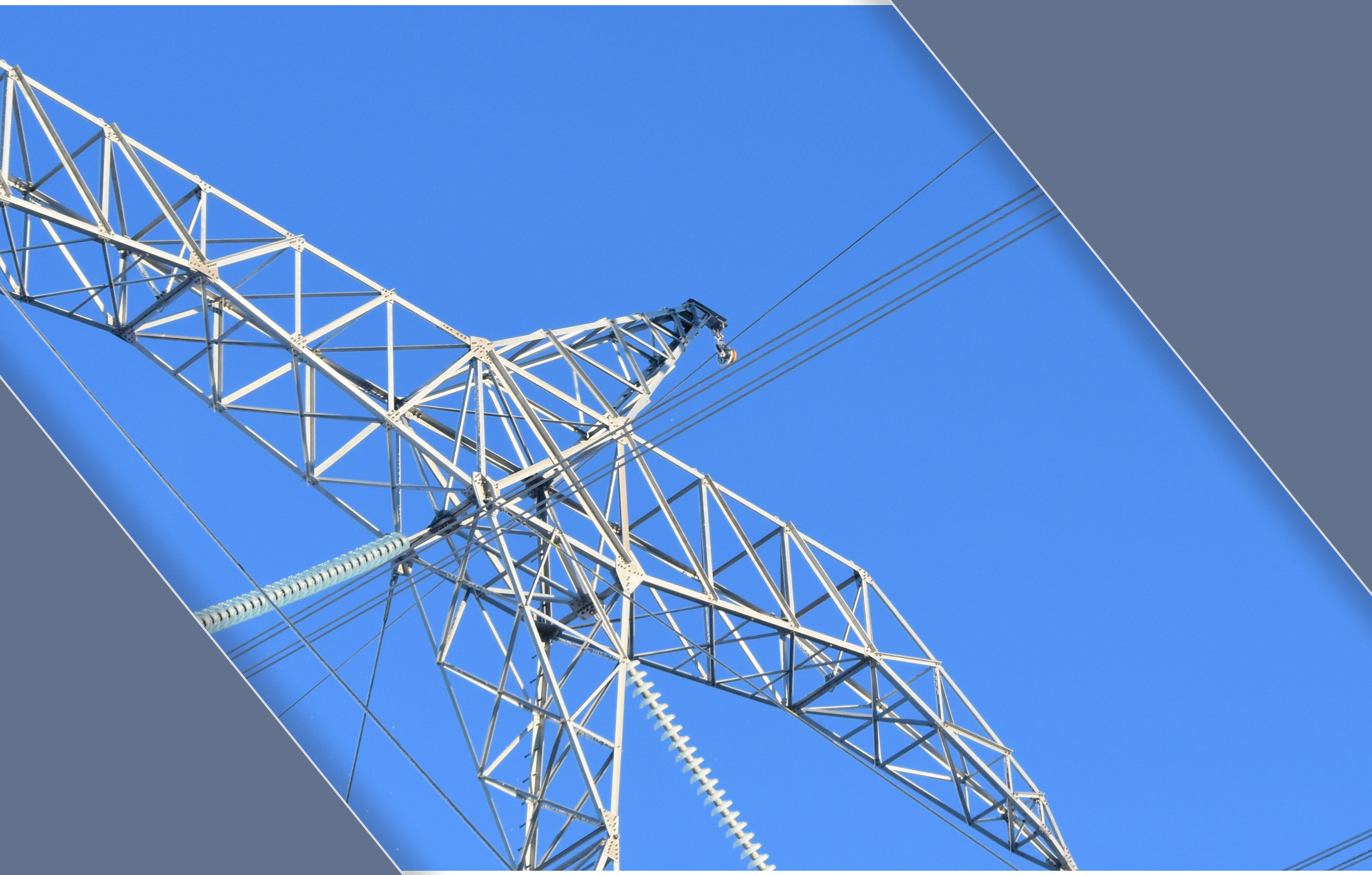


AESO 2020 Telecommunication Long-term Plan

JANUARY 2020

Contents

1.0 Executive summary

The *AESO 2020 Telecommunication Long-term Plan* (2020 Telecommunication LTP) provides the background, environment update, plan development and high-level plan for the utility telecommunication network used for the operation of the Alberta Interconnected Electric System (AIES). While there have been some changes and additions, this 2020 Telecommunication LTP is primarily an update of the AESO *2017 Telecommunication Long-term Plan*.

The utility telecommunication network will play an increasing role in the safe, reliable and economic operation of the AIES. Distributed energy resources (DER) and non-wire solutions will likely be key drivers, among other identified drivers, that will increase the role of the utility telecommunication network.

This 2020 Telecommunication LTP outlines possible projects that will improve and strengthen the reliability and availability of the utility telecommunication network, and therefore the transmission system. Particular focus was placed on opportunities to leverage existing or planned utility infrastructure to maximize benefit and minimize cost. In general, the telecommunication capital cost component represents one to five per cent of a transmission system upgrade or expansion. The possible projects described primarily focus on three areas of the province: the northwest, central, and south.

2.0 Background

2.1 ROLE OF THE AESO

The AESO is mandated through legislation to operate the AIES in a safe, reliable and economic manner, and to plan a transmission system that meets electricity demand today and in the future. The utility telecommunication network represents a key component of the overall transmission system.

2.2 PURPOSE OF THE UTILITY TELECOMMUNICATION NETWORK

The utility telecommunication network carries critical telecommunication services that are used to protect, monitor and control the transmission system. It helps quickly isolate faulted elements to maintain system stability and to protect equipment from unnecessary damage. It also allows transmission system operators to respond to changes in the system and take corrective action as needed. Outages on the utility telecommunication network can require outages on the transmission system. These critical telecommunication services require the utility telecommunication network to be highly reliable and have appropriate capacity.

The utility telecommunication network can also enable transmission facility owners (TFOs) to remotely monitor the condition of key equipment, remotely collect information for faster troubleshooting, and more effectively manage utility assets. As more devices become capable of providing information, the telecommunication network will be leveraged further and provide even more value to the AIES.

2.3 KEY BENEFITS OF THE UTILITY TELECOMMUNICATION NETWORK

- Enables coordinated monitoring, control and operation of the transmission system.
- Enables larger power flows on transmission lines by facilitating faster fault-clearing times.
- Enables the connection of additional and diverse generation on existing transmission lines.
- Enables the connection of additional load on existing transmission lines.
- Provides emergency voice and data telecommunication for effective power system restoration.

2.4 PRIVATE UTILITY TELECOMMUNICATION NETWORK

The utility telecommunication network is privately owned and operated by the TFOs. Utility telecommunication requires low communication latency, needs to be highly reliable, and must be available and functional under all (including during severe) operating conditions.

Some transmission telecom services can be provided by external telecommunication companies (telcos); however, for critical transmission services, being dependent on telco networks can be challenging due to their restoration times, service availability in remote areas, and backup power system capacity.

Additional challenges include traffic prioritization, communication latency, information security and the designed equipment performance. In some cases, telcos can meet the requirements for critical services but the cost can be expensive and this level of service is typically only available in dense urban areas.

3.0 Telecommunication environment update

3.1 TELECOMMUNICATION EQUIPMENT EVOLUTION

The standard telecommunication equipment and technology available to utilities has evolved. The equipment that controls the flow of traffic across the communication network (multiplexers or routers) is now more commonly packet based. This shift is due to the much larger equipment demand from telcos providing packet-based internet, data, and phone services. The legacy equipment and technologies are becoming harder to procure and support. As a result, many utilities are transitioning to packet-based technologies.

The benefits of packet-based telecommunication will continue to increase as more substation equipment evolves to packet communication. Packet-based networks are capable of enabling more flexible networks and more complex protection schemes. A challenge for utilities will be the increased impact and frequency of telecommunication planned outages associated with newer equipment, the impact of which will depend on a network's topology and designed secondary paths. Ultimately, the move to packet technology must be balanced with the risk of staying with a system and technology that is increasingly difficult to support and maintain.

3.2 DEPENDENCE ON TELECOMMUNICATION

Dependence on the utility telecommunication network for reliability and availability of the transmission system continues to grow.

In addition to the standard critical services needed for operation and protection of the transmission system, non-wires solutions involving telecommunication are being deployed more frequently. These alternative solutions are used for new connection projects, system-driven projects, and operational challenges. The telecommunication network is being used to address system congestion and protection mis-coordination, provide risk mitigation and automatic system stabilization, and prevent islanding or other undesirable system conditions. The primary drivers for leveraging telecommunication in this way are reduced costs, higher usage of existing transmission assets, fewer new transmission line builds, and denser connection of generation which may involve tapping into existing transmission lines.

The telecommunication network is also being leveraged further to carry more accurate real-time information using phasor measurement units, and to provide more accurate generation forecast data for the growing variable generation sources such as solar and wind. Inverter-based generation sources, including batteries, solar and wind (which have little inertia but fast response) may change: how quickly the system needs to respond; increase the amount of situational awareness needed across the system; and/or expand the use of automated control dependent on telecommunication. As the existing transmission system carries more power and the telecommunication network is leveraged further, the impact of telecommunication outages on the transmission system and challenges in scheduling outages will continue to increase. Therefore, the importance of having a reliable utility telecommunication network and implementing prudent telecommunication secondary paths is only expected to increase.

3.2.1 Increased role of the distribution system

The distribution system has been changing and evolving. Current trends suggest the role of the distribution system in the stable and reliable operation of the AIES will continue to increase. Telecommunication will be required to manage and support this increased role. The flow of information is expected to shift such that more data from the distribution system is needed in real time by the transmission system. The following areas present the drivers for the distribution system's increasing role.

3.2.1.1 Distributed energy resources (DER)

Distributed energy resources are generation resources connected to the electric distribution system. The overall cost of this generation, typically wind or solar, is expected to continue dropping and the deployment to continue increasing based on both economic and social drivers. Individually, one generator has little impact on the overall system but, as a group, they could become a significant percentage of overall generation in the province. This will have an impact on power flows, generation forecasting, system voltage and frequency balance, reliability, and system restoration. Telecommunication will likely be required to effectively monitor and control this growing generation source. Larger wind and solar sources are most often placed in remote rural areas where telecommunication can be a challenge. The future minimum telecommunication requirements for DER are still to be determined.

3.2.1.2 Distribution capabilities

The distribution facility owners (DFOs) have an increasing demand for telecommunication as they deploy new applications, and require more visibility and control of the distribution system. Many of these new applications increase their operational capabilities and present benefits to the overall electrical system. Applications such as distribution automation, demand response, and supervisory control and data acquisition (SCADA) make the distribution system more flexible and dynamic, resulting in improved system reliability. The transmission utility telecommunication network could be further leveraged to help support these new applications, in particular for rural areas where telecommunication access and reliability may be a challenge, and where the possible duplication of telecommunication infrastructure can be avoided. Leveraging the same highly reliable telecommunication network will also support the expected increased data flow between the distribution system and the transmission system control centers.

3.2.2 Market participant access

Most market participants, such as generators connecting to the transmission system or, in some cases, the distribution system, are required to establish communication with the AESO (SCADA, operational data, and operational voice) and their interconnecting TFO (teleprotection, SCADA, operational voice). The utility telecommunication network is an option for market participants to carry these services.
The cost to connect into the utility telecommunication network is paid for by the market participant. The AESO supports the services being carried on the utility telecommunication network as a highly available network built, paid for, and maintained for the purposes of operating the AIES.

3.2.3 Hybrid/low-capacity radio

Hybrid/low-capacity radio deployment is recommended for application with remedial action schemes (RAS), breaker failure, and transfer trip for last-mile connections that have slower latency requirements. The AESO encourages the deployment of low-capacity radio setups which are composed of a mix of licensed low-capacity UHF radios and unlicensed spread spectrum radios being applied in parallel to produce the necessary availability.

4.0 Telecommunication plan development

4.1 TELECOMMUNICATION PLANNING PROCESS

The telecommunication network is planned in coordination between the AESO and TFOs. A telecommunication work group is in place with the major TFOs and DFOs (AltaLink, ATCO, ENMAX, EPCOR and FortisAlberta) in the province. As the operators and primary planners of their utility telecommunication networks, the workgroup supports the AESO in creating the wider telecommunication long-term plan. The AESO's role in telecommunication planning at the provincial level is to: lead coordinated planning between the utilities; provide long-term direction; identify inter-organizational opportunities; and determine the need for key telecommunication projects.

In developing the 2020 Telecommunication LTP, the AESO evaluated the current and future needs for the utility telecommunication network. The telecommunication long-term plan is developed to align with the long-term transmission plan, which is a major driver of new telecommunication development and opportunities.

The compiled list of telecommunication projects and needs have been reviewed by the AESO and stakeholders. A high-level evaluation of the cost versus benefit is considered for all the outlined telecommunication projects. As per the standard process, individual business cases and justification documents are still required to support the execution and determine the specific timing of the outlined telecommunication projects.

4.2 TELECOMMUNICATION PLANNING GUIDELINES

In planning the utility telecommunication network, the critical and core services remain the primary drivers for technology selection, bandwidth capacity sizing, and secondary paths (network topology). These services include teleprotection, SCADA, inter-control-centre communication protocol, voice communication and mobile land radio communication. Other services can be considered based on the benefit for the system.

4.2.1 Secondary paths

Similar to the electric transmission system, the reliability and availability of critical telecommunication services is dramatically improved by having adequate secondary paths on the telecommunication network. Hardware redundancy is implemented as deemed necessary by the utilities, guarding against some single points of failure and reducing the impact of both planned and unplanned telecommunication outages on the transmission system. Secondary paths used to form ring topologies are the ideal solution, eliminating most single points of failure.

Telecommunication planning efforts focus on opportunities for establishing secondary paths and rings, which require small amounts of additional infrastructure. The 2020 Telecommunication LTP attempts to identify secondary paths possible in the near, medium, and long terms, leveraging existing and planned telecommunication. Identifying these potential secondary paths will ensure that opportunities for these improvements, in particular those associated with transmission line builds, are not missed. Planning considerations for secondary paths include bandwidth capacity, path length (communication latency), and the number and criticality of services improved.

4.2.2 Bandwidth capacity

The bandwidth capacity needed for the utility telecommunication network is growing as more devices are contributing data. Technology evolution is contributing to higher minimum bandwidth levels in some scenarios. It is recommended for secondary paths involving inter-utility exchange that, where prudent, the telecommunication links used have a minimum capacity of 150 megabits per second (Mbps), such that a minimum 50 Mbps can be exchanged. Adequate bandwidth capacity ensures communication latency, traffic prioritization, and that capacity bottlenecks do not restrict the functionality of the secondary paths. In terms of bandwidth capacity, fibre is still preferred—providing links of one gigabit per second (Gbps) and 10 Gbps capacity. Even higher bandwidth capacity is possible using the same fibre with specialized optical equipment.

4.2.3 Fibre deployment

Deployment of optical ground wire (OPGW), which is optical fibre contained within the transmission line overhead ground wire, on all new and rebuilt transmission lines (240 kV and higher) continues to be a very cost-effective way of deploying utility telecommunication that meets the needs of today and the future. The addition of OPGW on a transmission line typically represents a less-than-two per cent increase to the project cost. Fibre deployments, including OPGW, provide large bandwidth capacity that is immune to the atmospheric interference that impacts microwave radio. Leveraging multiple fibre pairs found in a typical fibre cable with redundant hardware, results in fewer single points of failure, increased reliability, and reduced impact of planned and unplanned telecommunication outages.

OPGW deployments can also provide relatively inexpensive telecommunication for new connections when the tapped line has OPGW. The tapping of existing transmission lines is becoming more common as the existing transmission assets are further leveraged. In many cases, telecommunication is a requirement for permitting a tapped connection.

The continued deployment of OPGW is recommended on all new transmission lines (240 kV and higher), and deployment on new 138/144 kV lines will continue to be considered, especially in areas where taps are expected in the future.

4.2.4 Microwave radio deployment

Microwave radio continues to be extensively used by the regional TFOs. While fibre has advantages, microwave radio will continue to be depended upon, and deployed on the network where it is both practical and economical. The telecommunication towers required by microwave radio represent the most significant cost in the deployment of additional microwave radio. Leveraging the existing telecommunication towers or upgrading the bandwidth capacity of existing microwave radios is a cost-effective method of creating new secondary paths or enabling the effective exchange of secondary paths.

5.0 Telecommunication plan

5.1 TELECOMMUNICATION RELIABILITY IMPROVEMENTS

Projects in the 2020 Telecommunication LTP have been selected to significantly reduce both planned and unplanned outages on the telecommunication network, and therefore improve the overall reliability and availability of the transmission system. Particular focus is placed on improvements to the 500 kV and 240 kV transmission systems. As per the standard process, individual business cases and justification documents are still required to support the execution and determine the required timing of the outlined telecommunication projects.

The 2020 Telecommunication LTP highlights key projects in the northwest, central, and south areas of the telecommunication network for the near-term (five year) and medium-term (ten year) time periods. When applicable, project alternatives are also outlined. The selected projects follow the outlined planning guidelines and, where possible, leverage existing telecommunication infrastructure.

5.1.1 Northwest area

5.1.1.1 Fort McMurray West 500 kV OPGW (near term)

The constructed Fort McMurray West 500 kV transmission line presents an opportunity to improve telecommunication for existing transmission facilities in the vicinity of the line using the available spare fibre contained within the OPGW. In addition to the three 500 kV line terminal substations, five 240 kV substations can be connected to the OPGW fibre. This fibre will provide a high-capacity, secondary connection for the northwest interconnection between AltaLink and ATCO leading all the way into the northeast, and provide secondary paths for more than eleven 240 kV teleprotection services, thereby improving the overall system reliability in these areas.

5.1.1.2 Northwest fibre (near term)

A fibre linking the Fox Creek area to the Wabamun and/or Edmonton areas, in conjunction with planned transmission development linking the Hinton/Edson and Valleyview areas to the Fox Creek area, and fibre already procured from the Grande Prairie area to the Fox Creek area, would tie the fibre across all those areas to the backbone fibre network. The benefits of such a connection would be high-capacity backhaul from the northwest including the City of Grande Prairie, increased system reliability in the region, secondary paths with low communication latency for five additional 240 kV lines, and a northwest interconnection between the AltaLink and ATCO networks.

5.1.2 Central area

5.1.2.1 EATL fibre connection (near term)

The existing Eastern Alberta Transmission Line (EATL) fibre can be leveraged with a mid-point connection to ATCO's backbone microwave radio network to provide lower communication latency secondary paths for the teleprotection of three or four 240 kV transmission lines. A midpoint connection could provide EATL a secondary fibre path that is independent of the four EATL optical repeater sites. Additionally, with the central backbone interconnection (see further details in section 5.1.2.2) it can provide a central fibre link between the AltaLink and ATCO fibre and microwave backbones.

5.1.2.2 Central backbone interconnection (near term)

A high-capacity interconnection between AltaLink and ATCO is recommended for the central area of the province. This interconnection would create several secondary paths with low latency and enable unconstrained exchange of services between AltaLink and ATCO by connecting their backbone networks.

Option 1: A fibre connection from the Red Deer area to the Battle River area would connect the EATL and Western Alberta Transmission Line (WATL) fibre at the midpoint in the province, completing a fibre ring up to Edmonton and potential for a future ring to Calgary. Fibre is preferred based on its immunity to atmospheric interference, multiple links possible from a fibre bundle, and higher bandwidth capacity. One planned transmission project within the *AESO 2020 Long-term Transmission Plan* (2020 LTP) will provide OPGW between the areas needed to support this option.

Option 2: A microwave radio connection between the AltaLink and ATCO backbone networks is possible by upgrading the bandwidth capacity of two radio links. While less expensive, this option doesn't provide the same capability and future potential as the fibre option possible given planned transmission development.

5.1.3 South area

5.1.3.1 South backbone interconnection (medium term)

A larger-capacity interconnection between AltaLink and ATCO is recommended for the south area of the province. This interconnection would create several secondary paths with low communication latency and enable unconstrained exchange of services between AltaLink and ATCO by connecting their backbone networks in the south.

Option 1: A microwave radio connection between the AltaLink and ATCO backbone networks is possible by upgrading the bandwidth capacity of one radio link. This less-expensive option will enable the needed functionality in the medium term, but doesn't have as much future potential as the fibre option.

Option 2: Given no planned transmission projects that would provide OPGW between the Blackie or High River area to the Brooks area, this option is not supported but included as a long-term desired state. A fibre linking the EATL and WATL fibres would complete the southern end of fibre ring(s) that would strengthen overall network reliability.

5.2 AESO 2020 LONG-TERM TRANSMISSION PLAN

The 2020 LTP highlights planned transmission system development in the near-, medium-, and long-term (20-year) time periods. Some of the planned transmission is mentioned previously as it directly supports identified telecommunication reliability improvements. For the following near-term transmission development from the Reference Case, OPGW deployment will have significant benefit potential. In addition to providing necessary telecommunication for the planned transmission line, other benefits include secondary paths with low communication latency for transmission lines (240 kV and higher), overall improved telecommunication reliability, and increased bandwidth capacity.

5.2.1 Northwest Planning Region

Development	Timing
Little Smoky 813S to Fox Creek 741S	Near term
Fox Creek 741S to Bickerdike 39S	Near term
Clairmont Lake 811S to New 9L11 Substation	Near term

5.2.2 Central Planning Region

Development	Timing
Tinchebray 972S to Gaetz 87S	Near term

5.2.3 South Planning Region

Development	Timing
Chapel Rock 491S to Pincher Creek Area	Near term
Tilley 498S to 1034L Tap	Near term

Note: the preceding lists focus on the 2020 LTP Reference Case, and on wider regional benefits which excludes the planned transmission lines within the Cities of Edmonton and Calgary. Other planned transmission lines may also be deployed with OPGW depending on the cost and benefits upon further investigation. For full details on planned transmission, please refer to the complete AESO 2020 LTP at www.aeso.ca/grid/LTP.

5.3 LIST OF OTHER TELECOMMUNICATION INITIATIVES

5.3.1 Private utility voice communications

Direct-voice communication over the utility telecommunication network between the major transmission and generation control and operation centres has been included in the proposed ISO Rule 502.17, *Voice Communication*. This direct-voice communication will ensure effective and unimpeded backup voice communication, monitored and controlled by the utilities between critical parties, in the event of a significant blackout and subsequent restoration event. Several generators already leverage voice communication over the utility telecommunication and the AESO proposes the addition of other key generators to the system. Satellite phone backups work well for localized events, but are an ineffective backup when many parties need to communicate and coordinate quickly.

5.3.2 Private utility data communications

SCADA information is critical for the monitoring, situational awareness, and control of the AIES. Improving SCADA information exchange to the AESO and between the major transmission control and operation centers is being investigated. The utility telecommunication network, over which the utilities have monitoring and restoration control, can be further leveraged for this purpose. Key generation control and operation centers could be also included to improve overall system reliability and emergency preparedness.

5.3.3 Distributed energy resource communication

Both the AESO and the DFOs will likely require an increasing amount of information and control of DER in the future. The telecommunication requirements will likely vary depending on the size and type of DER. Depending on these yet-to-be-defined telecommunication requirements for DER, a number of telecommunication options may be possible. The following are a few options with a brief description of the impact to the utility telecommunication network. Note: a combination of these options may also be the right solution.

Option 1: The most economical solution for DER will likely continue to be provided by the telco providers over the internet and/or a leased virtual private network. This option could see large amounts of generation visibility and control operating over the telco network. The AESO would consider using a series of regional collection points and the utility telecommunication network to mitigate the risk of complete visibility and control loss.

Option 2: Have DER deploy appropriate telecommunication to direct-connect with the utility telecommunication network. This may be cost prohibitive for smaller DER installations, and availability may depend on proximity to existing infrastructure. The AESO would consider the additional use of unlicensed spread-spectrum radios or other lower-cost radio solutions.

Option 3: Deploy a private field-area network, operated by the utilities, to provide blanketed coverage of dense DER regions. This would require a significant investment but may be justified based on the future defined telecommunication requirements, and the density/number of DER installations. This option may provide high reliability while keeping the terminal equipment costs affordable for smaller DER installations. This option would require an analysis of the potential technologies, the forecasted DER demand, and the cost comparison with other options.

5.3.4 Mobile radio system upgrade

The mobile radio system is critical for the safe day-to-day operation of the transmission and distribution system in remote areas of the province. A mobile radio system is necessary for coordination of field resources in the event of a significant blackout or disaster event in which the telco system may go down.

During the 2013 floods, telco communications were knocked out for the Canmore region and the mobile radio system was critical to restoration efforts and coordination between distribution, transmission, and generation for the region. During a significant blackout, voice communication enables the effective and fast restoration of the electrical system. Several Alberta electric utilities are looking to refresh their current legacy systems, which face obsolescence and the potential of increased failure rates. Those electric utilities are evaluating mobile radio system technologies, network topologies, and interoperability.

One possibility that continues to be explored is use of the Alberta First Responders Radio Communications System (AFRRCS), built by the Government of Alberta using the public safety frequency band. AFRRCS has the potential to meet the needs of the electric utilities, but has challenges around access and licensing for utilities in the public safety frequency band.

5.3.5 DFO-to-TFO control centre communication

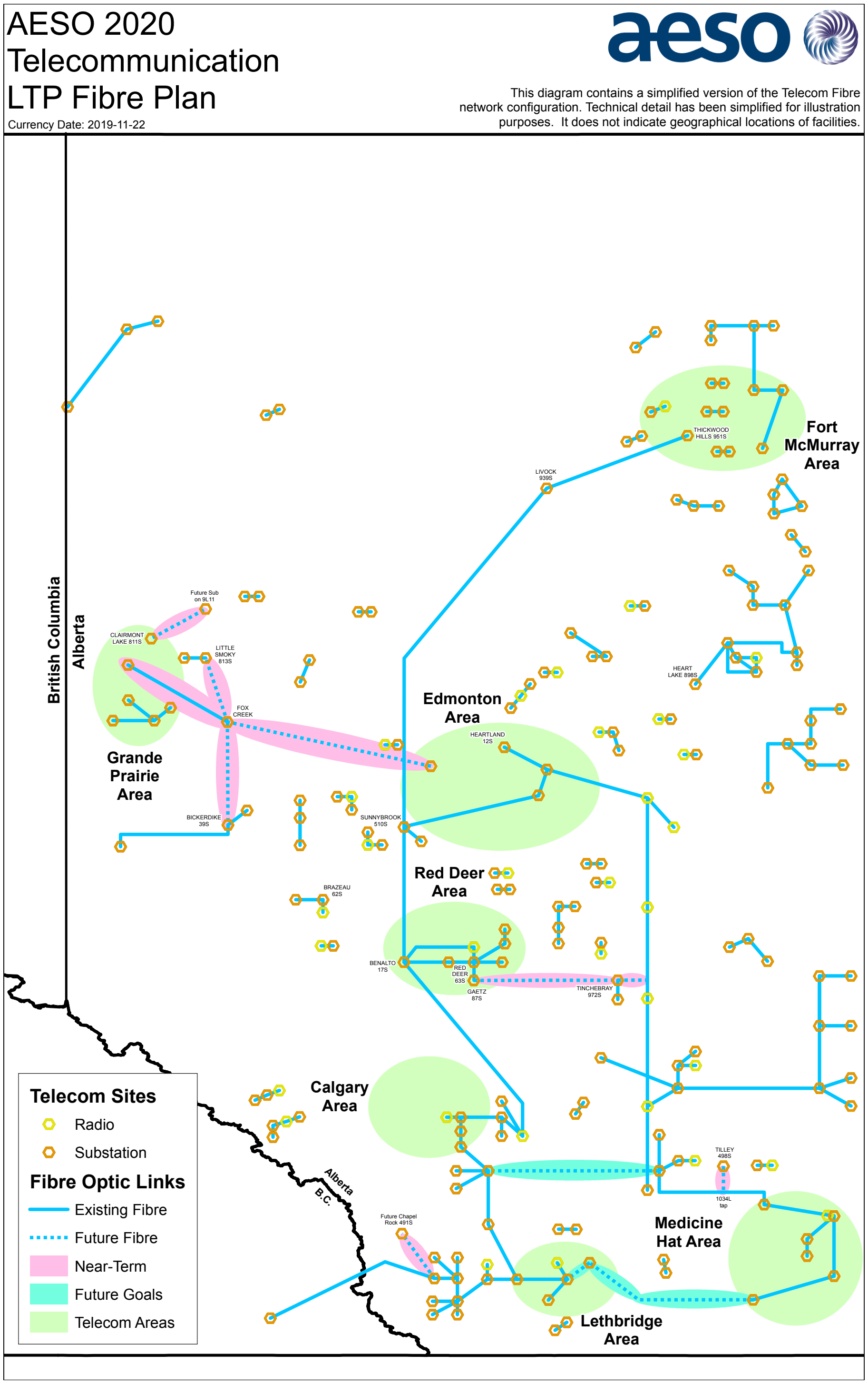
The data traffic between control centres of FortisAlberta and AltaLink currently depends on leased telco services. The AESO will investigate using existing telecommunication infrastructure to transition a connection between these control centres onto the utility telecommunication network. Most other major TFOs and associated DFOs have direct communication, as they typically reside in the same building. Further reinforcement between these control centres may also be investigated. The communication between the AESO, TFOs, and DFOs is essential and of growing importance to daily operations and emergency restoration.

5.3.6 Emergency restoration planning

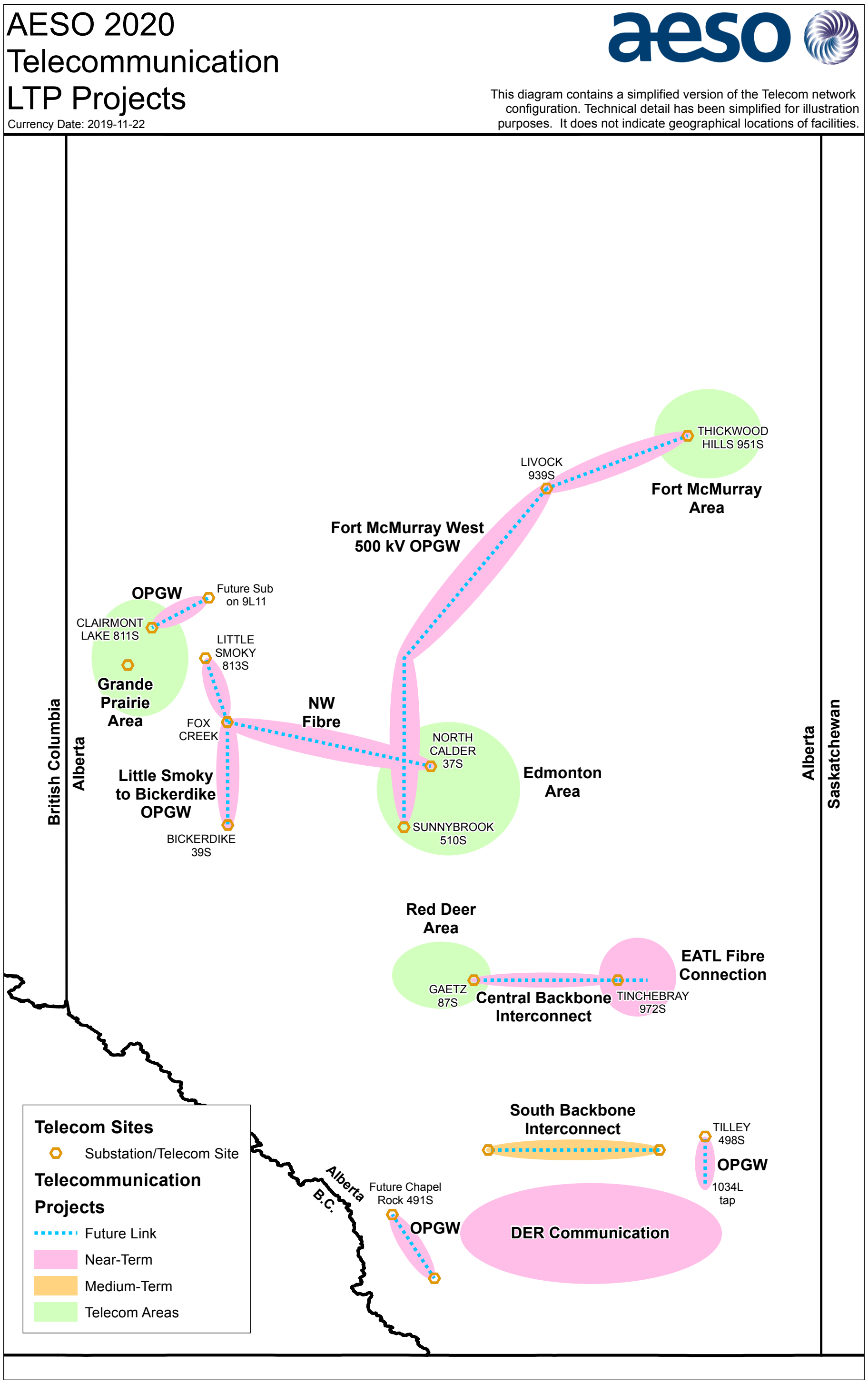
The AESO and the Telecommunication Work Group are acting to ensure emergency restoration plans have adequate telecommunication information and consideration. In the event of a large-scale outage, telecommunication is essential to the effective and fast restoration of power.

6.0 Appendices

6.1 FIBRE PLAN TIMELINE MAP



6.2 PROJECT DEVELOPMENT PLAN MAP



Alberta Electric System Operator

2500, 330-5th Avenue SW
Calgary, AB T2P 0L4
Phone: 403-539-2450
www.aeso.ca