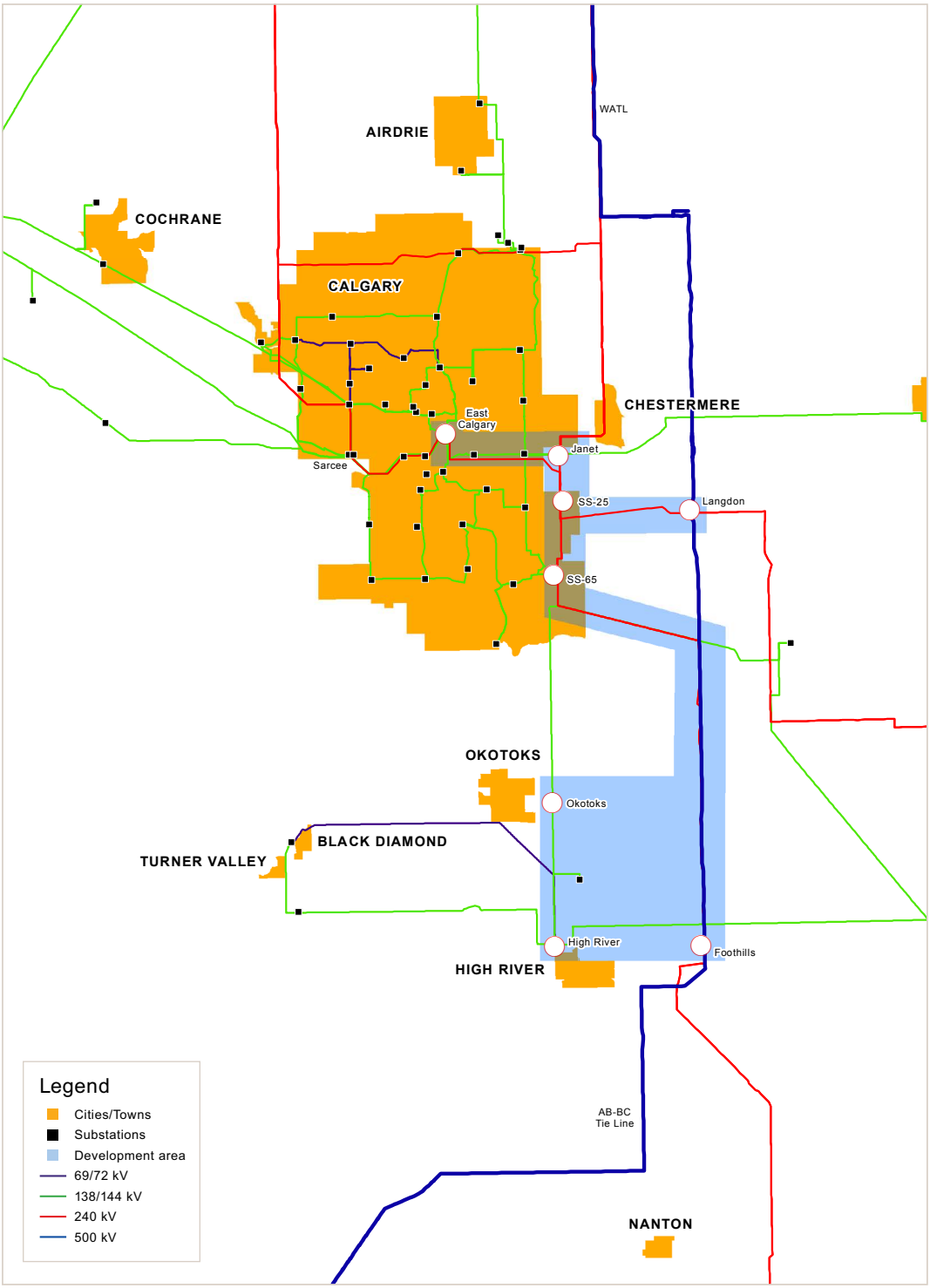
AltaLink is the TFO that builds, owns and operates transmission in this region.



Foothills Area Transmission Development – East

In addition to SATR, the Foothills Area Transmission Development – East project (FATD) is an integral part of the transmission system and will move wind energy generated in southern Alberta to the load centres of the Foothills and greater Calgary areas. This project includes a 240/138 kV substation near High River, 138 kV transmission system enhancements in the High River and Okotoks areas, and a double-circuit 240 kV line from Foothills into Calgary on the east side of the city. The primary TFO for this project is AltaLink Management Ltd.

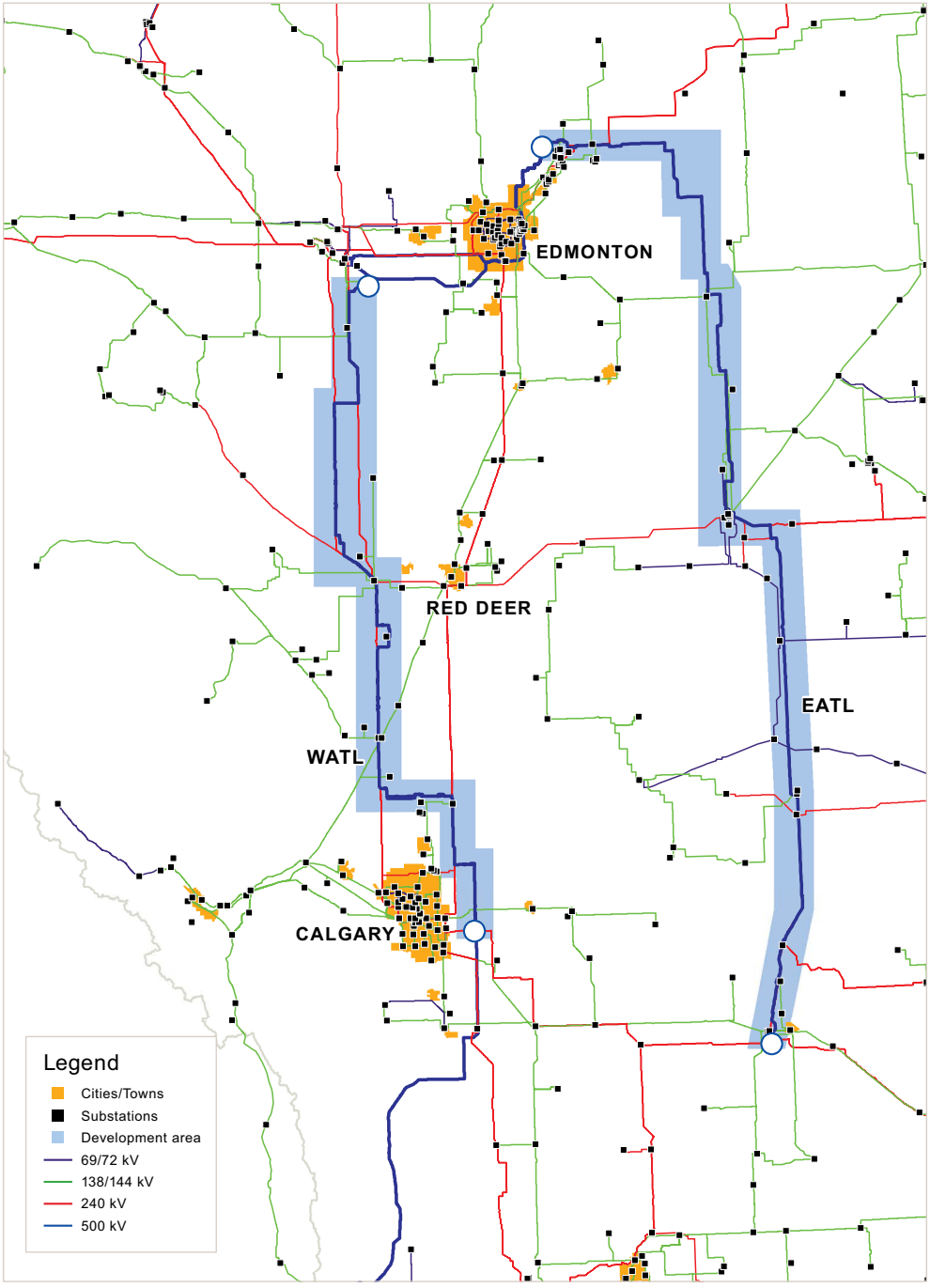
The FATD project was approved by the AUC on October 7, 2013.



Edmonton to Calgary Transmission Reinforcement

The Edmonton to Calgary Transmission System Reinforcement consists of two 500 kV high-voltage direct current (HVDC) high-capacity transmission lines between the Edmonton and Calgary/southern Alberta areas. Located on the east side of the province, the Eastern Alberta Transmission Line (EATL) connects the Heartland transmission hub northeast of Edmonton to a southern transmission hub in the Brooks area. The Western Alberta Transmission Line (WATL) is located on the west side of the province, connecting the Wabamun Lake transmission hub west of Edmonton to the Calgary area transmission hub near Langdon. The initial capability of each of these HVDC lines is 1,000 MW, and this can be expanded to 2,000 MW or higher should the need arise.

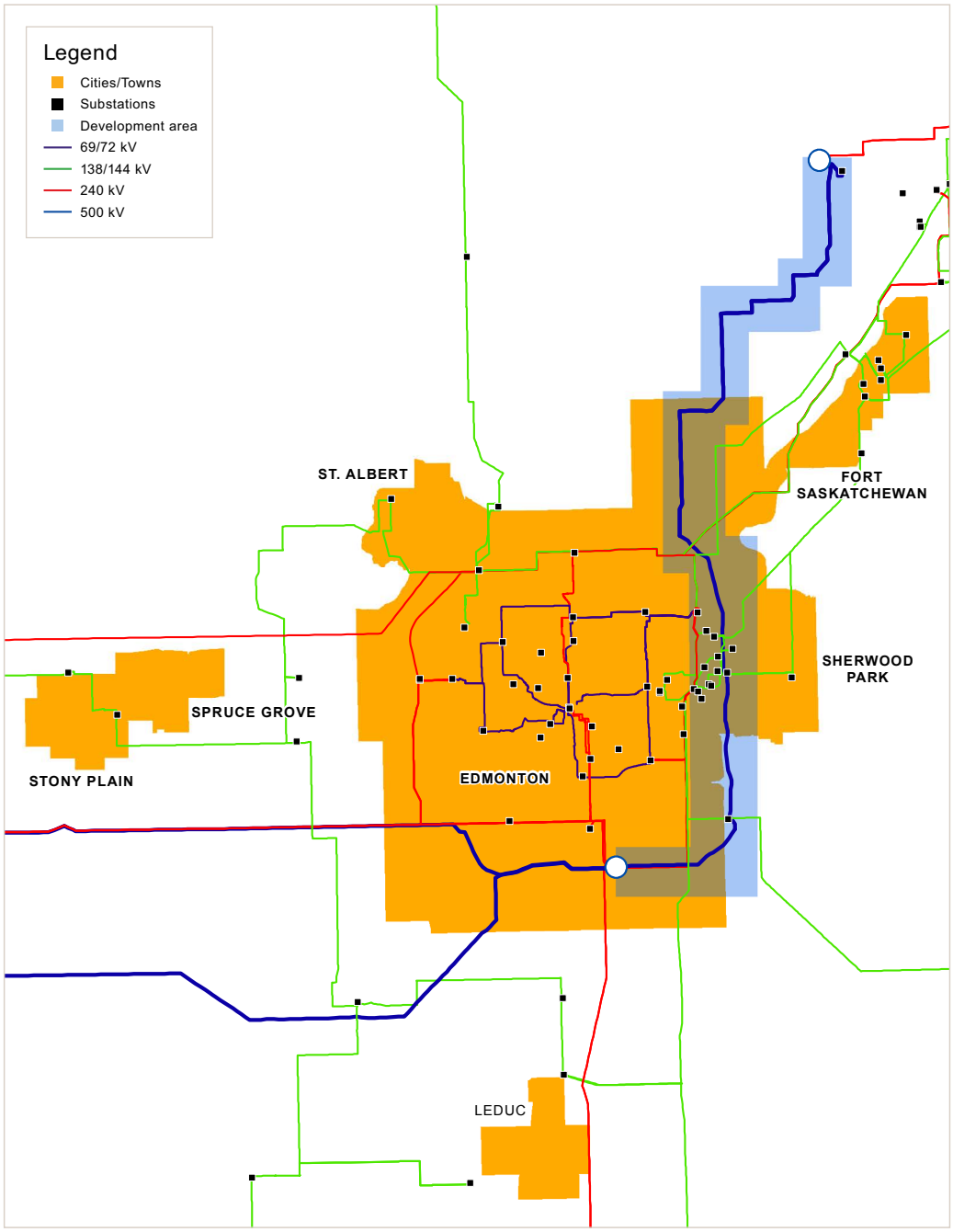
ATCO Electric Ltd. is the transmission facility owner (TFO) responsible for building and operating EATL. The TFO for WATL is AltaLink Management Ltd. WATL and EATL are anticipated to be in service by the end of 2015.



Heartland Transmission System Reinforcement

The Heartland Transmission System Reinforcement is a 500 kV alternating current (AC) double-circuit line from the existing Ellerslie substation in south Edmonton to the new Heartland substation in the industrial Heartland area near Fort Saskatchewan. It is designed to strengthen transmission into the area and will provide a strong source for an eventual 500 kV line into the Northeast (Fort McMurray) region as well as provide a strong interconnection for the east HVDC line (EATL).

Two transmission facility owners (TFOs) share responsibility for the Heartland line; AltaLink Management Ltd. and EPCOR Distribution and Transmission Inc. The Heartland line was initially energized at 240 kV in December 2013 and then energized at 500 kV in 2014.



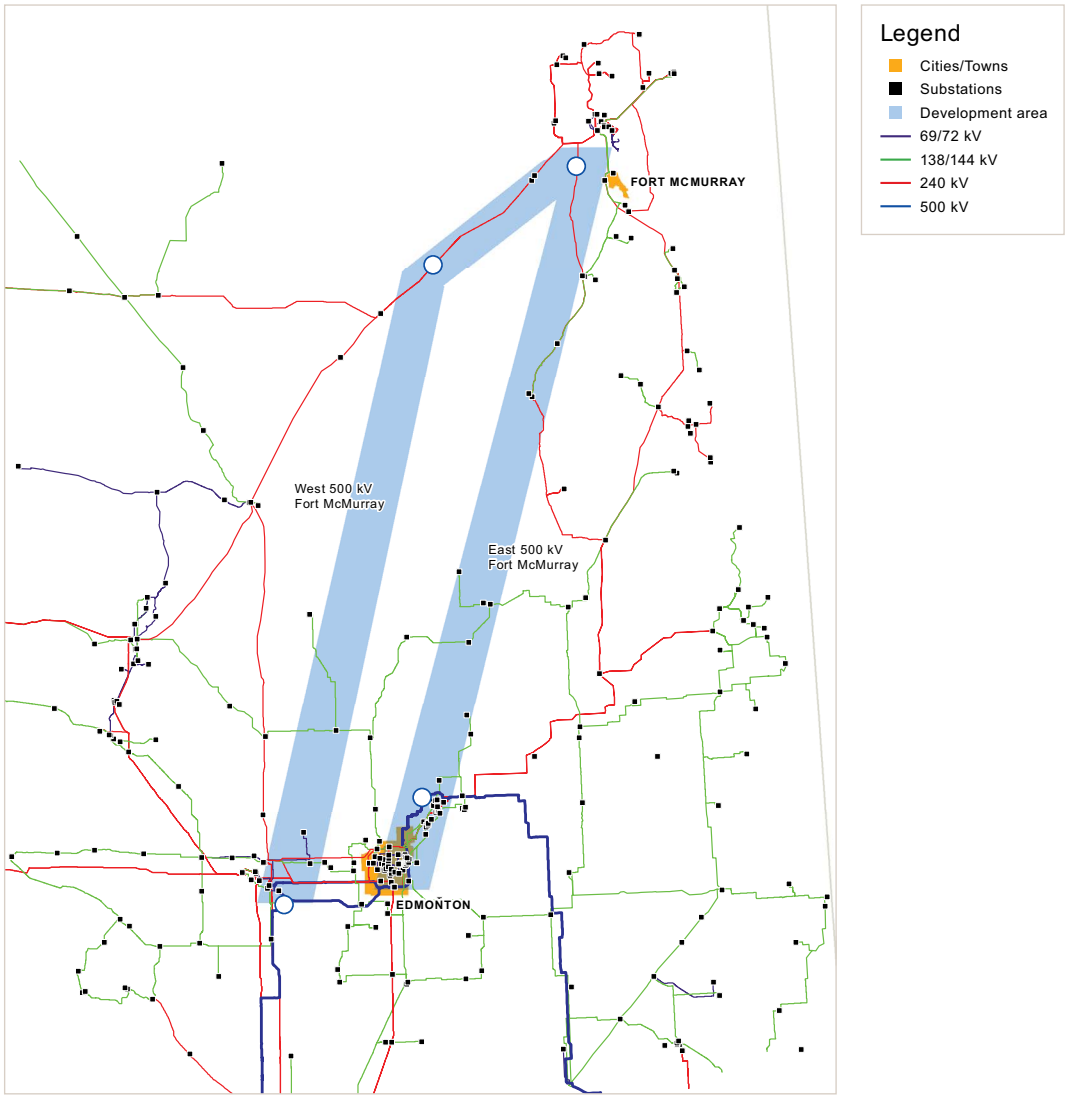
Fort McMurray Transmission System Reinforcement

The Fort McMurray Transmission System Reinforcement consists of two major components; the Fort McMurray West 500 kV Transmission Project and the Fort McMurray East 500 kV Transmission Project.

The Fort McMurray West 500 kV Transmission Project is an AC line from the Sunnybrook substation near the Genesee generating station to a new 500 kV switchyard at the Livock substation and a new 500 kV AC line from the Livock substation to a new 500 kV substation (to be referred to as Thickwood Hills) in the Fort McMurray area. The Sunnybrook substation near Genesee also serves as the termination point of WATL.

The TFO for this project, as awarded through the AESO's first ever Competitive Process in December 2014, is Alberta PowerLine Limited Partnership. The TFO is currently preparing to submit a Facility Application to the Alberta Utilities Commission (AUC) to construct and operate the line.

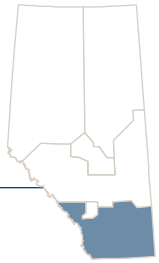
The Fort McMurray East 500 kV Transmission Project will consist of a 500 kV AC line from the new Heartland substation to the new Thickwood Hills 500 kV substation. Similar to the Fort McMurray West Transmission Project, the TFO will be selected through the AESO's Competitive Process. As oilsands development has slowed significantly due to the current economic environment and sustained low oil prices, the AESO is deferring the launch date of the project. The AESO will provide updates on the project following release of its next forecast in 2016 and will ensure that it aligns timing with need.



5.0 Regional transmission plans

PLANNING REGION

5.1 South



OVERVIEW AND FORECAST

The South Planning Region encompasses southern Alberta and includes Lethbridge, High River, Brooks, the Empress industrial area and Medicine Hat. It represents approximately 11 per cent of the province's population, and about 12 per cent of provincial electrical load. Load has grown at a rate of 0.6 per cent per year over the past decade. It is expected to continue to grow, at a rate of 1.8 per cent annually over the next 20 years, due in part to residential, commercial, and industrial development associated with the province's overall economic and population growth.

Generation sources in the South Planning Region consist of coal, natural gas, hydro and wind. The South Planning Region has the highest installed wind generation capacity in the province and there is considerable potential for growth. Some transmission expansion and reinforcements have already taken place in the region as part of the Southern Alberta Transmission Reinforcement (SATR) project.

5.1–1: South regional load and generation forecast

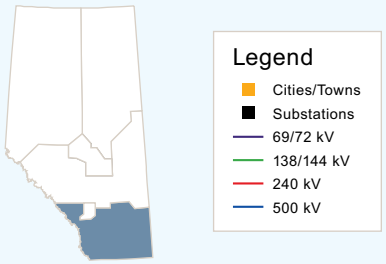
	Existing (MW)	2020 (MW)	2025 (MW)	2035 (MW)
Load at AIL Peak	1,236	1,527	1,689	1,929
Coal-fired	780	780	780	780
Cogeneration	95	95	95	95
Combined-cycle	330	680	680	680
Simple-cycle	44	41	492	582
Hydro	409	409	409	409
Wind	1,202	1,440	1,824	2,174
Other	42	61	61	61

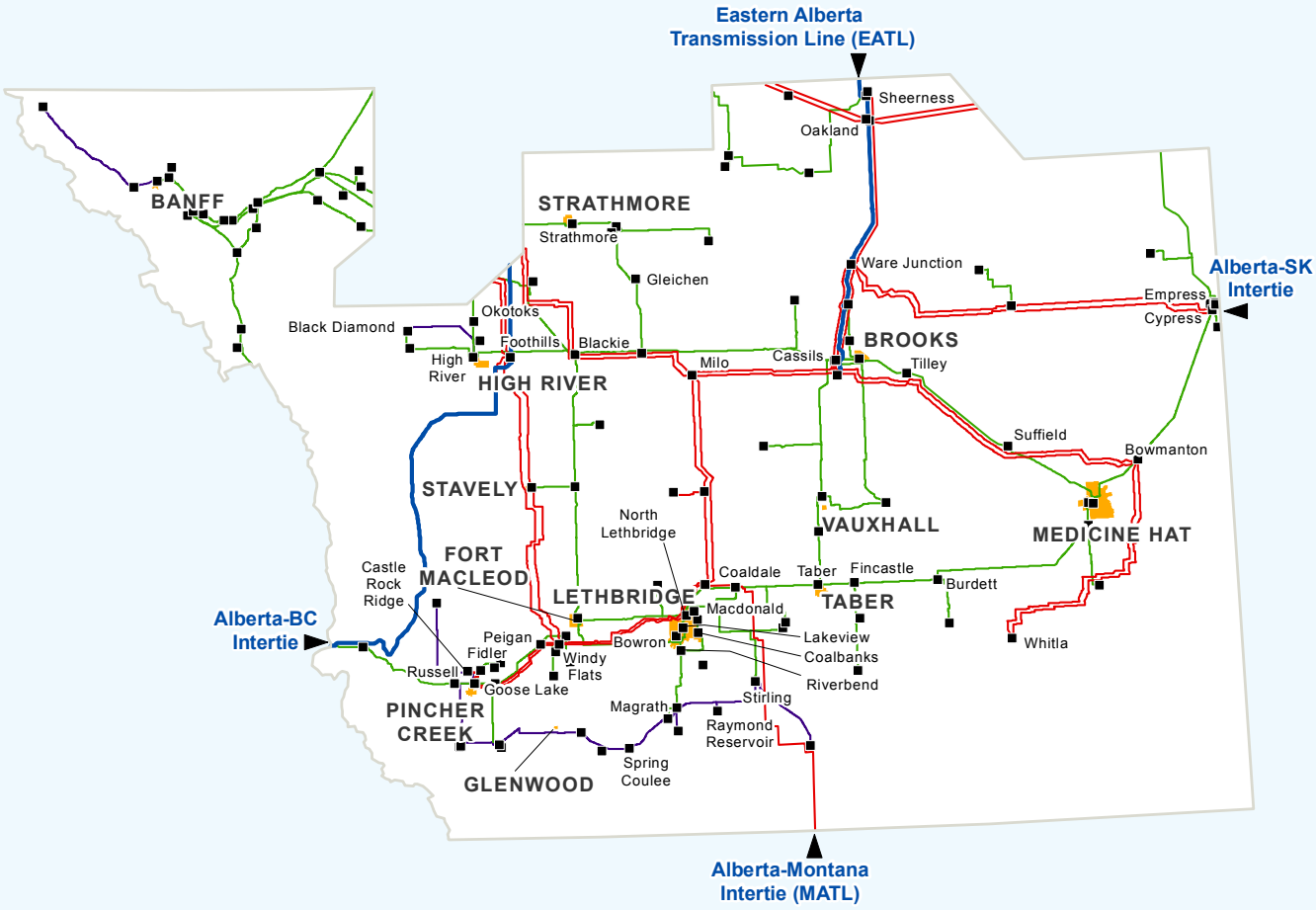
5.1–2: South regional characteristics

2013 Average Load (MW)	1,057
2013 Summer Peak (MW)	1,382
2013/2014 Winter Peak (MW)	1,300
Population (000s)	433
Area (000 km^2)	91

5.1-3 SOUTH PLANNING REGION

Existing transmission system





View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

EXISTING TRANSMISSION SYSTEM

Load in the South Planning Region is predominantly served through an extensive 138 kV transmission network supplied by a regional 240 kV network that connects the main south region load centres with regional generation sources. The region also contains a small number of 69 kV facilities, including ones located south of Lethbridge and within Banff National Park. These are older transmission facilities serving less densely populated areas.

There are existing 240 kV lines extending from the Calgary area to Brooks and Medicine Hat. A 240 kV network delivers power from the Sheerness and Battle River areas south to the Brooks area. The region also includes the SATR project, currently in varying stages of development and consisting of several 240 kV circuits designed to collect geographically dispersed wind generation sources and move power into load centres. In 2015, the double-circuit 240 kV line from Windy Flats (near Fort Macleod) to Foothills was energized, enabling additional wind development capacity in the south.

MAJOR TRANSMISSION PROJECTS APPROVED AND/OR UNDER CONSTRUCTION

- **Foothills Area Transmission Development – East**—A new 240/138 kV Foothills substation near High River (this project includes 240 kV enhancements in southeast Calgary)
- **Chapel Rock to Castle Rock Ridge Transmission Project**—A 500/240 kV substation on the BC–AB 500 kV intertie near Chapel Rock, with a 240 kV line to Castle Rock Ridge
- **Eastern Alberta Transmission Line**—A new 500 kV HVDC transmission line terminating at the Newell DC converter station near Brooks
- **Picture Butte to Etzikom Coulee Transmission Project**—A new substation, called Journault, in the Etzikom Coulee area and a new 240 kV transmission line between the Picture Butte and the new Journault substations (currently on hold)
- **Goose Lake to Etzikom Coulee Transmission Project**—A new 240 kV transmission line between the Goose Lake and new Journault substations (currently on hold)
- **Etzikom Coulee to Whitla Transmission Project**—A new 240 kV transmission line between the Journault and Whitla substations (currently on hold)

TRANSMISSION PLANS

Currently, transmission reinforcements are in development that will allow for anticipated wind generation to connect to the system and relieve related current and future constraints. Consequently, the need for future transmission development in the region is primarily confined to 138 kV and lower voltage levels. The observed performance issues are limited to the following sub-regions.

Vauxhall–Empress–Medicine Hat

Parts of the existing 138 kV transmission system in this sub-region are nearing capacity to serve new load and enable connection of forecast gas generation and distributed generation.

In the near term, the 138 kV line from the Empress substation to the Cypress substation is expected to become overloaded.

In both the medium and long term, additional 138 kV lines are expected to become overloaded over a larger area and the magnitude of the overloads is expected to increase. As well, low voltage conditions are expected in the Tilley-Suffield area.

Timeframe	Development
Near-term	▪ Rebuild 138 kV line from Cypress substation to Empress substation to higher capacity
Medium-term	▪ Convert Tilley substation from 138/25 kV to 240/138/25 kV substation ▪ Connect Tilley substation to 240 kV line between Cassils substation near Brooks and Bowmanton substation near Medicine Hat ▪ Build new 138 kV line from Tilley substation to Suffield substation ▪ Install 240/138 kV transformer at Whitla substation south of Bow Island ▪ Build new 138 kV line from Whitla substation to Fincastle substation ▪ Open 138 kV line between Taber substation and Fincastle substation ▪ Install voltage support at Suffield substation
Long-term	▪ Rebuild existing 138 kV line between Coaldale and Taber substations to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario the medium- and long-term developments are delayed beyond the 20-year planning horizon. However, the near-term development of the 138 kV line from the Cypress substation to the Empress substation is still required.

Glenwood

Much of this planning area is served by an aging 69 kV network which connects a number of small hydro and wind generators.

Due to load increases and the addition of wind generation in the Glenwood area over the near term, the 69 kV line from the Magrath substation to the Sterling substation is expected to become overloaded and low voltages are expected to occur.

In the medium term the severity of near-term overloads is expected to increase, along with the severity of low voltages.

In the long term, overloads are expected to become more widespread (stretching from Pincher Creek to Lethbridge) and also more severe. The severity of low voltages experienced in the medium term is also expected to grow.

Timeframe	Development
Near-term	▪ Upgrade existing 69 kV lines, from Stirling substation to Raymond substation and onto Magrath substation, to 138 kV ▪ Convert Raymond substation from 69 kV to 138 kV
Medium-term	▪ Add voltage support at Spring Coulee substation ▪ Rebuild 138 kV lines from Riverbend substation to Magrath substation and from Stirling substation to Coaldale substation to higher capacity
Long-term	▪ None

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, none of the above developments are required.

Lethbridge

In the near term, some 138 kV line overloads are observed but no voltage violations occur.

In the medium term, the severity of these overloads is expected to increase and an additional line, from MacDonald to Lakeview and North Lethbridge to Coalbanks, is expected to experience overloads. As in the near term, no voltage violations are expected.

In the long term, medium-term issues continue and the severity of overloads continues to increase. As well, overloads are expected on additional lines and on the 240/138 kV transformers at North Lethbridge substation.

Timeframe	Development
Near-term	▪ Add 138 kV breakers at North Lethbridge substation for better sectionalizing of Lethbridge 138 kV network
Medium-term	▪ Build new 240/138 kV substation in west Lethbridge connecting to double-circuit 240 kV line between Windy Flats near Fort Macleod and North Lethbridge substations ▪ Build new 138 kV line from new West Lethbridge substation to Bowron substation in south Lethbridge
Long-term	▪ Build 138 kV line from Bowron substation to tap point on Fort Macleod to Riverbend line and convert it to an in/out arrangement ▪ Build new 138 kV line from Chinook substation in west Lethbridge to new West Lethbridge 240/138 kV substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, the medium-term developments are delayed to the long term, and the long-term developments are delayed beyond the 20-year planning horizon. The near-term development is still required.

Strathmore–Blackie–High River

In the near term, the Strathmore area is expected to experience low voltage issues. Overloads due to load growth and generation additions are expected on the 138 kV line from the Blackie substation to the Gleichen substation.

In the medium term, overloads and low voltages identified in the near term are expected to become more severe.

In the long term, the 69 kV line from the High River substation to the Black Diamond substation is expected to become overloaded under normal operating conditions. As well, overloads on the 138 kV lines in the Blackie–Strathmore area are expected to become more severe and widespread, and the Strathmore area is expected to experience voltage collapse under certain contingencies.

The timing of the proposed plan below depends upon the following load and generation developments in the study area:

- A new point-of-delivery substation east of Chestermere expected to be in service by late 2017, as requested by FortisAlberta Inc.
- Distributed generation and gas generation facilities expected to be constructed and connected at Strathmore

Timeframe	Development
Near-term	▪ Upgrade protection on 138 kV Strathmore–Namaka–Gleichen line
Medium-term	▪ Build new 138 kV double-circuit line from Janet substation to East Chestermere substation ▪ Build new 138 kV double-circuit line from East Chestermere substation to Strathmore substation
Long-term	▪ Build new 138 kV line from Okotoks substation to Black Diamond substation ▪ Convert Black Diamond substation to 138/25 kV from 69/25 kV ▪ Discontinue use of 69 kV line from High River substation to Black Diamond substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario all long-term developments are delayed past the 20-year planning horizon. The medium-term developments are delayed to the long term. The near-term project remains.

Sheerness

Under summer light load conditions, with zero wind production, the 240 kV system in the Sheerness and surrounding areas is expected to experience high voltages in the near term. The high voltage condition only occurs when the system is lightly loaded.

Timeframe	Development
Near-term	▪ Upgrade voltage control equipment at Ware Junction and Oakland substations
Medium-term	▪ None
Long-term	▪ None

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

The voltage control at the Ware Junction and Oakland substations is still required in the near term.

PLANNING REGION

5.2 Calgary

OVERVIEW AND FORECAST

The Calgary Planning Region includes the City of Calgary, Airdrie and the surrounding area, and accounts for about 33 per cent of the province's total population.

This region represents 13 per cent of provincial load. Load growth has been 1.9 per cent annually over the past 10 years and is forecast to grow at a rate of 2.4 per cent over the next 20 years, due to population growth and associated commercial and residential demand growth.

Currently, the Calgary Planning Region contains natural gas generation including the Shepard Energy Centre, and represents over 1,300 MW of Alberta's generation capacity. That number is expected to increase to 1,714 MW by the end of the planning horizon.

5.2–1: Calgary regional load and generation forecast

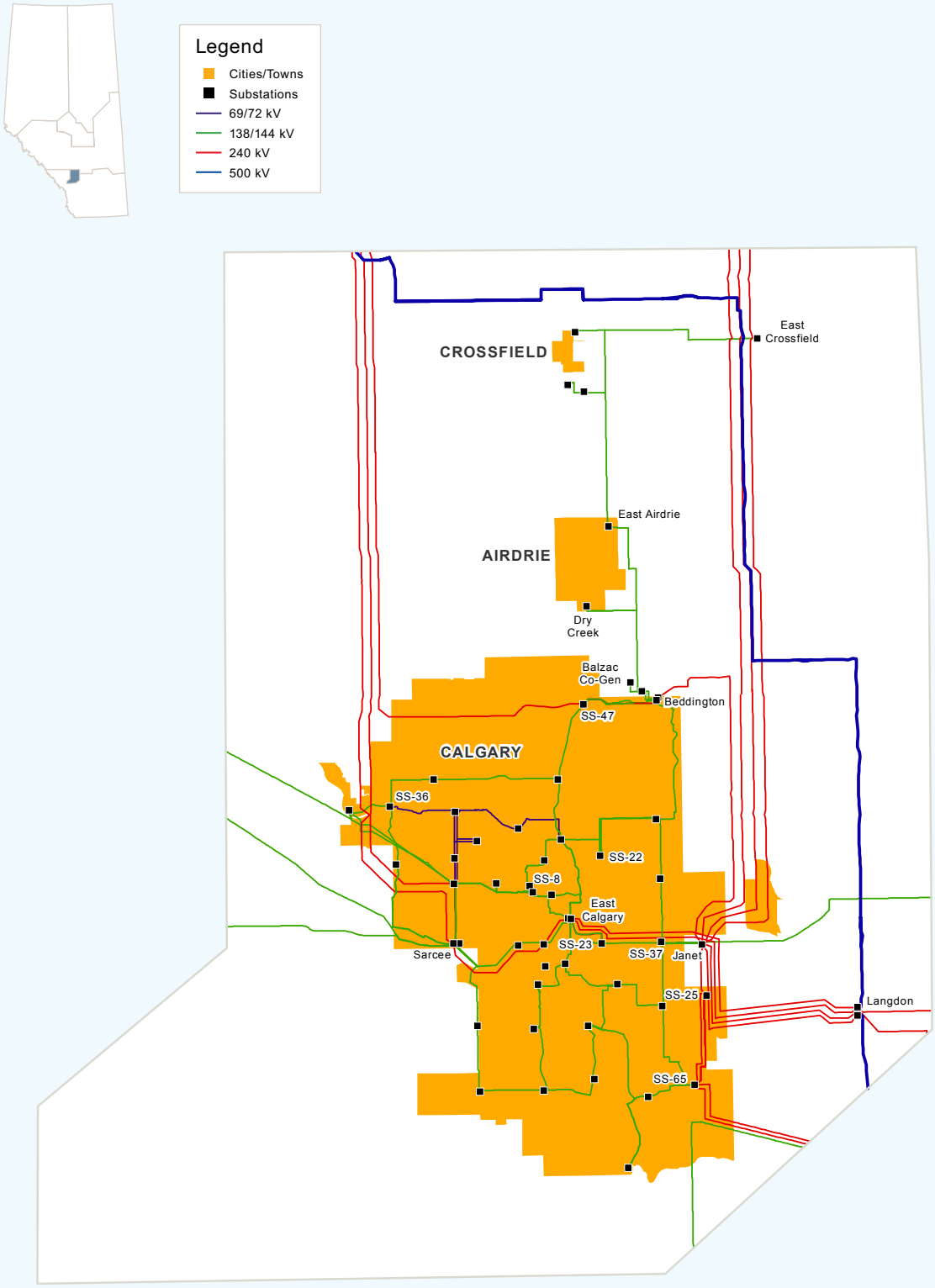
	Existing (MW)	2020 (MW)	2025 (MW)	2035 (MW)
Load at AIL Peak	1,715	2,019	2,283	2,745
Coal-fired	0	0	0	0
Cogeneration	12	12	12	12
Combined-cycle	1,313	1,240	1,408	1,408
Simple-cycle	144	144	144	144
Hydro	0	0	0	0
Wind	0	0	0	0
Other	0	0	0	150

5.2–2: Calgary regional characteristics

2013 Average Load (MW)	1,215
2013 Summer Peak (MW)	1,717
2013/2014 Winter Peak (MW)	1,715
Population (000s)	1,308
Area (000 km²)	45

5.2-3 CALGARY PLANNING REGION

Existing transmission system



View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

EXISTING TRANSMISSION SYSTEM

The existing transmission system in the Calgary Planning Region is designed to transfer power from major generation centres to one of the province's primary load centres.

The regional 240 kV network is served by the existing six north-to-south 240 kV transmission lines that terminate near and in Calgary, one of the major transmission hubs in the AIES. Calgary has five main 240 kV supply stations; Sarcee in the west side of the city, East Calgary in the south centre, Janet and SS-65 on the southeast side, and Beddington in the north. The underlying transmission system within the City of Calgary consists of 138 kV and 69 kV circuits delivering power to load-serving substations.

With the completion of WATL, Calgary will also be served from a 500 kV HVDC line from the Edmonton–Wabamun region. In addition, the 500 kV line from British Columbia (BC intertie) connects to the system in southeast Calgary.

MAJOR TRANSMISSION PROJECTS APPROVED AND/OR UNDER CONSTRUCTION

- **Western Alberta Transmission Line**—A new 500 kV HVDC transmission line terminating at the Crossings DC converter station on the east side of Calgary
- **Foothills Area Transmission Development – East**—A new 240/138 kV Foothills substation near High River (this project includes 240 kV enhancements in southeast Calgary)
- **Foothills Area Transmission Development – South Calgary**—A new 138 kV line from the 240/138 kV SS-65 substation to the 138/25 kV substations SS-54 and SS-41 in south Calgary (at time of publication this project was before the AUC awaiting approval)

TRANSMISSION PLANS

City of Calgary

In the near term, overloads are observed on the 138 kV lines supplying downtown Calgary and other 138 kV lines in northwest Calgary due to load growth. The north Calgary 69 kV system is also showing overloads due to load growth and is reaching the end of its economic life.

In both the medium term and long term, progressive increases in overload levels and the number of overloaded elements are expected to increase on the downtown Calgary, north 69 kV system and north Calgary 138 kV lines and 240/138 kV transformers, as well as on south Calgary 138 kV lines and transformers.

Timeframe	Development
Near-term	▪ Build new 240 kV line from East Calgary substation in Highfield industrial area to SS-8 substation in northwest corner of downtown Calgary ▪ Convert SS-8 to 240/138 kV substation ▪ Add new 138 kV line between SS-47 substation north of Calgary airport and SS-36 substation in northwest Calgary ▪ Add new 138 kV line from SS-22 substation south of Calgary airport to SS-23 substation in Valleyfield industrial area of Calgary ▪ Build 240 kV double-circuit line to connect Beddington substation in northeast Calgary to one of the 240 kV lines between Red Deer and Calgary in an in/out configuration

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Timeframe	Development
Medium-term	▪ Add new 240/138 kV substation in far northwest corner of Calgary ▪ Add new 138 kV lines from new 240/138 kV substation to load substations in north Calgary ▪ Upgrade transformer at SS-36 substation in northwest Calgary
Long-term	▪ Add new 240 kV line from the new Foothills substation to Sarcee substation on west side of Calgary ▪ Add new 240 kV line from Beddington substation to SS-8 substation in downtown Calgary ▪ Add new 138 kV line from Janet substation on east edge of Calgary to SS-37 substation 3 km east of Janet

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, all long-term projects are delayed beyond the 20-year planning horizon. All medium-term projects are delayed to the long term. All near-term projects move to the medium term, with the exception of the new 240 kV line from the East Calgary substation to the SS-8 substation. The 240 kV line would be replaced with a new 138 kV transmission line between SS-2 and SS-8.

Airdrie

In the near term, overloads are expected on the 138 kV lines in the Airdrie area due to high Crossfield-area generation and local load growth.

The near-term overloads persist in the medium term through to the long term, and some overloads are expected to become progressively more severe.

Timeframe	Development
Near-term	▪ Convert 240 kV connection at East Crossfield substation from a tap to an in/out arrangement ▪ Rebuild entire 138 kV loop from East Crossfield substation to Balzac substation to higher capacity except line between East Airdrie substation in northeast corner of Airdrie and Dry Creek substation in southwest corner of Airdrie ▪ Build new 138 kV lines from East Crossfield substation to East Airdrie substation ▪ Build new 138 kV line from Beddington substation to Dry Creek substation ▪ Open 138 kV line between East Airdrie and Dry Creek substations
Medium-term	▪ None
Long-term	▪ None

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, all near-term developments are delayed to the long term.

PLANNING REGION

5.3 Central

OVERVIEW AND FORECAST

The Central Planning Region spans the province east to west between the borders of B.C. and Saskatchewan, and north to south between Cold Lake and Calgary. Its major population centres are the cities of Red Deer and Lloydminster. The region also includes Camrose and Wetaskiwin and represents about 12 per cent of Alberta's population, primarily concentrated in the Red Deer area.

The region currently represents 18 per cent of Alberta's load. Over the next 20 years, load is forecast to grow by 1.6 per cent annually as a result of increasing pipeline load, industrial growth and urban growth in the Red Deer and Joffre areas.

The Central Planning Region has diverse sources of generation consisting of coal, natural gas, hydroelectric, wind and biomass. In the past 10 years it has seen approximately 500 MW of generation capacity growth, with approximately 230 MW of that from new wind power facilities, 200 MW from cogeneration and the remainder from small gas units.

Wind generation is expected to show the strongest growth over the next 10 years, and gas-fired generation is forecast in the latter half of the 20-year forecast period in response to a system-wide need for generation as coal units retire.

5.3–1: Central regional load and generation forecast

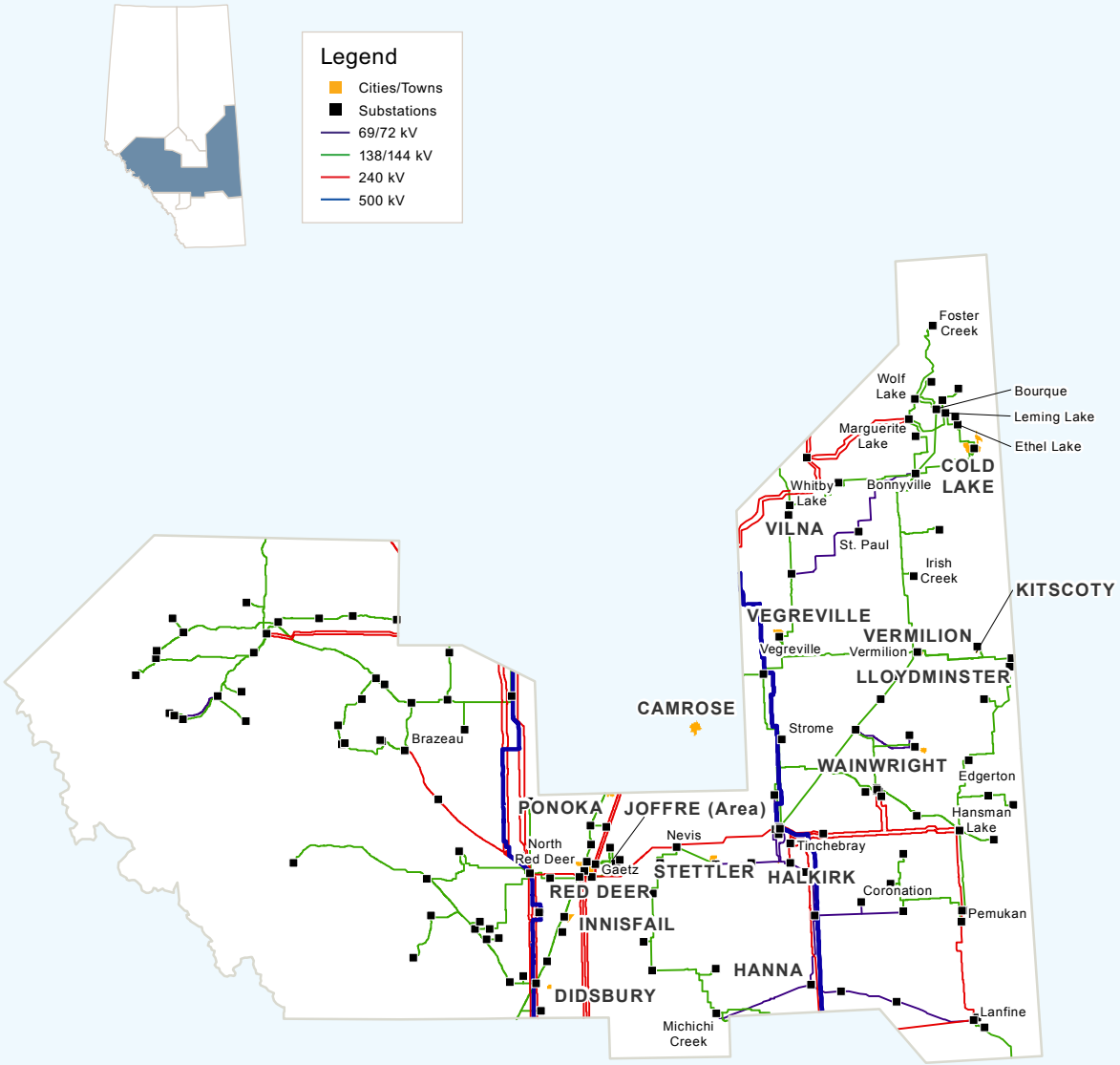
	Existing (MW)	2020 (MW)	2025 (MW)	2035 (MW)
Load at AIL Peak	2,053	2,469	2,674	2,973
Coal-fired	689	540	540	0
Cogeneration	1,083	1,078	1,078	1,078
Combined-cycle	0	0	0	500
Simple-cycle	0	180	180	270
Hydro	485	485	485	485
Wind	232	311	439	505
Other	61	61	84	84

5.3–2: Central regional characteristics

2013 Average Load (MW)	1,654
2013 Summer Peak (MW)	1,777
2013/2014 Winter Peak (MW)	2,087
Population (000s)	461
Area (000 km^2)	146

5.3-3 CENTRAL PLANNING REGION

Existing transmission system



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EXISTING TRANSMISSION SYSTEM

The Central Planning Region contains six 240 kV lines that function as the system backbone between the Edmonton Planning Region and the Calgary Planning Region. These lines run through the Central Planning Region and are connected at two source substations that supply local load, located near the City of Red Deer.

Local area load is supplied by 138 kV and 144 kV systems. The transmission system includes 72 kV lines and substations serving load in the eastern part of the Central Planning Region. An additional 240 kV development in the Hanna region serves local regional load and provides access points for wind generation.

The Cold Lake area is located in the Central Planning Region and is served by a 240 kV line and local 144 kV lines to support oilsands and industrial development. The western part of this planning region is primarily served by 138 kV lines serving load. As well, the Brazeau hydro power plant is located in this region.

In addition to the facilities mentioned above, the new 500 kV north-south HVDC transmission lines between Edmonton and Calgary (EATL and WATL) pass through the Central Region to carry power between the Edmonton Planning Region and the South Planning Region.

MAJOR TRANSMISSION PROJECTS APPROVED AND/OR UNDER CONSTRUCTION

- **Central East Transmission Development**—Multiple 138/144 kV enhancements in the Wainwright and Lloydminster areas to serve increasing load and generation, and 240 kV and 144 kV enhancements in the Cold Lake area
- **Hanna Region Transmission Development Stage 2**—Increasing capacity of the 240 kV loop from the Sheerness area to the Hansman Lake substation to support future pipeline development should projects move forward (currently on hold)
- **Red Deer Area Transmission Development**—New 240/138 kV substations near Ponoka, Innisfail and Didsbury, and 138 kV enhancements

TRANSMISSION PLANS

The primary drivers for future transmission development in the Central Region are oilsands development in the Cold Lake area, industrial activity and urban load growth in the Red Deer area, and potential pipelines and wind generation on the east side of the region.

Central East

Several 138 kV and 144 kV lines supplying load in this sub-region are overloaded and voltages in the Vegreville and Lloydminster areas are below limits in the near term.

The amount and magnitude of overloads and performance requirement violations in the Central East sub-region are expected to increase in both the medium term and long term as load and generation in the area increase.

Timeframe	Development
Near-term	▪ Add voltage reinforcement at Strome substation east of Camrose, Irish Creek substation north of Kitscoty and Whitby Lake substation near Vilna ▪ Add new 240/144 kV substation near Vermilion ▪ Add new 240 kV line from Tinchebray substation northeast of Halkirk to new substation near Vermilion energized at 144 kV ▪ Reconfigure 144 kV lines in vicinity of Vermilion to terminate at new substation ▪ Add new 240 kV line from Hansman Lake substation southeast of Hughenden to Edgerton substation energized at 144 kV ▪ Rebuild 144 kV line from Vermilion to Irish Creek to higher capacity
Medium-term	▪ Add new 240/144 kV substation near Lloydminster ▪ Install two 240/138 kV transformers and 240/25 kV transformer at new 240 kV substation near Vermilion ▪ Install a 240/138 kV transformer at Edgerton substation ▪ Energize new line from Tinchebray to new Vermilion substation to 240 kV ▪ Energize new line from Edgerton to Hansman Lake substations to 240 kV ▪ Add new 240 kV line from Edgerton substation to new substation near Lloydminster ▪ Add new 240 kV line from new Lloydminster substation to new Vermilion substation ▪ Add new 144 kV line from new Vermilion substation to Vegreville substation ▪ Add voltage reinforcement at Vegreville substation
Long-term	▪ Replace existing 240/144 kV transformer at Nevis substation near Stettler with higher-capacity unit ▪ Add additional voltage reinforcement at Irish Creek substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

In addition to the above, a new 240 kV path from the Hanna–Central East area to the Red Deer area would potentially be needed to transfer energy between these two regions under a high wind development scenario.

Low-growth Scenario

Under the Low-growth Scenario the following changes would be made to the above proposed developments:

- Voltage support reinforcements at Irish Creek are moved from the near term to the long term—the rest of the near-term voltage reinforcements are not required
- Rebuild of the 144 kV line from Vermilion to Irish Creek is moved from the near term to the long term
- All 240 kV developments in the Central East sub-region in the near and medium term are replaced with 138/144 kV developments

Cold Lake

Cold Lake area load is growing due to oilsands development and pipeline expansion.

In the near term, the area is expected to experience low voltages at several substations. This condition is expected to worsen as load and generation increase in the medium to long term.

Timeframe	Development
Near-term	▪ Add voltage reinforcement in the Cold Lake area
Medium-term	▪ None
Long-term	▪ Add voltage reinforcement at St. Paul substation ▪ Add new 144 kV line between Marguerite Lake, Wolf Lake and Bourque substations east of Cold Lake ▪ Add new 144 kV switching station at intersection of lines from Marguerite Lake substation to Leming Lake substation and Leming Lake substation to Ethel Lake substation ▪ Add new 144 kV line from new switching station to Ethel Lake substation ▪ Add third 240/138 kV transformer at Marguerite Lake ▪ Rebuild 138 kV line between St. Paul substation and Bonnyville substation to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario none of the above developments are required.

Hanna

In the near term, transmission performance is adequate.

In the medium term, no voltage issues are expected, but some overloads are expected on the 240 kV loop from Sheerness to Hansman Lake. In the long term, load growth is expected to cause additional overloads and some performance requirement violations are expected on the local 144 kV and 72 kV systems.

Timeframe	Development
Near-term	▪ None
Medium-term	▪ Replace protection equipment on 240 kV lines at Oakland, Lanfine and Pemukan substations to bring lines up to capacity of conductor ▪ Add voltage reinforcement at Coronation substation
Long-term	▪ Replace 240/144 kV transformer at Nevis substation with higher capacity unit ▪ Replace current-limiting protection equipment on 144 kV line at Michichi Creek substation to Coyote Lake substation to bring lines up to capacity of conductor

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario the above developments are not required except for the Coronation substation voltage reinforcement.

Red Deer

As a result of the significant enhancements added in the Red Deer area over the past few years, there are no overloads or performance requirement violations expected in the near and medium terms.

In the long term, no voltage criteria violations are expected and only two overload conditions are expected due to local load growth; at the 240/138 kV transformers at the Gaetz substation and on the 138 kV line from the Gaetz substation to the North Red Deer substation.

Timeframe	Development
Near-term	▪ None
Medium-term	▪ None
Long-term	▪ Install third 240/138 kV transformer at Gaetz substation in northeast corner of Red Deer ▪ Rebuild 138 kV line from Gaetz substation to North Red Deer substation to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, the above long-term developments are moved out beyond the 20-year planning horizon.

Central West

No criteria violations are expected over the 20-year horizon and, as such, no development is expected to be required in this sub-region.

PLANNING REGION

5.4 Northwest

OVERVIEW AND FORECAST

The Northwest Planning Region represents approximately one third of the area of the province and less than five per cent of the population. The largest population centre is the City of Grande Prairie.

This region has a relatively high amount of industrial load. As a result, regional load accounts for approximately 10 per cent of the provincial total. Load growth over the past decade has been the slowest of any region at an annual rate of 1.2 per cent. Growth is expected to increase to a rate of 1.8 per cent over the next 20 years.

Industrial load primarily comes from the forestry industry as well as oil and gas developments, including recent oilsands development in the Peace River area. The AESO expects future load growth to come from oilsands projects in the Peace River area, along with related infrastructure development.

Generation consists of coal, natural gas and biomass. Cogeneration, combined-cycle and simple cycle are the most probable gas generation sources to develop over the forecast term in place of coal and older gas units that are expected to retire. Hydroelectric generation is not expected in the forecast period but could be developed in the future if economics are favourable.

5.4–1: Northwest regional load and generation forecast

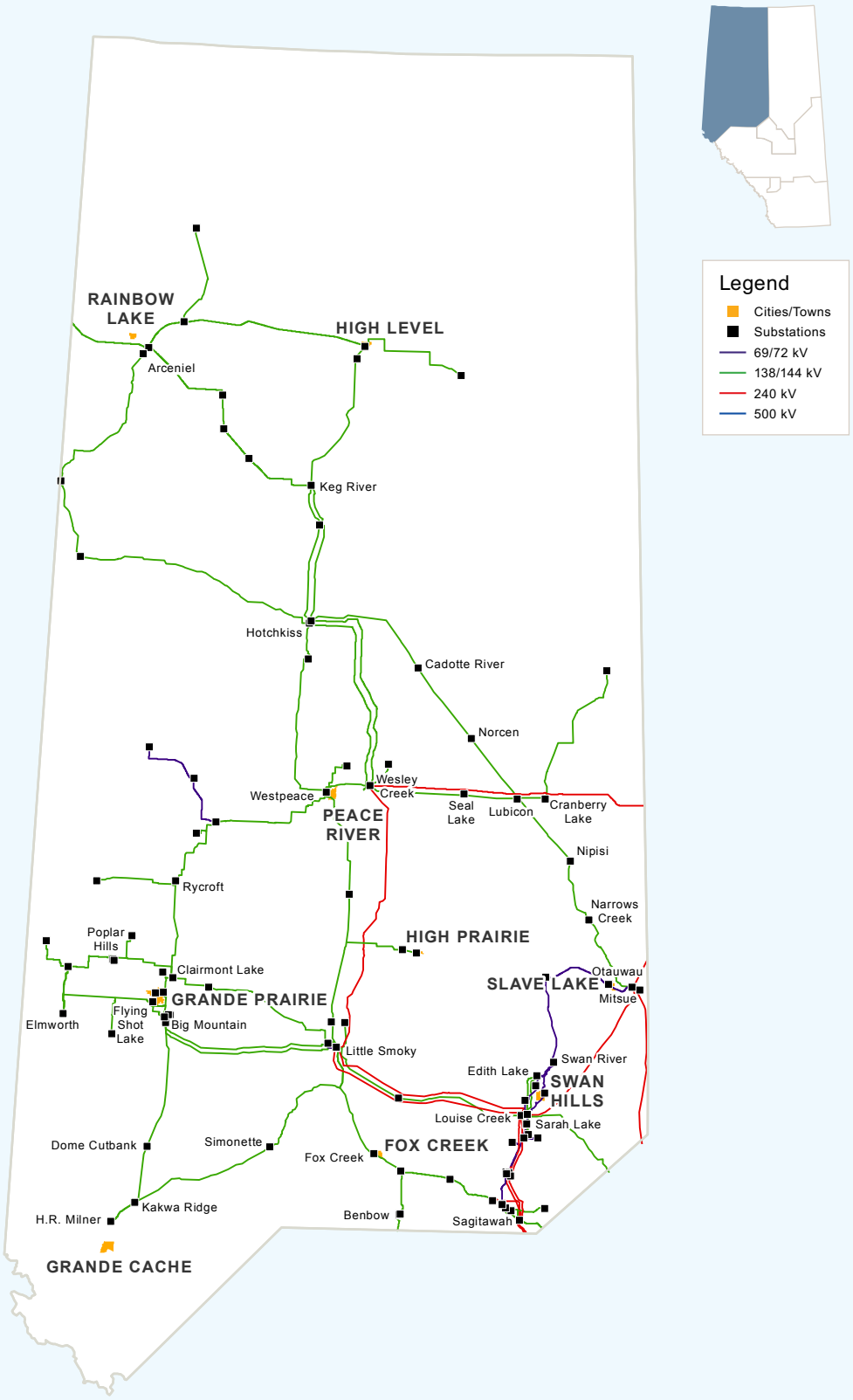
	Existing (MW)	2020 (MW)	2025 (MW)	2035 (MW)
Load at AIL Peak	1,079	1,347	1,465	1,628
Coal-fired	144	0	0	0
Cogeneration	166	881	881	881
Combined-cycle	73	73	73	773
Simple-cycle	506	523	523	703
Hydro	0	0	0	0
Wind	0	0	0	0
Other	157	212	212	262

5.4–2: Northwest regional characteristics

2013 Average Load (MW)	1,057
2013 Summer Peak (MW)	1,151
2013/2014 Winter Peak (MW)	1,231
Population (000s)	179
Area (000 km^2)	230

5.4-3 NORTHWEST PLANNING REGION

Existing transmission system



View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

EXISTING TRANSMISSION SYSTEM

The Northwest Planning Region is primarily served by a 240 kV network that moves power into the region from generation in the Wabamun area and from cogeneration in the northeast. Local load is supplied, via a 144 kV network, from the following 240 kV substations: Louise Creek; Little Smoky; Wesley Creek; Sagitawah; Bickerdike; Mitsue; North Barrhead and Wabamun. A portion of the load in the Swan Hills, High Prairie and Peace River areas is served by a 69/72 kV network.

MAJOR TRANSMISSION PROJECTS APPROVED AND/OR UNDER CONSTRUCTION

Currently, there are no major projects approved or under construction in the Northwest Planning Region.

TRANSMISSION PLANS

The existing Northwest Planning Region transmission system is currently experiencing a number of constraints across the region. These constraints become more severe over time due to high load growth and potential generation additions. Specific constraint issues are itemized by sub-region and can be found in the subsequent sub-region transmission plans.

Peace River–North

In the near term, constraints are expected under normal operating conditions on the 144 kV line between the Wesley Creek 240/144 kV substation east of Peace River and the West Peace River 144 kV substation.

In the medium term, thermal constraints are expected to increase on the 144 kV line between the Wesley Creek and West Peace River substations. As well, thermal overloads under abnormal operating conditions are expected on Wesley Creek 240/144 kV transformers and on the 144 kV lines from the West Peace River to Hotchkiss substations, and between the Wesley Creek and Lubicon substations.

It is important to note that all of the near- and medium-term issues occur in the Peace River area, and are due to increased power transfers from that area to other areas.

In the long term, the near- and medium-term issues on the above-mentioned infrastructure are expected to become more severe. Also in the long term, thermal overloads are expected on the 144 kV line in the High Level area, due to forecast generation development.

Timeframe	Development
Near-term	▪ Build new single-circuit 240 kV line from Wesley Creek substation east of Peace River to Little Smoky substation near Valleyview ▪ Rebuild 144 kV line from Wesley Creek substation to West Peace River substation to a higher capacity
Medium-term	▪ None
Long-term	▪ Add new 240/144 kV substation near Seal Lake on 240 kV line between Brintnell substation southwest of Fort McMurray and Wesley Creek substations ▪ Add new 144 kV lines east of Peace River from Cranberry Lake substation to Nipisi substation and from Seal Lake substation to Norcen substation ▪ Open 144 kV lines between Wesley Creek and Seal Lake substations, Cadotte River and Norcen substations, and Mistue and Narrow Creek substations (local area loads will be supplied from new 240/144 kV substation near Seal Lake) ▪ Rebuild of 144 kV line from Blumenort substation to High Level substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario none of the above developments are required other than the rebuild of the 144 kV line from the Blumenort substation to the High Level substation. However, the existing 144 kV line from the Arcenciel substation to the Keg River substation may need to be rebuilt to a higher capacity in the long term because the above-mentioned near-term developments would not have occurred.

Swan Hills–High Prairie

In the near term, voltage criteria violations are expected on the 72 kV system and thermal overloads are expected on 144 kV lines from the Sagitawah substation due to local area load growth.

In the medium term, thermal overloads are expected on the 72 kV line between the Edith Lake and Swan River substations, and voltage criteria violations are expected in the area. The thermal overloads expected on the 144 kV lines from the Sagitawah substation in the near term become more severe in the medium term. Also in this timeframe, thermal overloads are anticipated on 240 kV lines between the Sundance and Mitsue substations and the 144 kV line between the Sagitawah and Entwistle substations.

In the long term, thermal overloads are expected on the 72 kV line between the Edith Lake and Swan River substations, along with voltage criteria violations in that area. The thermal overloads expected on the 144 kV lines from the Sagitawah substation in both the near and medium terms become more severe in the long term. Thermal overloads are also expected on the local 144 kV network in the Louise Creek–Sarah Lake areas within this timeframe.

Timeframe	Development
Near-term	▪ Add second 144/72 kV transformer at Otauwau substation near Town of Slave Lake
Medium-term	▪ None (Note that medium-term overloads and performance requirement violations are resolved by near- and medium-term developments in other sub-regions)
Long-term	▪ Rebuild 144 kV line from Louise Creek substation to Sarah Lake substation to higher capacity ▪ Add second 144/72 kV transformer at Sarah Lake or Edith Lake substations

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, the long-term developments are moved beyond the 20-year planning horizon. The near-term addition of a 144/72 kV transformer at Otauwau is still required.

Fox Creek–Valleyview

In the near term, widespread thermal overloads and performance requirement violations are expected on local 144 kV networks in the area if there is a loss of supply from either Bickerdike or Sagitawah due to load growth.

In both the medium and long terms, near-term issues escalate further as load in the northwest grows, particularly in the Grande Prairie area due to forecast load increases.

Timeframe	Development
Near-term	▪ Increase 240/144 kV transformer capacity at Little Smoky substation ▪ Add new 240 kV lines from Little Smoky substation to Fox Creek substation (ATCO) ▪ Expand Fox Creek substation to include 240/144 kV facilities ▪ Add new 240 kV lines from Fox Creek substation to Bickerdike substation near Edson ▪ Open 144 kV line between Fox Creek and Little Smoky substations ▪ Add voltage support at Fox Creek substation
Medium-term	▪ None
Long-term	▪ Add additional 240 kV circuit from Little Smoky to Fox Creek and onto Bickerdike ▪ Add voltage support at Benbow substation near Chevron Kaybob facility

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, all developments are moved beyond the 20-year planning horizon except for the addition of a 240/144 kV transformer at the Little Smoky substation, which remains in the near term.

Grande Prairie–Grande Cache

In the near term, voltage criteria violations and instability are expected in this sub-region. Major overloading is expected on several circuits into and within Grande Prairie due to load growth.

In the medium term, the voltage issues noted in the near term become more severe and widespread. Under normal operating conditions, thermal constraints are expected on sections of the 144 kV line from Peace River to Grande Prairie and on the 240/144 kV transformers at the Little Smoky substation. Increased thermal overloads are expected on the 144 kV lines from the Little Smoky substation to the Grande Prairie area and on the local 144 kV network west of Grande Prairie.

In the long term, all the above issues cited for the medium term become more severe and widespread.

In addition to load-driven needs, the forecast generation development at the existing H.R. Milner site in the Grande Cache area will require the 240 kV developments identified in the following table. The generation forecast and customer connection plans in the Grande Cache area will evolve. While existing coal generation is near end of life, a combination of natural gas and coal generation may continue to utilize the existing 144 kV transmission capacity in the future. The transmission plans take into account that a generation plant can be unavailable during certain times. In the longer term, a large natural gas generating facility would need a 240 kV connection and could be connected to the 240 kV network in several ways.

Timeframe	Development
Near-term	▪ Add new 240 kV line from Little Smoky substation to Big Mountain substation south of Grande Prairie ▪ Expand Big Mountain substation to include 240 kV facilities ▪ Add new 144 kV line from Big Mountain substation to Poplar Hill substation northwest of Grande Prairie ▪ Add voltage support at Big Mountain substation ▪ Add voltage support in Rycroft area ▪ Add voltage support at Thornton and other Grande Cache area substations
Medium-term	▪ Add second 240 kV line from Little Smoky substation to Big Mountain substation south of Grande Prairie ▪ Add second 240/144 kV transformer at Big Mountain substation ▪ Add additional voltage support at Rycroft substation
Long-term	▪ Add new 144 kV line from Big Mountain substation to Clairmont Lake substation or other suitable location near Clairmont Lake ▪ Add new 144 kV switching station at junction of new 144 kV line from Big Mountain to Poplar Hill substation and existing 144 kV line between Flying Shot substation southwest of Grande Prairie and Elmworth substation ▪ For forecast new generation development at existing H.R. Milner site in Grande Cache area: – Expand H.R. Milner substation to include 240/144 kV facilities – Build single-circuit 240 kV line from H.R. Milner substation to Big Mountain substation and from H.R. Milner substation to Fox Creek substation – Create local 144 kV loop from H.R. Milner substation by building new 144 kV line to connect to new substation north of Dome Cutbank substation – Build single 144 kV line from Fox Creek substation to Simonette substation – Open 144 kV lines from Kakwa Ridge substation to Simonette substation and from Thornton to Big Mountain substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, all of the above developments are moved past the 20-year planning horizon with the exception of the following:

- Near-term—a new 144 kV line from the Big Mountain substation to the Poplar Hill substation and addition of voltage support at the Thornton substation and other Grande Cache area substations as required
- Long-term—a new 144 kV line from the Big Mountain substation to the Clairmont Lake substation or other suitable location near Clairmont

PLANNING REGION

5.5 Northeast

OVERVIEW AND FORECAST

The Northeast Planning Region is sparsely populated, with approximately two per cent of the provincial population. Most residents are located in the Fort McMurray area of the Regional Municipality of Wood Buffalo.

The economy in this region is driven by the oilsands industry and the need for transmission development is directly linked to future oilsands projects. Oilsands load accounts for approximately 20 per cent of all electricity consumed in Alberta. Over the past 10 years, load in this region has grown the strongest of any region at a rate of 4.1 per cent annually, and growth is expected to continue at a rate of 3.3 per cent annually over the next 20 years, despite the current low price of oil.

Generation in the Northeast Planning Region comes primarily from natural gas generation in the Fort Saskatchewan and Fort McMurray areas. There is also biomass generation in the Athabasca area. The majority of existing generators in this region consist of onsite cogeneration units which supply local steam and electric load in industrial plants with excess power sold to the electricity market.

In the next 10 years, it is expected that some baseload demand in the Northeast will be met by oilsands-related cogeneration additions, and combined-cycle generation additions will occur in the Fort Saskatchewan planning area. In the second 10-year forecast period, smaller growth of cogeneration is expected, while combined-cycle and simple-cycle is expected to grow to meet system-wide load increases and coal generation retirements. Hydroelectric generation also has potential within this planning region.

5.5–1: Northeast regional load and generation forecast

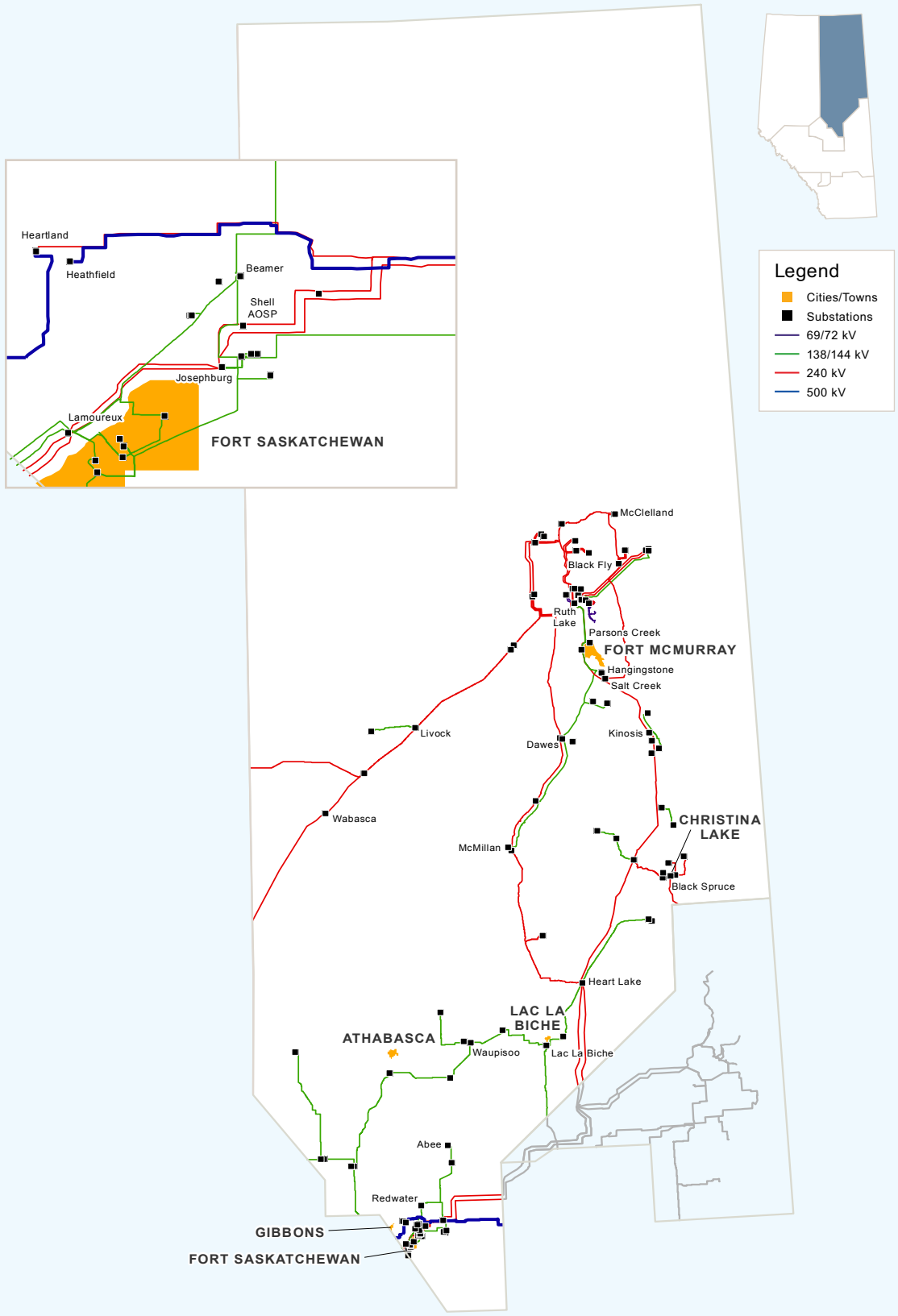
	Existing (MW)	2020 (MW)	2025 (MW)	2035 (MW)
Load at AIL Peak	2,623	4,450	4,977	5,481
Coal-fired	0	0	0	0
Cogeneration	3,088	4,078	4,231	4,632
Combined-cycle	0	940	940	2,210
Simple-cycle	0	90	180	450
Hydro	0	0	0	0
Wind	0	0	0	0
Other	149	149	149	149

5.5–2: Northeast regional characteristics

2013 Average Load (MW)	2,284
2013 Summer Peak (MW)	2,502
2013/2014 Winter Peak (MW)	2,814
Population (000s)	88
Area (000 km^2)	169

5.5-3 NORTHEAST PLANNING REGION

Existing transmission system



View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

EXISTING TRANSMISSION SYSTEM

The Northeast Planning Region transmission system consists of a 240 kV network primarily serving large industrial operations in the Fort McMurray and Fort Saskatchewan areas. In addition, local 138/144 kV networks serve load across the planning region. Several 144 kV networks connect load and behind-the-fence facilities in the Fort McMurray area.

MAJOR TRANSMISSION PROJECTS APPROVED AND/OR UNDER CONSTRUCTION

- **Eastern Alberta Transmission Line**—A new 500 kV HVDC transmission line terminating at the Heathfield DC converter station northeast of Edmonton
- **Fort McMurray West 500 kV Transmission Project**—A new 500 kV AC transmission line at the Thickwood Hills substation southwest of Fort McMurray
- **Fort McMurray East 500 kV Transmission Project**—A new 500 kV AC transmission line between the Heartland substation northeast of Edmonton and Thickwood Hills substation southwest of Fort McMurray (currently on hold)
- **Christina Lake Area 240 kV Transmission System Development**—Three new 240/144 kV substations in the Christina Lake area connecting to the existing Heart Lake substation via a new 240 kV transmission line to serve new oilsands load in the area
- **Northwest of Fort McMurray 240 kV Transmission System Development**—Two new 240 kV transmission lines from the existing 240 kV lines north and west of Fort McMurray to the new Ells River substation to serve oilsands load in that area (currently on hold)

TRANSMISSION PLANS

The existing Northeast Planning Region transmission system is currently experiencing a number of constraints. They are itemized by sub-region and can be found in the subsequent sub-region transmission plans.

Fort McMurray

The addition of the Fort McMurray West 500 kV transmission line will provide adequate capacity to move energy to and from the Fort McMurray region. However, the Fort McMurray 144 kV network serving load around the urban service area of Fort McMurray from the Ruth Lake 240/72/144 kV substation will need reinforcement due to local load growth.

In the near term, no constraints are expected in and around the town of Fort McMurray.

In the medium term, load growth is expected to exceed the capacity of this network.

In the long term, a progressive increase in thermal and voltage constraints on 144 kV lines and 240/144 kV transformers is expected.

Timeframe	Development
Near-term	▪ None
Medium-term	▪ Add transformer at Ruth Lake substation north of Fort McMurray ▪ Add new 144 kV line from Salt Creek substation to Parsons Creek substation at north edge of Fort McMurray ▪ Add new 144 kV line from Ruth Lake substation to Parsons Creek substation ▪ Add second 500/240 kV transformer at Thickwood Hills substation
Long-term	▪ Connect Hanging Stone substation into 144 kV line between Salt Creek substation south of Fort McMurray and Parsons Creek substation ▪ Add second 240/144 kV transformer at Salt Creek substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, long-term system enhancements driven by the large load connection projects noted above will not be required. Addition of the second transformer at Thickwood Hills is cancelled. Projects in the medium term are moved out to the long term.

The Fort McMurray area is unique in that major transmission enhancements are driven by large oilsands projects. In addition to the above local issues around the town of Fort McMurray, there are several constraints that will result from potential oilsands projects and these will drive additional transmission system enhancements. The uncertainty around the timing of the oilsands projects makes it difficult to predict when the related transmission system enhancements will be required.

Depending on the timing and location of additions, performance requirement violations are expected if large industrial facilities are commissioned in these areas:

- Livock–Birchwood Creek
- Christina Lake
- North of Fort McMurray
- Kinosis

Large oilsands project-driven enhancements include:

Connection of load projects	Development
Kinosis area	▪ Add voltage support on Kinosis 144 kV network ▪ Add new 240 kV transmission line from Dawes substation to Kinosis substation
Livock and Birchwood areas	▪ Install Livock 500/240 kV transformer
North of Fort McMurray area	▪ String second 240 kV circuit on existing double-circuit towers from Salt Creek substation to Black Fly substation and onto McClelland substation northeast of Fort McMurray
Christina Lake area	▪ Build second 240 kV circuit between Heart Lake, Ipiatik, Pike and Black Spruce substations in Christina Lake area
McMillan area	▪ Add second 240/144 kV transformer at McMillan substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Athabasca–Lac La Biche

In the near term, due to local area load growth driven by pipeline additions, multiple thermal and voltage constraints are expected on the 138 kV Athabasca–Lac La Biche network during outages to the 240 kV network.

In both the medium term and long term, progressive increases in local area load result in an increase of thermal and voltage constraints on Athabasca–Lac La Biche area 138 kV lines.

Timeframe	Development
Near-term	▪ Add new 138 kV line between Abee and Waupisoo substations ▪ Rebuild 138 kV line between North Calder and Viscount substations in north Edmonton and onto Cardiff substation near Morinville to higher capacity
Medium-term	▪ None
Long-term	▪ Terminate 138 kV line between Whitby Lake substation near Vilna and Lac La Biche substations using an in/out at Whitefish Lake 240/138 kV substation ▪ Add voltage support at Viscount substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, projects in the long term are moved beyond the 20-year planning horizon. The rebuild of the 138 kV line between the North Calder and Viscount substations is still required in the near term. The rebuild of the 138 kV line from Viscount to Cardiff is delayed to the long term.

Fort Saskatchewan

In the near term, local load growth is expected to drive thermal constraints on the 138 kV lines near Beamer. Thermal constraints are expected on the 138 kV lines near the Fort Saskatchewan substation due to transfers between this and the Edmonton Region.

In both the medium term and long term, progressive increases in thermal constraints are expected on Fort Saskatchewan area 138 kV lines.

Timeframe	Development
Near-term	▪ Connect second circuit of 240 kV double-circuit line from Lamoureux to Deerland using an in/out at Josephburg substation ▪ Open 138 kV paths parallel to 240 kV path connecting to east of Edmonton ▪ Rebuild 138 kV line between Beamer and Shell substations
Medium-term	▪ None
Long-term	▪ Add new Fort Saskatchewan 240/138 kV substation at intersection of 240 kV lines between 500/240 kV Heartland substation near Gibbons and Deerland substation northeast of Fort Saskatchewan, and 138 kV line between Beamer and Redwater ▪ Add new 138 kV line from new Fort Saskatchewan substation to Beamer substation ▪ Add new 138 kV line from new Fort Saskatchewan substation to Redwater substation

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

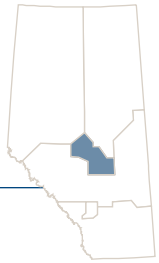
In addition to the above developments, a proposed large combined-cycle facility in the Fort Saskatchewan area will drive additional 240 kV enhancements if constructed. These enhancements would depend on the final size and location of that generation project.

Low-growth Scenario

Under the Low-growth Scenario, long-term projects move beyond the 20-year planning horizon. All near-term projects remain, except for the 240 kV double-circuit line from Lamoureux to Deerland, which moves from the near term to the long term.

PLANNING REGION

5.6 Edmonton



OVERVIEW AND FORECAST

The Edmonton Planning Region contains the City of Edmonton, St. Albert, Sherwood Park, Spruce Grove, Leduc, Camrose and the Wabamun Lake area. It represents approximately 36 per cent of Alberta's population.

This region represents 20 per cent of Alberta's load, which has grown at an average annual rate of 1.9 per cent over the last decade. Over the next 20 years, load is forecast to grow at 2.1 per cent annually. The bulk of this growth is expected in the City of Edmonton area, driven primarily by residential, commercial and industrial development.

Generation in this region is primarily coal, in the Wabamun area. Some natural gas generation is located in the Edmonton area as well. Combined-cycle generation is expected in the next 20 years to provide baseload generation as coal units retire. Additional smaller technologies such as waste heat capture are also expected to develop.

5.6–1: Edmonton regional load and generation forecast

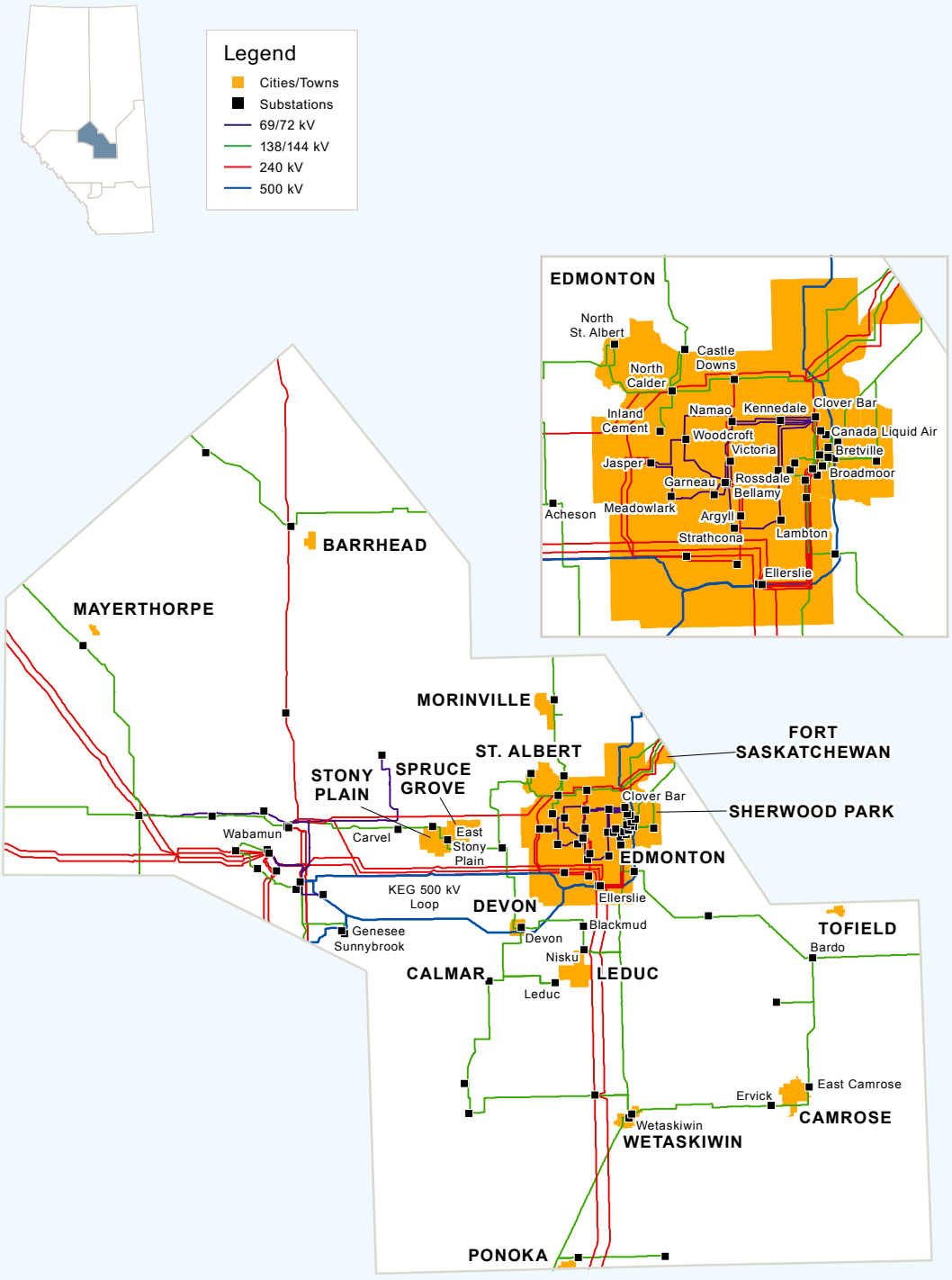
	Existing (MW)	2020 (MW)	2025 (MW)	2035 (MW)
Load at AIL Peak	2,185	2,467	2,739	3,207
Coal-fired	4,658	4,082	4,082	1,729
Cogeneration	39	39	39	39
Combined-cycle	0	900	900	3,300
Simple-cycle	250	250	250	250
Hydro	0	0	0	0
Wind	0	0	0	0
Other	0	0	0	158

5.6–2: Edmonton regional characteristics

2013 Average Load (MW)	1,579
2013 Summer Peak (MW)	2,167
2013/2014 Winter Peak (MW)	2,185
Population (000s)	1,411
Area (000 km^2)	22

5.6-3 EDMONTON PLANNING REGION

Existing transmission system



View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

EXISTING TRANSMISSION SYSTEM

Containing a large concentration of generation sources, the Edmonton Planning Region is the central transmission hub for the provincial transmission network, connecting the north and south AIES with transmission lines operating at 500 kV and 240 kV. These large bulk lines transfer power from the Edmonton Planning Region to the rest of the province.

Local load in this region is served by a transmission network consisting of 500 kV, 240 kV, 138 kV and 69/72 kV lines. A 500 kV loop between Wabamun and Edmonton feeds power from coal generating plants in Wabamun to the southeast corner of the city. The 72 kV system is wholly within the City of Edmonton and is dedicated to serving load within the city. The 138 kV system feeds load in the areas outside the City of Edmonton as well as the east industrial area.

MAJOR TRANSMISSION PROJECTS APPROVED AND/OR UNDER CONSTRUCTION

- **South and West of Edmonton Transmission Development**—Reinforcement of existing 138 kV load-serving loops to provide reliability in response to growing load
- **Fort McMurray West 500 kV Transmission Project**—A new 500 kV AC transmission line terminating at the Sunnybrook AC substation west of Edmonton
- **Western Alberta Transmission Line**—A new 500 kV HVDC transmission line terminating at the Sunnybrook DC converter station west of Edmonton

TRANSMISSION PLANS

The existing Edmonton Planning Region transmission system is currently experiencing a number of constraints. They are itemized by sub-region and can be found in the subsequent sub-region transmission plans.

West of Edmonton

This sub-region has a parallel path between 138 kV infrastructure and 240 kV infrastructure. In the near term, an outage of a 240 kV line will cause thermal overloads on the 138 kV lines as the power takes an alternate path.

Also in the near term, the placement of additional generation in the Wabamun 240 kV network prior to significant retirements of the existing coal plants will cause overloads on the 240 kV paths into the City of Edmonton.

In both the medium term and long term, load growth is expected to increase the severity of thermal overloads.

Long-term overloads are dependent on the location, magnitude and timing of generation additions and retirements. Development has been included below. However, the final configuration of developments will be addressed as generation retirements and additions become firmer, and as final connection alternatives are studied.

Timeframe	Development
Near-term	▪ Add new 138 kV transmission line from Acheson substation west of Edmonton to North St. Albert substation ▪ Open 138 kV line between Inland Cement tap in north Edmonton to North St. Albert substation
Medium-term	▪ None
Long-term	▪ Rebuild the 138 kV line from Acheson substation to Spruce Grove substation to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, long-term developments are moved beyond the 20-year planning horizon. The near-term projects remain.

City of Edmonton

In the near term, capacity of the transmission network in this sub-region is at the thermal limit of its ability to serve load. The system is being operated radially with normally opened points to manage the growing constraints. The underground cables in the City of Edmonton are aging and EPCOR Distribution and Transmission Inc.'s assessment of their condition has led to de-rates on some lines.

In both the medium term and long term, Edmonton 240 kV infrastructure is forecast to experience load growth, increasing the severity of thermal overloads.

In the long term, thermal overloads are expected on the 500/240 kV transformers in the Ellerslie substation, which transfers power from the 500 kV loop to the 240 kV lines to serve the city.

Timeframe	Development
Near-term	▪ Convert Hardisty substation in east Edmonton to 240/15 kV from 72/15 kV ▪ Add new 240 kV loop from Lambton substation in southeast Edmonton to Hardisty substation and onto Bellamy substation at Rossdale ▪ Discontinue use of 72 kV lines from Rossdale substation (Bellamy) to Strathcona substation to Lambton substation ▪ Replace existing 240/72 kV transformers at Clover Bar substation in northeast Edmonton with larger units ▪ Add new 240/72 kV substation near Namao in northeast, cut into 240 kV line between Castle Downs substation and Victoria substation on north edge of downtown Edmonton ▪ Add new 72 kV line from new substation to existing Namao substation ▪ Add new 240/72 kV transformer at Castle Downs substation in northeast ▪ Add new 72 kV transmission lines from Castle Downs substation to Kennedale substation, and onto Namao substation ▪ Discontinue use of 72 kV lines between Clover Bar and Hardisty substations, and Hardisty and Lambton substations ▪ Discontinue use of existing 72 kV lines that connect Clover Bar, Victoria, Namao, Kennedale, and Woodcroft substations ▪ Convert Victoria substation from 240/72/15 kV to 240/15 kV ▪ Add new 240 kV line from Victoria substation to Bellamy substation ▪ Discontinue use of 72 kV lines between Rossdale and Victoria substations

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Timeframe	Development
Medium-term	▪ Add new 72 kV line from new substation near Namao to Woodcroft substation west of Namao ▪ Discontinue use of 72 kV line from Rossdale to Woodcroft ▪ Rebuild 72 kV lines from Jasper substation in west Edmonton to Woodcroft, Jasper to Meadowlark south of Jasper, and Meadowlark to Garneau substation near University of Alberta to higher capacity
Long-term	▪ Add new 500/240 kV substation tapping West Fort McMurray 500 kV line north of Lake Wabamun ▪ Add new 240 kV line from new substation to North Calder substation in north Edmonton

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, long-term projects are not required. All near- and medium-term projects remain except for:

- Near-term Victoria substation development
- Addition of a new 240 kV line from Victoria substation to Bellamy substation
- Discontinuation of use of 72 kV lines between Rossdale and Victoria substations

East of Edmonton

In the near term, single-contingency outages in either the Edmonton or the Fort Saskatchewan area are expected to create thermal overloads on the 138 kV connections between these areas. There are also thermal overloads expected within the Edmonton area.

In both the medium and long terms, East of Edmonton infrastructure is forecast to experience load growth, increasing the severity of thermal overloads.

Timeframe	Development
Near-term	▪ Add new 240/138 kV substation near north edge of Edmonton/Strathcona refinery area ▪ Add new 138 kV transmission line from new substation to nearby Bretville substation ▪ Reconfigure 138 kV network in East Edmonton–Sherwood Park area ▪ Open 138 kV network between Edmonton and Fort Saskatchewan areas
Medium-term	▪ None
Long-term	▪ Rebuild 138 kV line from new substation above to nearby Canada Air Liquide substation, and on to Broadmoor substation in Sherwood Park to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario the following projects are moved beyond the 20-year planning horizon:

- Near-term—a new 138 kV transmission line from the new substation (north edge of the Edmonton/Strathcona refinery area) to Bretville
- Long-term—a 138 kV line from the new substation, to the Canada Liquide Air substation and on to the Broadmoor substation, to a higher capacity

All other near-term projects remain.

Wetaskiwin–Camrose

The Wetaskiwin–Camrose area is supplied by a long 138 kV loop. In the near term, local area load growth will result in thermal overloads on this loop.

In the medium and long terms, this sub-region is expected to also see voltage issues as well as increases in the near-term thermal overloads.

Timeframe	Development
Near-term	▪ Add voltage reinforcement at East Camrose substation ▪ Rebuild 138 kV line between Wetaskiwin substation and Ervick substation near Camrose to higher capacity ▪ Install high-side breaker at Wetaskiwin substation
Medium-term	▪ Rebuild 138 kV line between Saunders Lake substation near Nisku and Bardo substation southwest of Tofield to higher capacity ▪ Open 138 kV line between Bardo and North Holden substations
Long-term	▪ Rebuild 138 kV transmission line from East Camrose substation to Bardo substation to higher capacity ▪ Rebuild 138 kV transmission line from East Camrose substation to Ervick substation to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, all projects are moved beyond the 20-year planning horizon except for the installation of high-side breakers at Wetaskiwin substation, which moves from the near term to the medium term, and voltage reinforcement at the East Camrose substation which moves from the medium term to the long term.

North of Edmonton

This sub-region has a 240 kV path out of the Wabamun area, parallel with a 138 kV path from the City of Edmonton. In the near term, an outage of a 240 kV line will cause a thermal overload on 138 kV lines as the power takes the alternate path.

In both the medium and long terms, North of Edmonton infrastructure is forecast to experience load growth, increasing the severity of thermal overloads.

In the long term, this sub-region is expected to experience performance requirement violations as well as overloads.

Note: These issues overlap with Northwest and Northeast Planning Region issues. The mitigations for them, and corresponding Low-growth Scenario options, are addressed in those regional plans.

Leduc–Nisku–Devon

In the near term, the existing infrastructure is sufficient to supply local area load. However, the load in the Leduc–Nisku–Devon sub-region will outgrow the capacity of the long 138 kV loop that supplies this area in both the medium and long terms. This loop is expected to experience thermal overloads and performance requirement violations.

This area may experience strong growth as there are plans for increased development in the Nisku–Leduc industrial area and around the Edmonton International Airport.

Timeframe	Development
Near-term	▪ None
Medium-term	▪ Add new 138 kV transmission line from Saunders Lake substation near Nisku to Leduc substation
Long-term	▪ Rebuild 138 kV line between Devon, Blackmud (north edge of Nisku) and Nisku substations to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario the new 138 kV transmission line from the Saunders Lake substation to Leduc substation is delayed from the medium term to long term. The long-term project is still required.

Wabamun Load Loop

Wabamun load is supplied by a local area 138 kV loop. In both the medium and long terms, this sub-region is forecast to experience load growth exceeding the capacity of the 138 kV load loop and the 240 kV sources.

In the long term, the Wabamun Load Loop sub-region is expected to experience performance requirement violations.

Timeframe	Development
Near-term	▪ None
Medium-term	▪ Add second 240/138 kV transformer at Wabamun substation ▪ Rebuild 138 kV line from Wabamun substation to Carvel substation west of Stony Plain to higher capacity
Long-term	▪ Rebuild 138 kV line from Carvel substation to East Stony Plain substation to higher capacity ▪ Rebuild sections of 138 kV line between Harry Smith substation east of Spruce Grove and East Stony Plain substations to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario, all of the projects are moved beyond the 20-year planning horizon except for the second 240/138 kV transformer in the Wabamun substation, which is delayed from the medium term to the long term.

South of Edmonton

In the long term, load growth on the Leduc–Nisku–Devon and Wetaskiwin–Camrose loops is expected to overload the two 240 kV lines from the Ellerslie substation. There are no anticipated overloads in the near or medium term.

Timeframe	Development
Near-term	▪ None
Medium-term	▪ None
Long-term	▪ Rebuild two 240 kV lines from Ellerslie substation to Saunders Lake substation to higher capacity

View Single Line Diagrams (SLDs): ***www.aeso.ca/2015SLD***

Low-growth Scenario

Under the Low-growth Scenario all developments are moved beyond the 20-year planning horizon.

6.0 Glossary of terms

Glossary of terms

Alberta Interconnected Electric System (AIES): The system of interconnected transmission power lines and generators in Alberta.

Alberta Internal Load (AIL): The total electricity consumption within the province of Alberta including behind-the-fence (BTF) load, the City of Medicine Hat and losses (transmission and distribution).

Alternating current (AC): A current that flows alternately in one direction and then in the reverse direction. In North America, the standard for alternating current is 60 complete cycles each second. Cycles per second is also referred to as Hertz (Hz).

Ancillary services: Services necessary to support the transmission of energy from resources to loads while maintaining reliable operation of the transmission system in accordance with good utility practice.

Behind-the-fence load (BTF): Industrial load served in whole, or in part, by onsite generation built on the host's site.

Biomass: Organic matter that is used to produce synthetic fuels or is burned in its natural state to produce energy. Biomass fuels include wood waste, peat, manure, grain by-products and food processing wastes.

Bulk transmission system: The integrated system of transmission lines and substations that delivers electric power from major generating stations to load centres. The bulk system, which generally includes 500 kilovolt (kV) and 240 kV transmission lines and substations, also delivers/receives power to and from adjacent control areas.

Bus (busbar): Electrically conductive structures in a substation to which elements such as transformers or transmission lines are connected.

Capability: The maximum load that a generating unit, generating station or other electrical apparatus can carry under specified conditions for a given period of time without exceeding limits of temperature and stress.

Capacitor/capacitor bank: A device used to control voltages by eliminating a voltage drop in the system. Capacity: The amount of electric power delivered or required for a generator, turbine, transformer, transmission circuit, substation or system as rated by the manufacturer.

Carbon offset: A financial instrument representing a reduction in greenhouse gas (GHG) emissions.

Circuit: A conductor or a system of conductors through which electric current flows.

Cogeneration: The simultaneous production of electricity and another form of useful thermal energy used for industrial, commercial, heating or cooling purposes.

Combined-cycle: A system in which a gas turbine generates electricity and the waste heat is used to create steam to generate additional electricity using a steam turbine.

Conductor: A metallic wire or combination of wires through which electric current is intended to flow.

Congestion: The condition under which transactions that market participants wish to undertake are constrained by conditions on the transmission grid.

Constraint: A restriction on a transmission system or segment of a transmission system that may limit the ability to transmit power between various locations.

Control area: A defined region of the electricity grid for which supply and demand are kept in balance by the control area's system operator.

Converter station: A location where electric energy is converted to direct current (DC) from AC or vice versa.

Customer sectors: Types of electric load classified according to type of use. Four sectors commonly used are residential, commercial, farm and industrial.

Cutplanes: An imaginary line that cuts across the transmission lines that connect two or more areas. The loading on these lines is summed together to measure the power flow across the cutplane.

Demand (electric): The volume of electric energy delivered to or by a system, part of a system, or piece of equipment at a given instant or averaged over any designated period of time.

Demand transmission service (DTS): The service provided to loads for interconnection access to the Alberta transmission system.

De-rate: A reduction in a generating unit's or other piece of electric equipment's net capacity.

Direct current (DC): Current that flows continuously in the same direction (as opposed to AC). The current supplied from a battery is direct current.

Dispatch: The process by which a system operator directs the real-time operation of a supplier or a purchaser to cause a specified amount of electric energy to be provided to, or taken off of, the system.

Distributed generation: Small-scale power sources typically connected to a distribution system at customer locations.

Double circuit: A line of supporting structures that carries two power circuits.

Dynamic stability: The characteristic of a power system that, when disturbed from an original state through events such as short circuits, allows recovery to a normal state through damping of the oscillations generated by the disturbance events.

Emission intensity: The ratio of a specific emission (such as carbon dioxide) to a measure of energy output. For the electricity sector, emission intensity is usually expressed as emissions per megawatt hour (MWh) of electricity generated.

Frequency excursion: Any deviation, up or down, of the base frequency of a power system. In North America the base power system frequency is 60 Hertz (60 cycles per second).

Gas turbine: See simple-cycle.

Generating unit: Any combination of an electrical generator physically connected to reactor(s), boiler(s), combustion or wind turbine(s) or other prime mover(s) and operated together to produce electric power.

Geothermal energy: Where the prime mover is a turbine driven either by steam produced from hot water or by natural steam that derives its energy from heat found in rocks or fluids beneath the surface of the Earth.

Gigawatt (GW): One billion watts.

Gigawatt hour (GWh): One billion watt hours.

Greenfield: Land being considered for development that has not previously been used for commercial or industrial purposes.

Greenhouse gas (GHG) emissions: Gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect.

Grid: A system of interconnected power lines and generators that is operated as a unified whole to supply customers at various locations. Also known as a transmission system.

Gross domestic product (GDP): One of the measures of national income and output for a given country's economy. GDP is defined as the total market value of all final goods and services produced within the country in a given period of time (usually a calendar year). It is also considered as the sum of the value added at every stage of production (the intermediate stages) of all final goods and services produced within a country in a given period of time and is given a monetary value.

Heat rate: A measure of generating plant thermal efficiency generally expressed as units of energy input per unit of energy output.

High voltage direct current (HVDC): The transmission of electricity using direct current.

Independent system operator (ISO): A system and market operator that is independent of other market interests. In Alberta the entity that fulfils this role is the Alberta Electric System Operator.

Interconnection or transmission interconnection: An arrangement of electrical lines and/or transformers that provides an interconnection to the transmission system for a generator or large commercial or industrial customer.

Intertie: A transmission facility or facilities, usually transmission lines, that interconnect two adjacent control areas.

Levelized unit electricity cost (LUEC): The constant price required to cover all expenses incurred over the lifetime of a generating unit.

Load (electric): The electric power used by devices connected to an electric system.

Load factor: A measure of the average load, in kilowatts, supplied during a given period. It is generally used to determine the total amount of energy that would have been used if a given customer's maximum load was sustained over an extended period of time and, through comparison, show what percentage of potential load was actually used.

Looped system: A system of power lines in which circuits are contiguously connected between substations and then back to the same substation.

Megawatt (MW): One million watts.

Megawatt hour (MWh): One million watt hours.

Merchant transmission: Transmission line(s), constructed by proponents that are not regulated utilities, for the purpose of selling transmission capacity to third parties such as generators or load customers who wish to make transactions over the merchant transmission line.

Merit order: In the electricity wholesale market, merit order refers to the list used to dispatch electricity generation to meet demand. The lowest cost generation is dispatched first.

Meters or metering: Equipment that measures and registers the amount and direction of electrical quantities.

Needs Identification Document (NID): A document filed by the AESO with the Alberta Utilities Commission (AUC) to define the need to reinforce the transmission system to meet load growth and/or provide non-discriminatory access to interconnect new loads and generators to the system.

Non-wires solution: Refers to a solution to address transmission reliability issues that do not include the construction or upgrading of physical transmission infrastructure. One common example is "transmission must-run."

Nuclear generation: Where heat produced in a reactor by the fissioning of nuclear fuel is used to create steam in a boiler. This steam is then used to drive a turbine, which in turn drives the electric generator.

Offset: See carbon offset.

Operating reserve: Generating capacity that is held in reserve for system operations and can be brought online within a short period of time to respond to a contingency. Operating reserve may be provided by generation that is already online (synchronized) and loaded to less than its maximum output and is available to serve customer demand almost immediately. Operating reserve may also be provided by interruptible load.

Parallel path: Electric power flows on all interconnected parallel paths in amounts inversely proportional to each path's resistance. This also refers to the flow of electric power on one electric system's transmission facilities resulting from scheduled electric power transfers between other electric systems.

Peak load/demand: The maximum power demand (load) registered by a customer or a group of customers or a system in a stated period of time. The value may be the maximum instantaneous load or, more usually, the average load over a designated interval of time such as one hour, and is normally stated in kilowatts or megawatts.

Peaking capacity: The capacity of generating equipment normally reserved for operation during hours of the highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity, and at other times to serve loads on an around-the-clock basis.

Point-of-delivery (POD): Point(s) for interconnection on the transmission facility owner's (TFO) system where capacity and/or energy is made available to the end-use customer.

Power pool: An independent, central, open-access entity that functions as a spot market, matching demand with the lowest-cost supply to establish an hourly pool price.

Reactive power: The component of electric power that does not provide real work but is required to provide voltage.

Reliability: The combined adequacy and security of an electric system. Adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of customers at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system facilities.

Reliability criteria: A set of tests against which the operation of a power system is measured to ensure acceptable performance.

Reserve margin: The percentage of installed capacity exceeding the expected peak demand during a specified period.

Simple-cycle: Where a gas turbine is the prime mover in a plant. A gas turbine consisting typically of one or more combustion chambers where liquid or gaseous fuel is burned. The hot gases are passed to the turbine where they expand, driving the turbine that in turn drives the generator.

Single circuit: A transmission line where one circuit is carried on a set of structures (poles or lattice towers).

Solar (power): A process that produces electricity by converting solar radiation to electricity or to thermal energy to produce steam to drive a turbine.

Static var compensator (SVC): An electrical device for providing fast-acting reactive power compensation on electricity networks.

Substation/switching station: A facility where equipment is used to tie together two or more electric circuits through switches (circuit breakers). The switches are selectively arranged to permit a circuit to be disconnected or to change the electric connection between the circuits.

Supply transmission service (STS): The service provided to generators for interconnection access to the Alberta transmission system.

Tap: A point of connection along a transmission line between substations.

Tarrif (Transmission): The terms and conditions under which transmission services are provided, including the rates or charges that users must pay.

Thermal overload: A condition where the thermal limit of a piece of electrical equipment such as a conductor or transformer is exceeded.

Transfer capability: The measure of the ability of interconnected electric systems to move or transfer power in a reliable manner from one area to another over all transmission lines (or paths) between those areas under specified system conditions. The units of transfer capability can be expressed in megawatts.

Transformer: An electrical device for changing the voltage of alternating current.

Transmission: The transfer of electricity over a group of interconnected lines and associated equipment, between points of supply and points at which it is transformed for delivery to consumers or is delivered to other electric systems.

Transmission facility owner (TFO): The owner of the system of high-voltage power lines and equipment that links generating units to large customer loads and to distribution systems.

Transmission losses: Energy that is lost through the process of transmitting electricity.

Transmission must-run (TMR): A generator required to operate at a minimum specified output level to maintain system reliability in the event of an outage to certain transmission system elements.

Transmission path: One or more transmission lines that form the transmission connection between two points on the system.

Transmission system (electric): An interconnected group of electric transmission lines and associated equipment for moving or transferring electricity in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers or is delivered to other electric systems.

Voltage: The difference of electrical potential between two points of an electrical circuit expressed in volts. It is the measurement of the potential for an electric field to cause an electric current in an electrical conductor. Depending on the amount of difference of electrical potential, it is referred to as extra low voltage, low voltage, high voltage or extra high voltage.

Voltage stability: Operation within acceptable voltage ranges. Normal voltage limits are defined as the operating voltage range on the interconnected system that is acceptable on a sustained basis. Emergency voltage limits are defined as the operating voltage range on the interconnected system that is acceptable for the time sufficient for system adjustments to be made following a facility outage or system disturbance.

Voltage violation: A measured or calculated condition where the voltage at a point on the transmission system is outside the acceptable limits as described in the criteria.

Watt: The unit of power equal to one joule of energy per second. It measures a rate of energy conversion. A typical household incandescent light bulb uses electrical energy at a rate of 25 to 100 watts.

Watt hour (Wh): An electrical energy unit of measure equal to one watt of power supplied to or taken from an electric circuit steadily for one hour.

Western Electricity Coordinating Council (WECC): An organization formed to coordinate and promote electric system reliability for the system that interconnects Alberta, B.C., 14 western U.S. states and part of one Mexican state.

Errata

On November 12, 2015, the AESO posted the *2015 Long-term Transmission Plan* on ***www.aeso.ca*** and filed copies for information with both the Minister of Energy and the Alberta Utilities Commission, in accordance with the AESO's statutory obligations as defined in Section 33(1) of the *Electric Utilities Act* and sections 10(1) and 10(2) of the *Transmission Regulation*.

The following corrections were identified subsequent to November 12, 2015:

Description	Page	Correction	Date
Text change to table "City of Calgary" Timeframe: Near-term, first bullet	39	"northeast" is replaced with "northwest"	Nov 19, 2015
Text change to table "Cold Lake" Timeframe: Near-term, first bullet	45	"None" is replaced with "Add voltage reinforcement in the Cold Lake area"	Nov 19, 2015
Text change to table "Fort McMurray" Timeframe: Medium-term – new bullet inserted	56	"Add new 144 kV line from Ruth Lake substation to Parsons Creek substation" (inserted into table as third bullet)	Nov 19, 2015

Alberta Electric System Operator
2500, 330-5th Avenue SW
Calgary, AB T2P 0L4
Phone: 403-539-2450
Fax: 403-539-2949
www.aeso.ca
www.poweringalberta.ca
@theaeso

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