Notice

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AESO Transmission Projects Information Session

October 3, 2019

Agenda

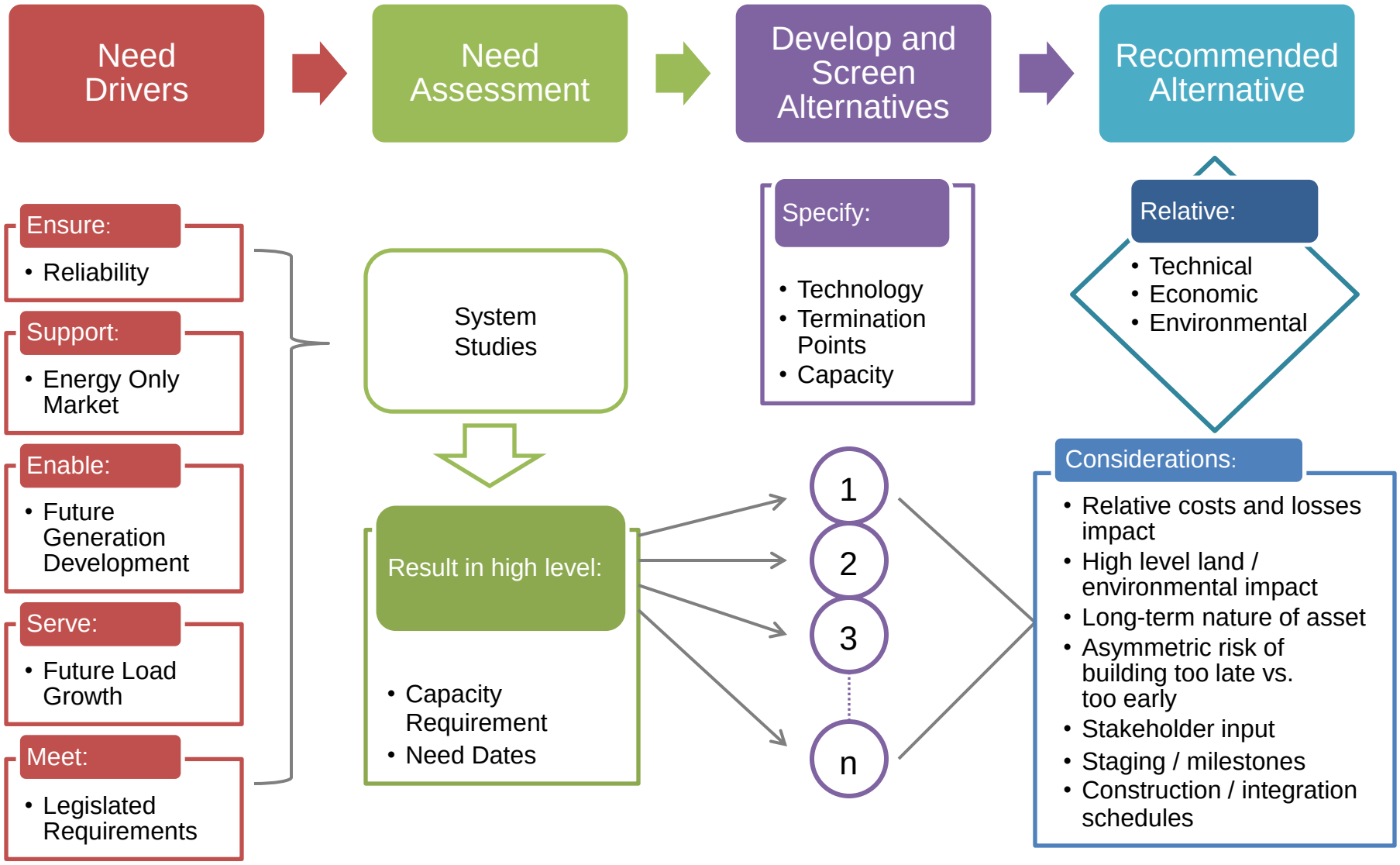
- Welcome and introductions
- Transmission Planning and Regulatory Process
- Alberta–British Columbia Intertie Restoration (AIR)
- Question and answer (Q&A) period
- Break
- Chapel Rock-to-Pincher Creek (CRPC) and Central East Transfer-out (CETO) Generation Integration including Renewables
- Q&A period
- Next steps

Welcome and introductions

- Jerry Mossing, Executive Advisor
- Sami Abdulsalam, Director, Transmission Planning
- Amir Motamedi, Manager, System Planning
- Lei Xiong, Manager, Transmission Analytics Support
- David Johnson, Manager, Forecasting & Market Simulation

Transmission Planning and Regulatory Process

How does the AESO plan?

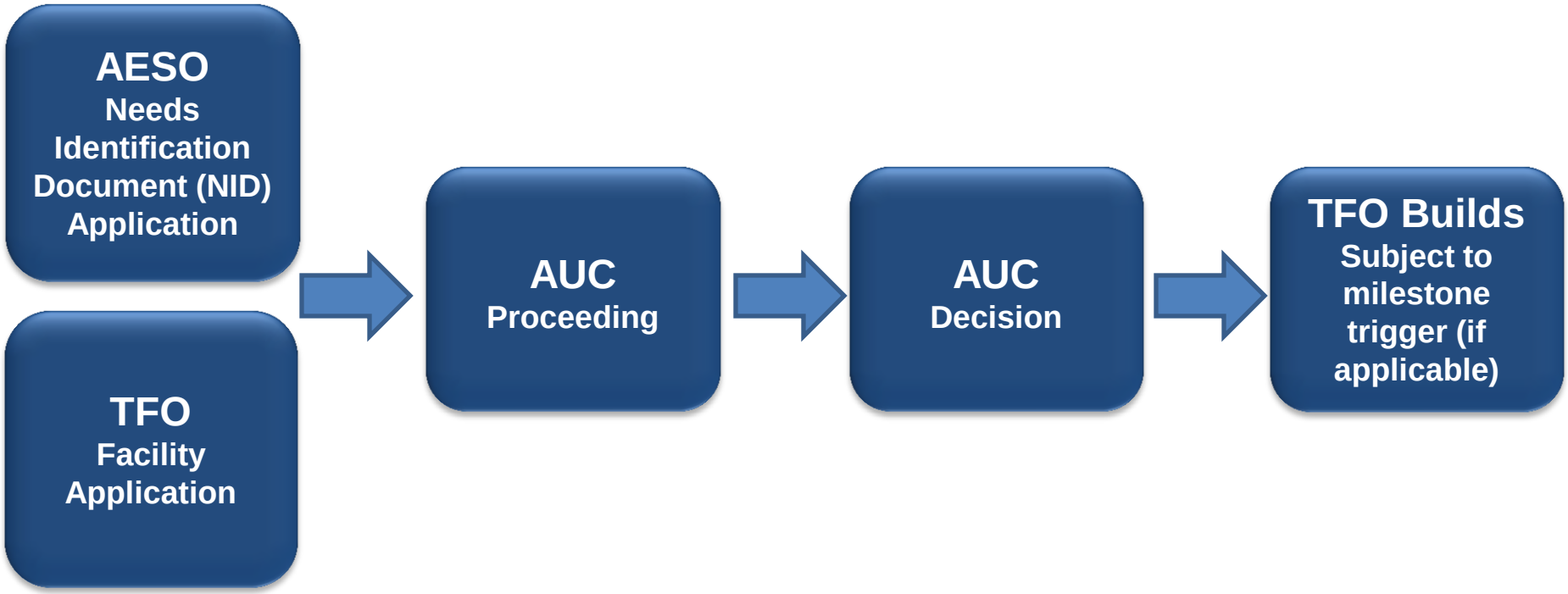


More on Long-Term transmission planning: www.aeso.ca > Grid > Long-term Transmission Plan

The AESO's planning approach

- Flexibility
  - Meet near-term needs while being flexible to adapt to credible future scenarios
  - Plan for uncertainty as the new norm; adopt scenario-based planning
- Optimization
  - Make use of existing facilities; timely planning for new facilities
  - While enabling continued development of resources
  - Maintaining system reliability
- Staged Developments
  - Construction milestones enable incremental transmission capability
    - Defer transmission rate impact
    - Opportunities to adjust pace of development
    - Prioritize development as needs/pace shifts

Regulatory process



AB-BC Intertie Restoration (AIR)

AIR Background

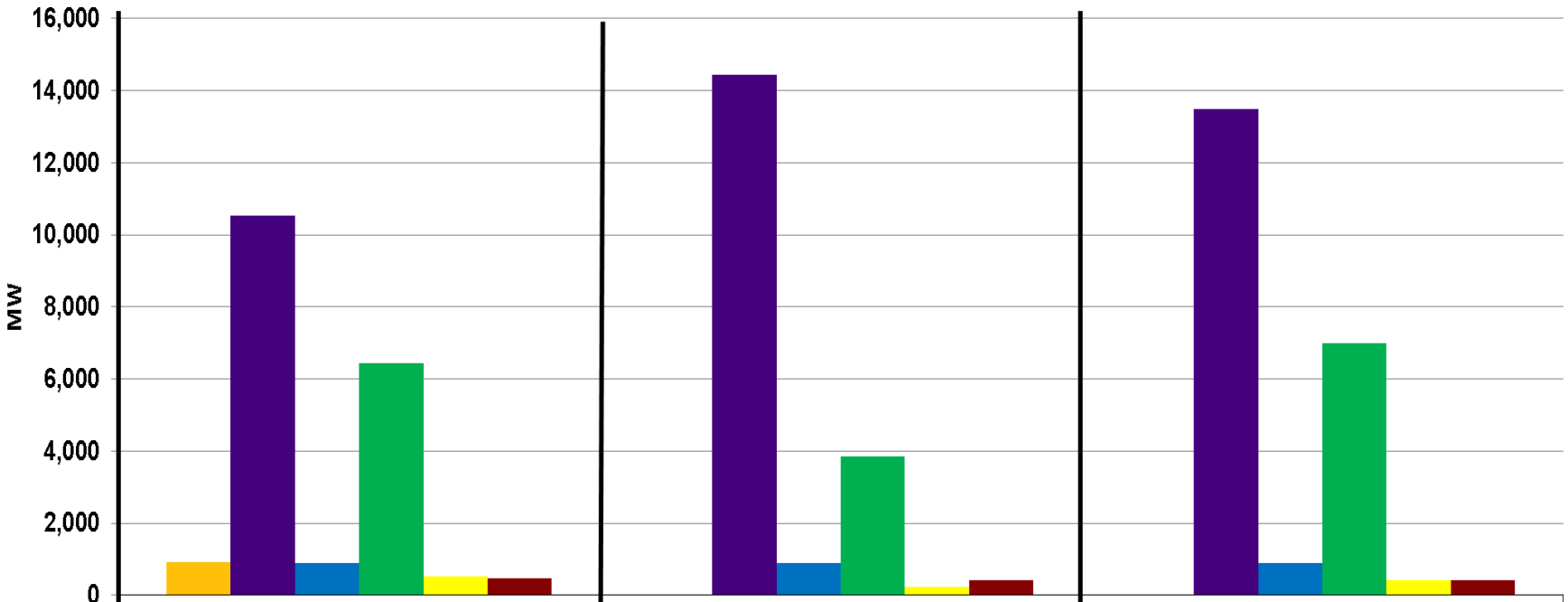
- Intertie restoration activities ongoing since the legislated requirement was enacted
- Incremental increases have been realized
- Western Regional Electricity Cooperation and Strategic Infrastructure (RECSI) revealed benefits associated with restoring the AB-BC intertie
  - AIR ranked top among all studied projects from a cost-benefit perspective
- AESO leveraged a wide range of sensitives including carbon pricing, Western Electricity Coordinating Council (WECC) generation economics and renewable penetration levels
  - These assessments conducted by General Electric (GE)
- The Chapel Rock-to-Pincher Creek (CRPC) development aids in Intertie Restoration

Forecast scenarios and sensitivities

A wide range of scenarios and sensitivities are used to ensure resilience of the project results

- The AESO studies on Production Cost Simulation carried out by GE modeled the whole WECC power systems with sensitivities in carbon price, solar deployment, and storage system
  - Carbon price (BAU $30/tonne, Low $20/tonne, High $57/tonne)
  - Solar deployment (500 MW PV deployment in 2030)
  - Storage options (150 MW, 350 MW)
- Additional production cost simulation modeling performed with 2019 LTO reference case
- Recent planning studies also utilized the LTO Alternate Renewable Policy case with wind output sensitivities – to test impact of higher renewables on intertie flows

Generation scenarios at study year 2030



	Production Cost Simulation BAU	2019 LTO Reference Case	2019 LTO Alternate Renewable Policy
Coal-fired	929	0	0
Gas-fired	10,527	14,435	13,502
Hydro	894	894	894
Wind	6,445	3,854	7,004
Solar	515	231	425
Other	464	423	423

AIR Project Need

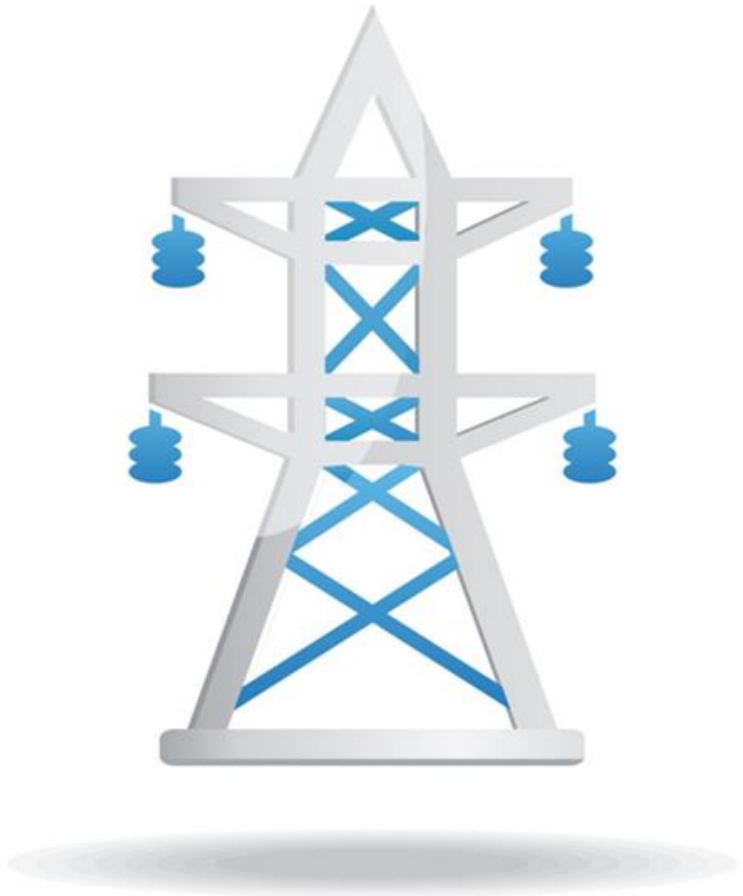
AIR Project need

- Legislation
  - Mandate to restore Intertie capability
- Reliability
  - Offers enhanced system reliability during extreme events and enhanced system flexibility
- Competitive market
  - Enhances competition and enables increased access to the Alberta market
- Cost/Benefit
  - Wide-range of production cost simulation and economic efficiency assessments indicate net-positive benefits relative to restoration costs

AIR Blocks

AIR Plan

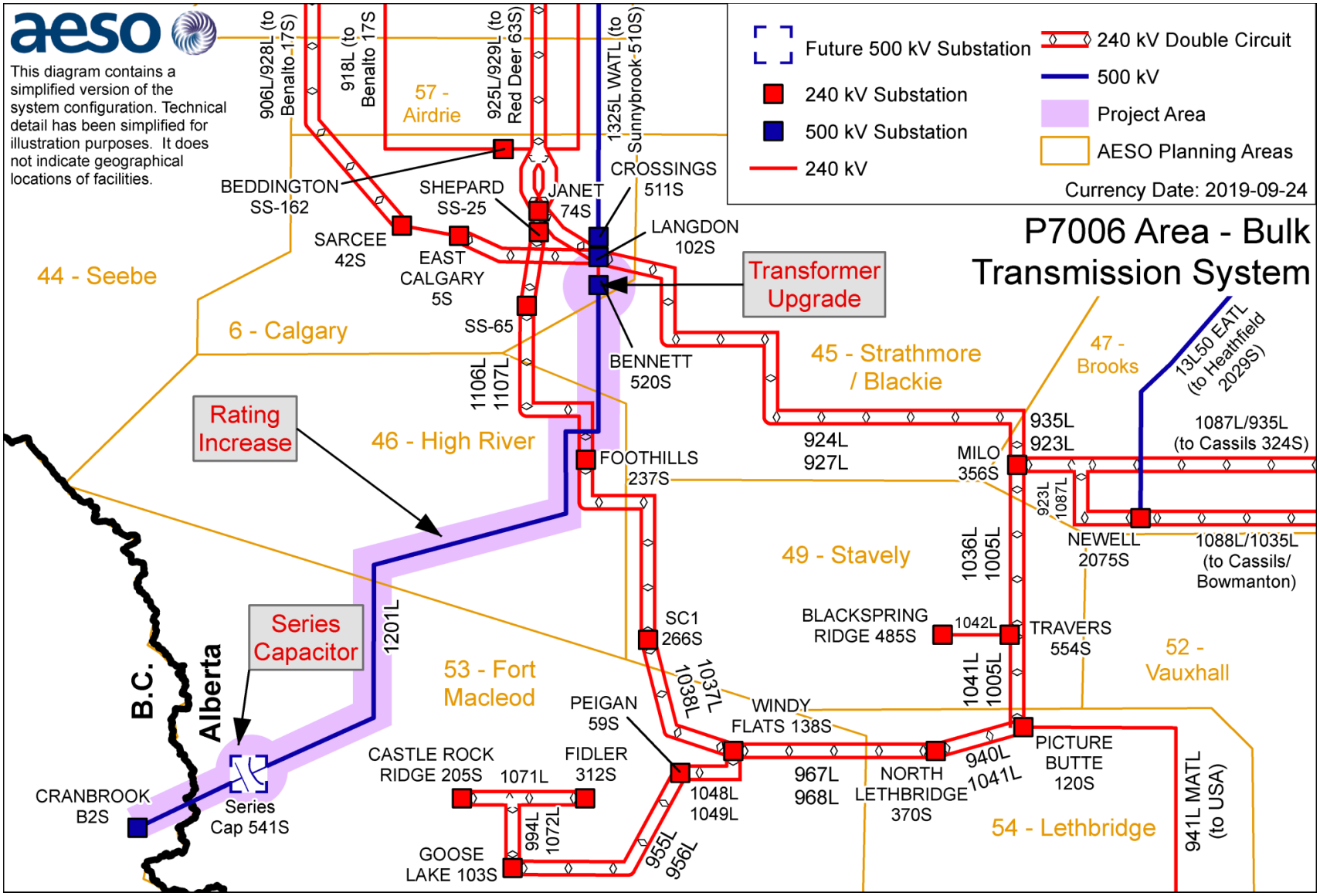
- The ultimate target for Intertie restoration is simultaneous import capability on BC and MATL (Montana–Alberta Tie Line) to path ratings
  - MATL 310 MW + BC 1,200 MW = 1,510 MW
  - Requires mitigation for both loadability and Alberta under-frequency
    - Loadability increase is needed for loss of generation internal to Alberta
    - Alberta under-frequency recovery for loss of Intertie at high import



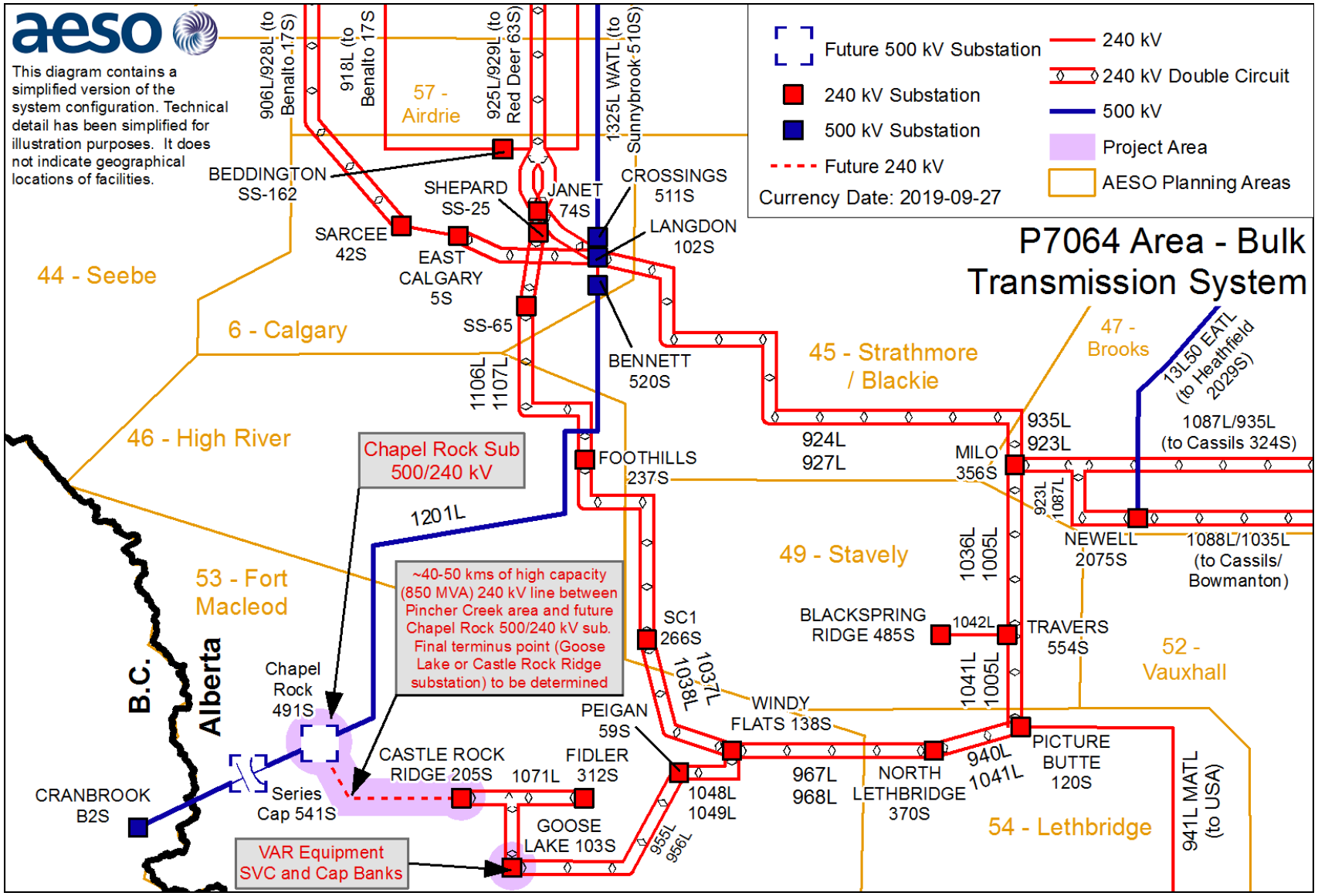
AIR Plan

- Plan for using incremental increases in three blocks
  - **Loadability Block 1**
    - AIR - BC 800 MW to 950 MW, no change to MATL, no change to simultaneous capability of 1,110 MW using Load Shed Services for imports (LSSi)
  - **Loadability Block 2**
    - CRPC – BC 950 MW to 1,150 MW, no change to MATL, no change to simultaneous capability
  - **Under-frequency Mitigation Block**
    - Mitigate Alberta under-frequency through mitigation services alone, or in combination with a new MATL back-to-back convertor station to achieve simultaneous import capability to combined path ratings of 1,510 MW

Loadability Block 1 (AIR)



Loadability Block 2 (CRPC)

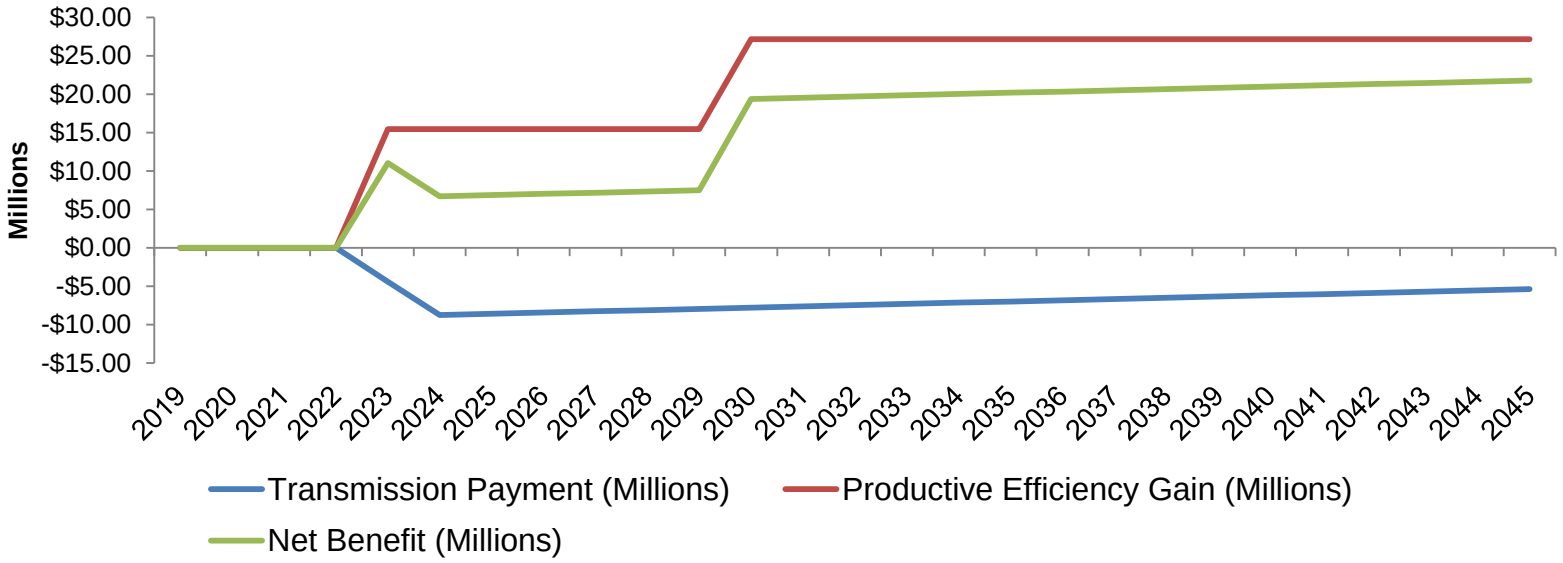


Under-frequency Mitigation Block

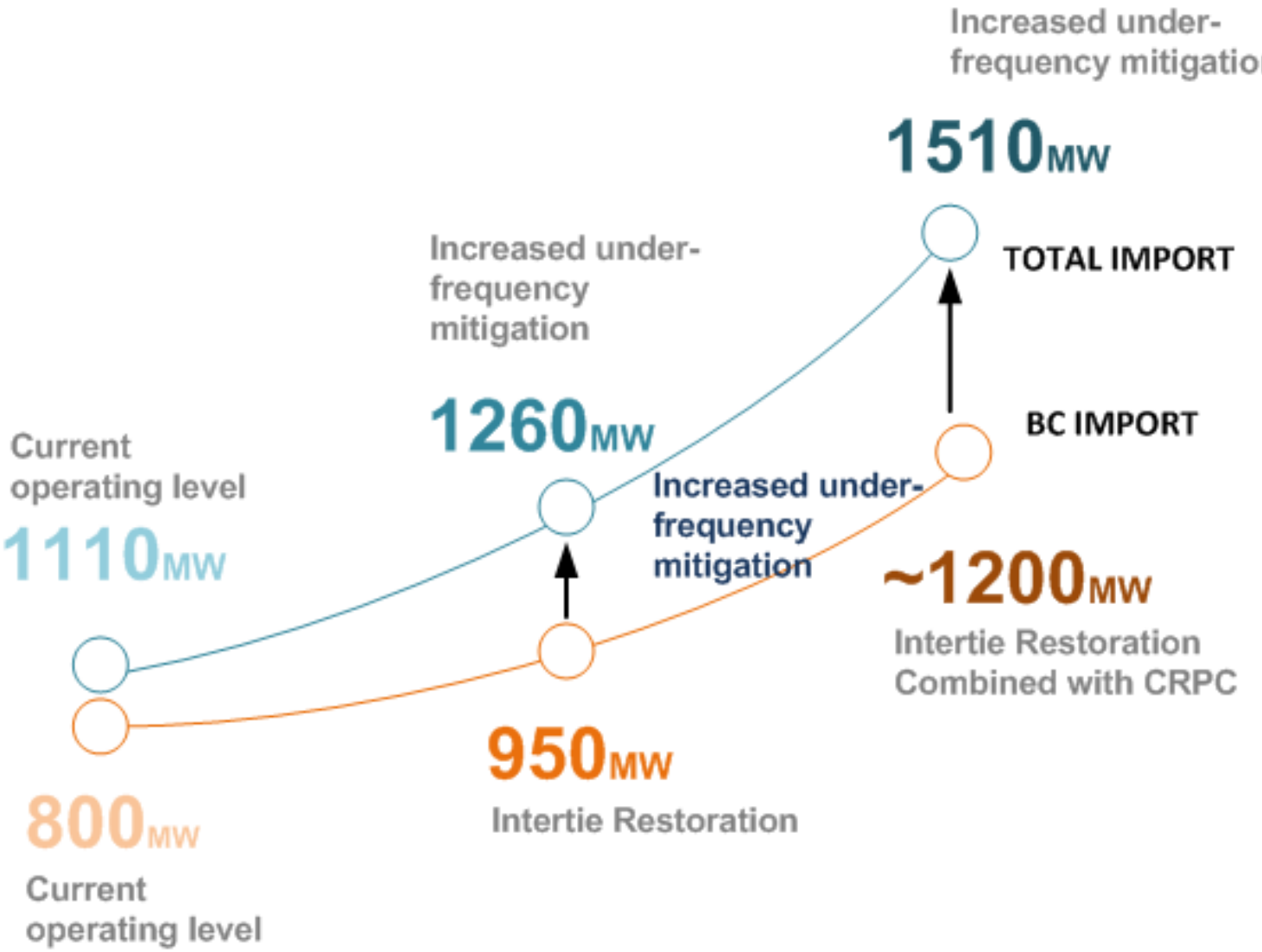
- Not a location specific need
- Loss of BC Intertie when imports near or at path rating requires additional under-frequency mitigation
  - Currently under-frequency mitigation services for Intertie are provided by LSSi and operating reserves
  - Other technologies, such as battery storage may provide this service at a competitive price
- Moving MATL from an AC Intertie to a DC Intertie (via a back-to-back convertor) would reduce the amount of under-frequency mitigation services

Cost-benefit analysis – sample

- To determine the efficiency of AIR we used a net-present-value analysis of the costs and benefits of Intertie restoration
  - Quantified benefits
    - AESO estimated the cost of meeting Alberta electricity demand with and without the intertie restored
  - Quantified costs
    - We utilized expected future tariff payments for the project cost and considered multiple frequency product options



AIR Summary

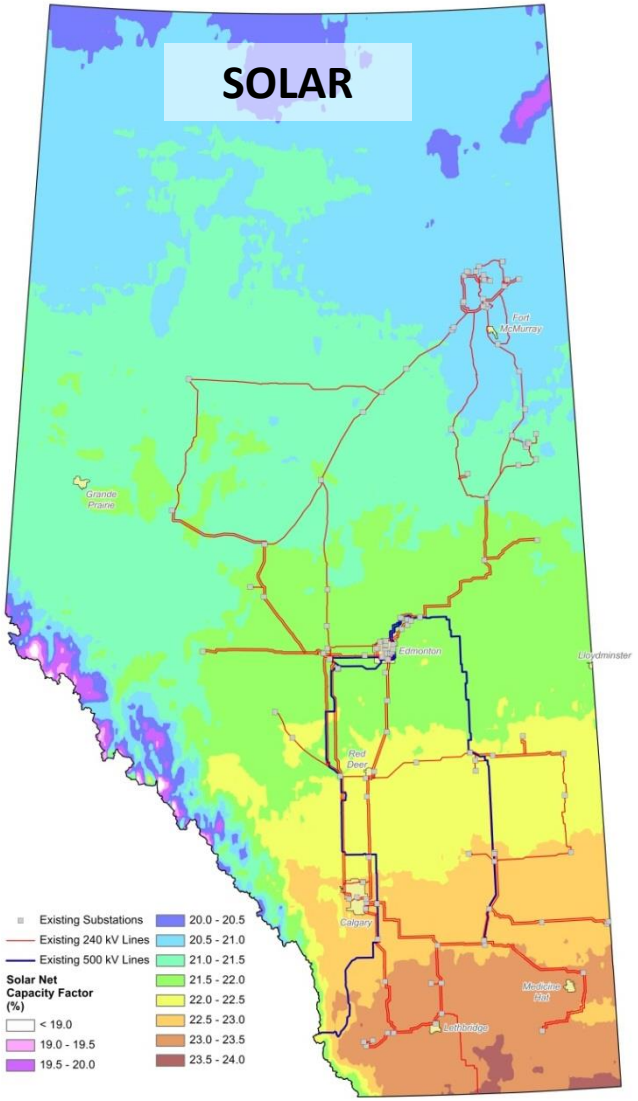

Increased under-frequency mitigation
1510MW
TOTAL IMPORT
Increased under-frequency mitigation
1260MW
BC IMPORT
Current operating level
1110MW
Increased under-frequency mitigation
~1200MW
Intertie Restoration Combined with CRPC
950MW
Intertie Restoration
800MW
Current operating level

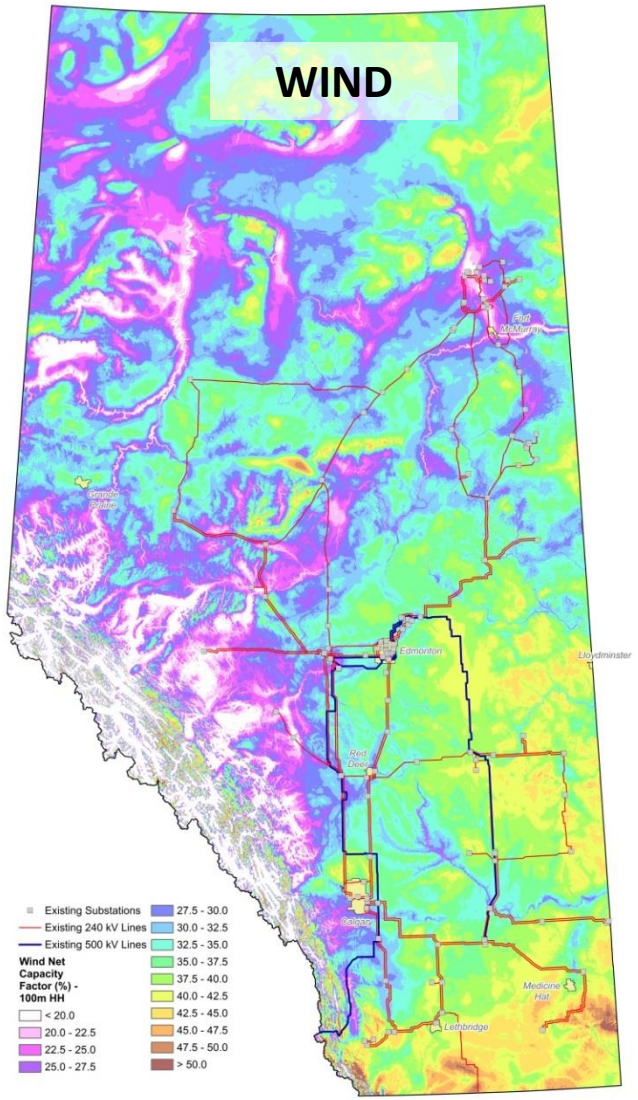
Question & Answer Period

Break

South and Central East Regions Generation Potential, Interest and Forecast

Solar and wind resource potential

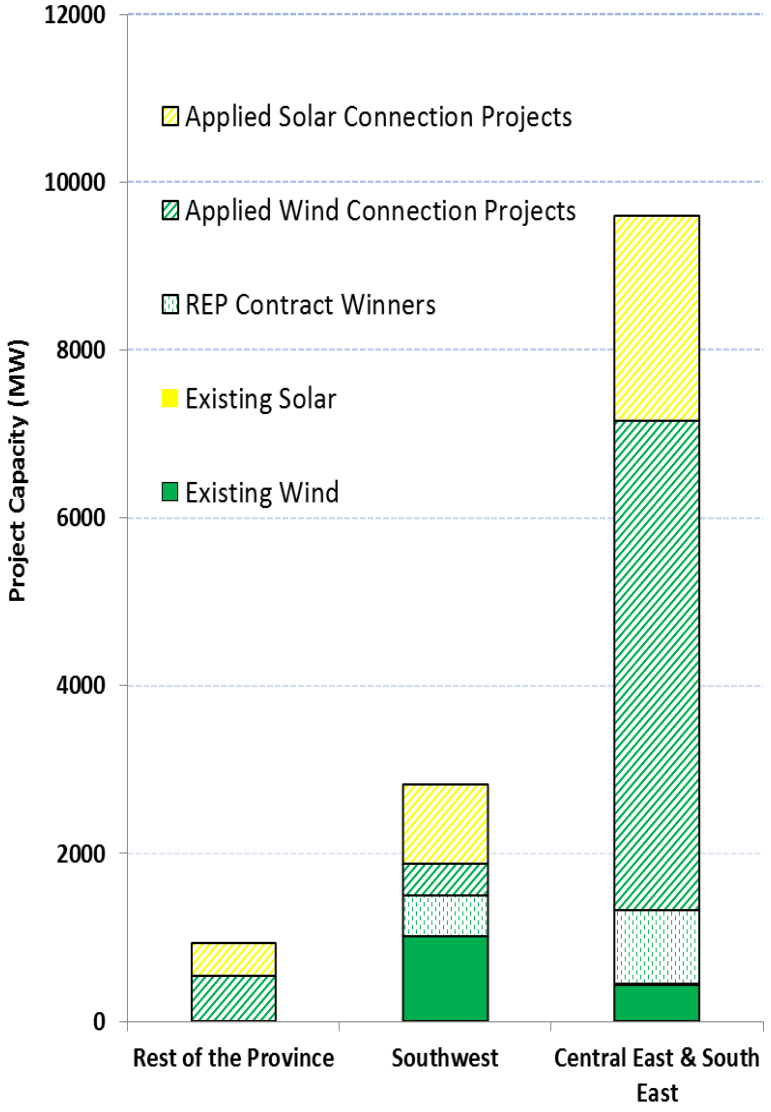




Data source: AWS Truepower

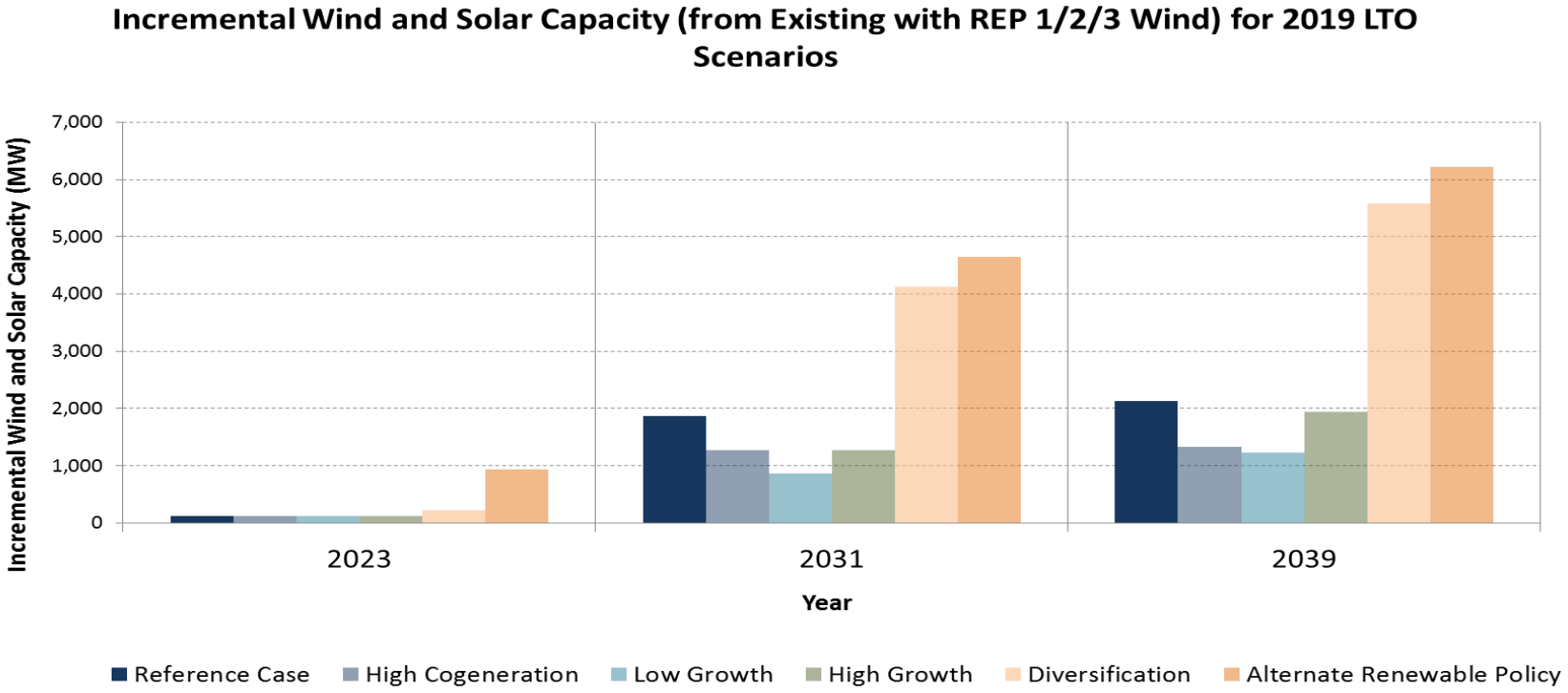
Renewable generation interest

- 1,647 MW of existing wind generation in the South and Central East
- Renewable Electricity Program (REP) Contracted Renewables: ~1,360 MW of new wind generation in the South and Central East
- High interest: over 90% of wind and solar applications are in the South and Central East (September AESO project list)
- Developers are focused in the renewables rich areas – Southern Central East regions



Renewable generation forecast

- The 2019 LTO scenarios forecast ~900 to ~4,500 MW of additional wind and solar development by 2031 in addition to existing and REP winners
- Pace of renewable development is dependent on a variety of drivers including: technology innovation, natural gas prices, carbon prices, economics, corporate power purchase arrangements (PPAs) and policy



Study Condition Development

Project specific approach: South and Central East

A project specific approach to develop study conditions for CETO and CRPC

- Up-to-date information within the study area
  - Latest forecast intelligence
  - Recent project information and announcements
- Local generation dispatch scenarios impact is examined to ensure a robust and flexible transmission development plan
  - Assess thermal plant dispatch scenarios around replacement of thermal generation in Central East and Southeast and their production profiles
    - Peaking units
    - Baseload units

Study condition development

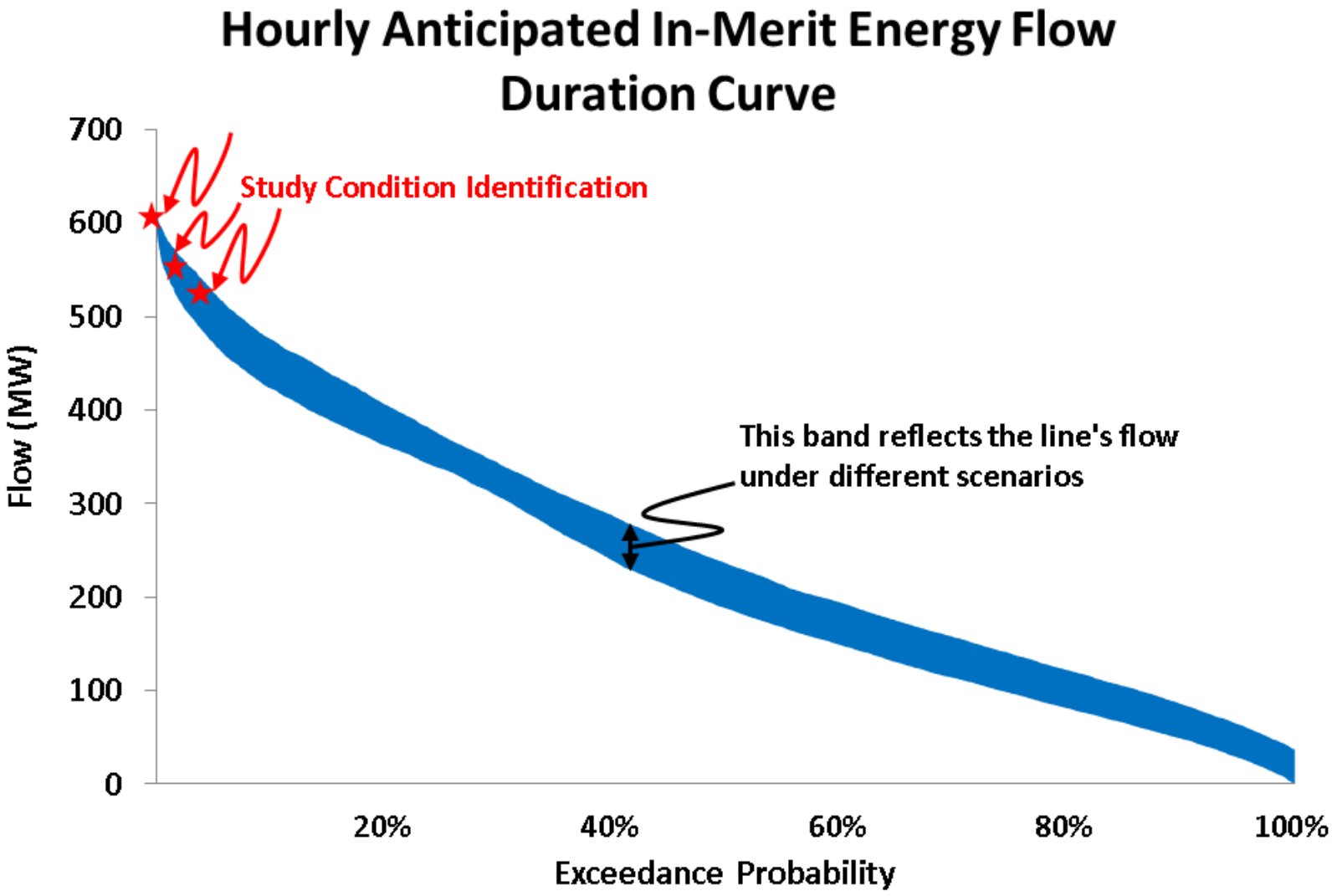
Generation dispatches were developed using a statistical method and a market simulation method

- Traditionally, a statistical method was used to create generation dispatches
  - Based on pre-defined planning conditions
    - Load at summer light, summer peak and winter peak
    - Intertie flows
    - Wind and solar at their highest expected coincident output
  - Conventional generation outputs are guided by historical outputs
  - Overall system dispatches are balanced based on an anticipated (forecast) merit order(s)

Market simulation method

- A market simulation method is also adopted to study the dynamic relationship between market supply, demand and transmission system in an integrated manner
  - Utilizes latest market fundamental assumptions used in the 2019 LTO generation outlook development
  - Models the full transmission network with aligned transmission assumptions used in planning studies
  - Applies offer behavior and merit order modeling
- This method created hourly economic dispatches which are then evaluated to select study conditions based on stressed power flow conditions

Study condition development example



Need for Transmission Development

Existing transmission capabilities for South and Central East regions

- ~450 MW following REP 1, 2 & 3 projects in-service
  - Assumes no other generation projects in these areas by 2023
  - Developer interest is currently at ~10,000 MW (wind and solar)
- The approved Provost to Edgerton and Nilrem to Vermilion (PENV) development adds an additional ~350 MW capability to the system
- Maximum N-0 Capability
  - Congestion is managed via Remedial Action Schemes (RAS) which is necessary to reach these capabilities
- Battle River and Sheerness generation assumed to be base loaded
- Actual transmission system capability will be lower
  - Location and size of new capacity integration may vary compared to optimized locations
  - Use of RAS may be limited due to operation complexities or MSSC

Need for transmission development

- Existing transmission system in the area is not capable of transferring the potential, interest and forecast generation to the load areas
- Transmission plans must efficiently utilize the existing collector transmission systems in renewable rich areas
- On-line thermal generation is required for system reliability in the Central East region (supports operation of Eastern Alberta Transmission Line (EATL))
- Enable broad geographic renewable integration
  - Diversity benefit
  - System access benefit – enhance competition
- CRPC also contributes to restoring the import capability of the AB-BC intertie

Planning for the near and long-term while managing timing of build

- The AESO is advancing the needed development plans while prudently managing in-service dates
  - Manage timing
    - Development and use of construction milestones
  - Manage cost
    - Considering single circuit line construction to stage developments
- Provide certainty to landowners and support investor decisions
  - Transmission plans will be advanced to construction once existing transmission capability is used and in stages
  - Allows for flexibility and adaption to pace of development in both thermal and renewable generation over the next 20 years

Chapel Rock-to-Pincher Creek (CRPC) and Central East Transfer-out (CETO) Approach

CETO and CRPC planning approach

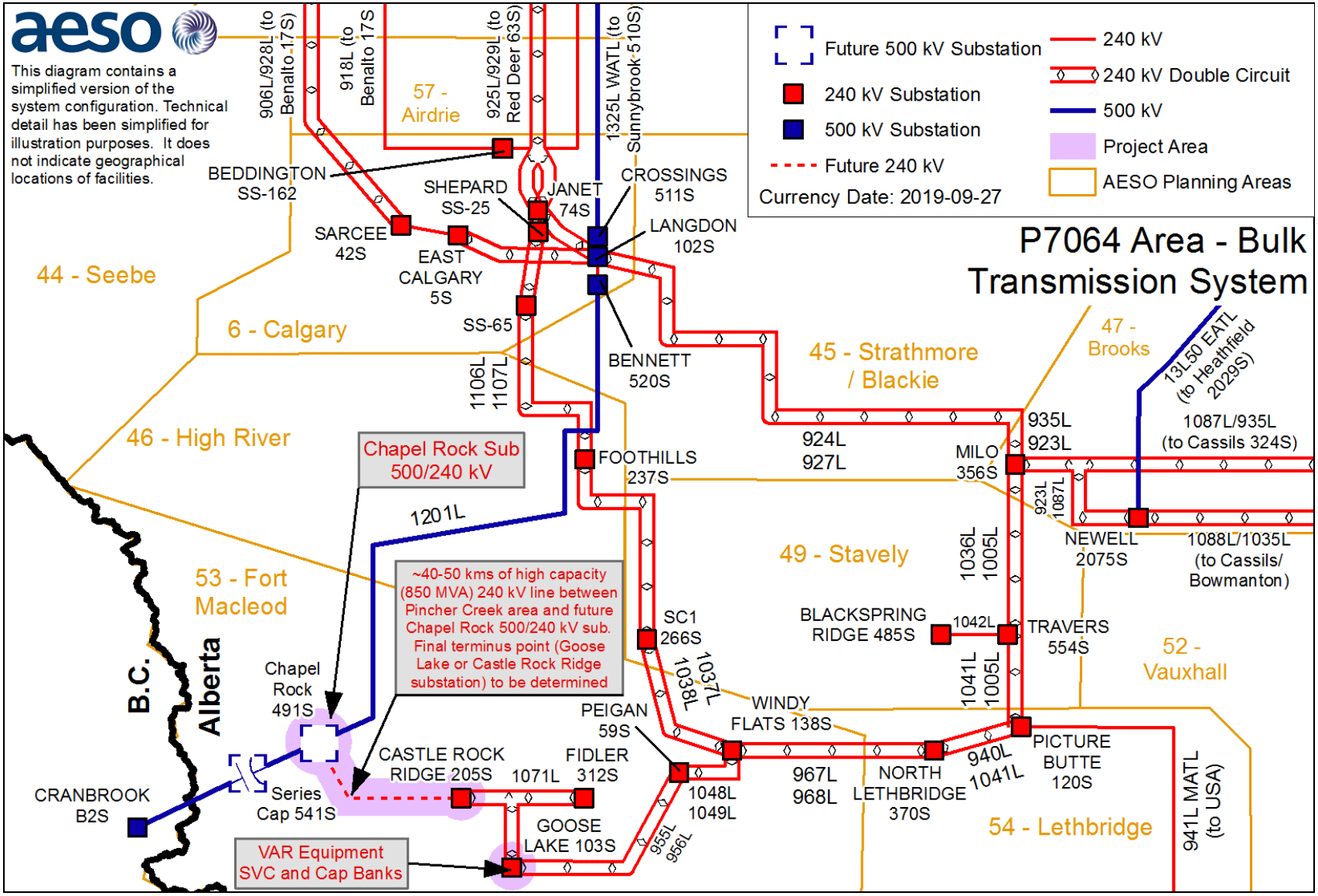
- Both plans considered concurrently to:
  - Offer a holistic and system-wide optimized renewable integration plan
  - Provide a clear picture on where and how the South and Central East generation integration plan will transpire and how much will it cost
  - Enable the design of staged transmission capability enhancements in geographically wide and diverse areas

CETO and CRPC planning approach

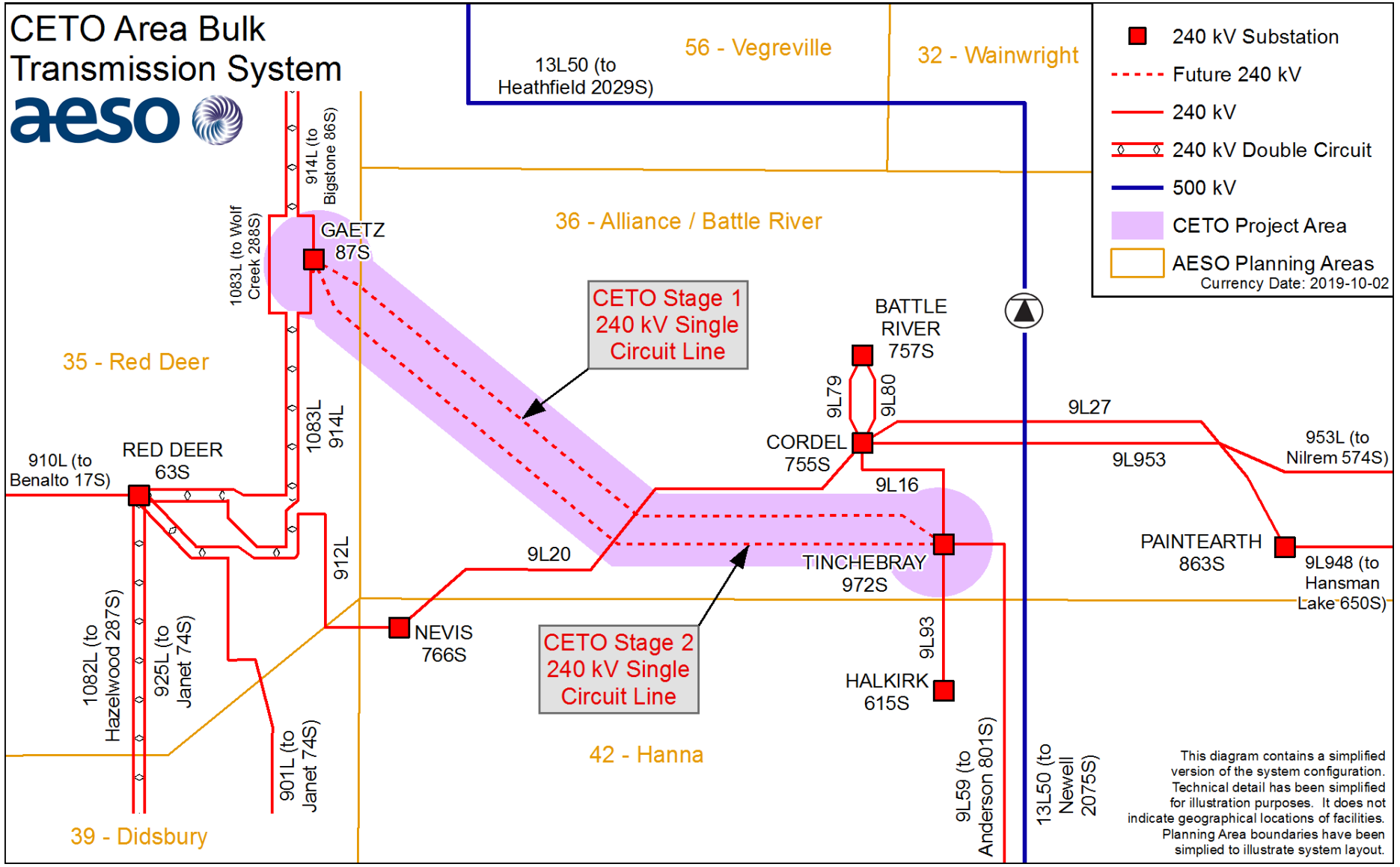
- Establishing need
  - Capability assessment to optimize existing transmission assets
  - The AESO is simultaneously enabling Southwest, Southeast and Central East for renewable integration to enable competition and diversity
  - One project only will not be sufficient to enable long-term forecasted renewables, need for both CETO and CRPC (CETO second stage could be delayed)
- A single-study approach for both projects reflecting an optimized system capability

Transmission Development Facilities
CRPC and CETO

Planned Southwest Transmission Development (CRPC)



Planned Central East CETO Transmission Developments



Transmission development plans

- CRPC
  - New Chapel Rock substation connecting directly to existing 500kV intertie between Alberta and BC
  - One 240 kV transmission circuit from new Chapel Rock substation to Pincher Creek Area
  - New voltage support equipment at the existing Goose Lake substation
  - CRPC will enable approximately 600 MW of additional transmission capability
- CETO
  - Add two, staged, 240 kV circuits between Gaetz 87S and Tinchebray 972S substations
  - CETO will enable approximately 700 MW of additional capability in a staged manner

Other assessed transmission alternatives for renewable integration

- A number of transmission options were considered, including:

Southwest

- System reconfiguration in Southwest and Calgary
- Developments similar to Foothills Area Transmission Development (FATD) West
- Different components of previous Southern Alberta Transmission Reinforcement (SATR) plan
- Others

Central East and Southeast

- Eastern Alberta Transmission Line (EATL) bi-pole
- 500 kV outlets in Central East
- Developments connecting Central East to the Edmonton and Calgary regions
- Others

- CRPC and CETO shown to be the most efficient transmission projects compared to the above

Pace of Transmission Development

Pace of transmission development

- Transmission developments will be tied to construction milestones
  - CETO is dependent upon the conventional generation replacement in Battle River and Sheerness
  - Staging; add incremental capability as existing capability is utilized
- The earliest in-service date for CRPC and first stage of CETO is 2023 based on two years of construction and assuming construction milestone trigger immediately after Permit and License (P&L)
- Second stage of CETO could be triggered before 2030 depending on pace of renewables and base load behaviour of thermal generation replacements

CRPC and CETO milestones

- The milestones are designed to trigger after the N-1 capability is reached but before the N-0 capability limit
- The milestones are designed to allow for one typical windfarm to connect while construction is underway
- CRPC milestone
  - 150 MW in Pincher Creek area or
  - 300 MW in Southwest sub-region (west of Lethbridge)
- CETO milestone
  - **CETO Stage 1**: 150 MW in Southeast or Central East sub-regions
  - **CETO Stage 2**: 550 MW in Southeast or Central East sub-regions

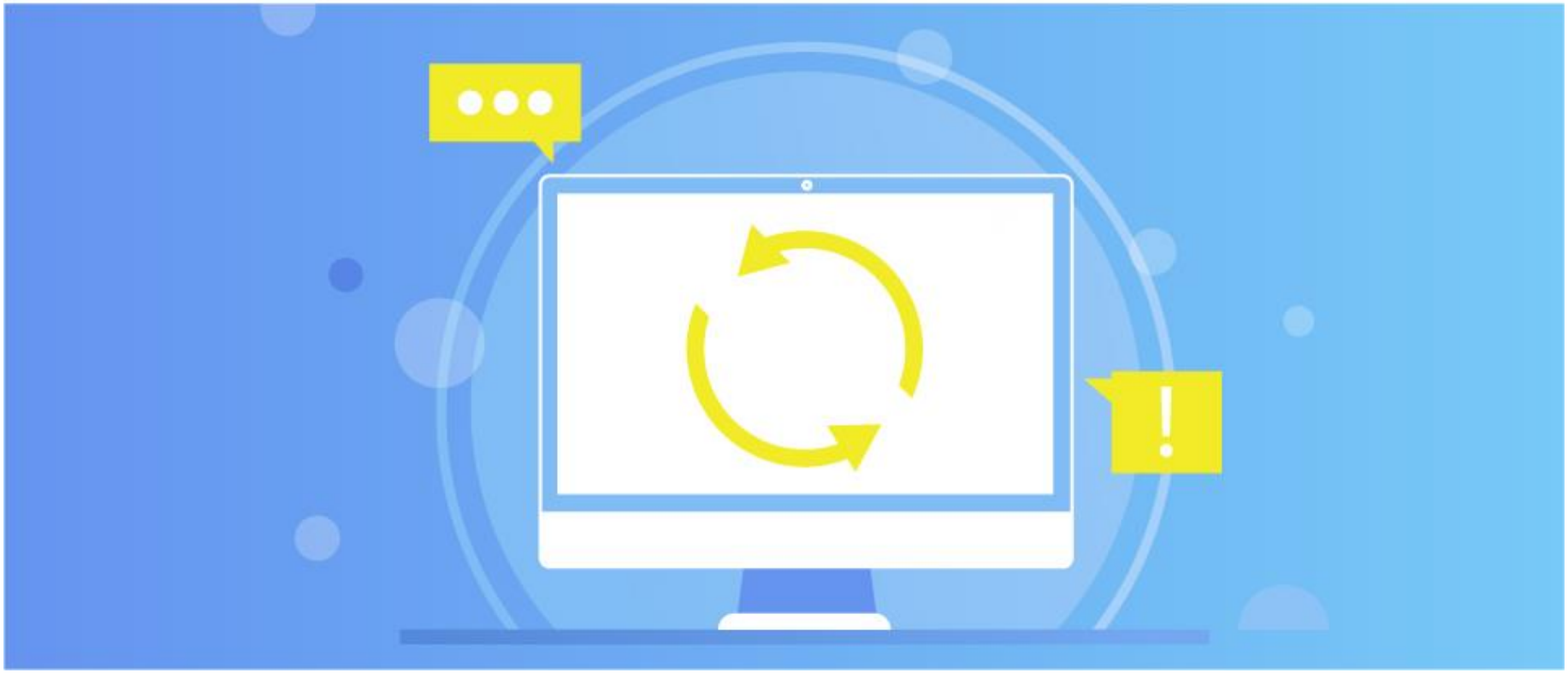
Question & Answer Period

Next Steps

Next steps

– AESO will seek approval from the AUC for the CRPC and CETO transmission developments and AIR in conjunction with AltaLink's and ATCO's Facility Applications

Contact the AESO



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