Alberta Electric System Operator

Large Load Integration Phase I

Interim Connection Limit and Assignment

JUNE 4, 2025

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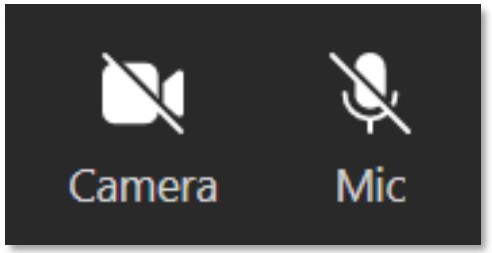
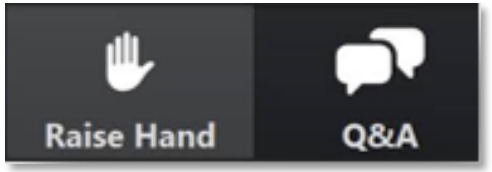




LAND ACKNOWLEDGEMENT

Welcome and Introductions

Name	Role
Rob Davidson	Vice President, Grid Reliability – Projects and Planning
Cam Bush	Chief Engineer
Chris Connoly	Program Manager, Large Load Connections
Liz Wilson	Senior Stakeholder Engagement Advisor

AESO Stakeholder Engagement Framework

Registrants

- Advantage Energy
- AIMCO
- Air Products
- Alberta Direct Connect Consumers Association (ADCC)
- Alberta Innovates
- Alberta Newsprint
- Alberta Utilities Commission (AUC)
- Alpine Sun
- Alta Solutions Inc.
- AltaLink
- ACR Resources
- Arder Energy Inc.
- Armada-Nowlit
- Arvin Capital Management
- ATB
- ATCO
- Aventail Capital Group
- BMO
- BBA Consultants
- BBA Engineering
- Beacon Data Centers
- Beneva
- Best Consulting Solutions Inc.
- BHE Canada Ltd
- Bird Construction
- Bitdeer
- BP
- Burns & McDonnell
- Calgary Herald
- Camelot Power
- CanREA
- Capital Power
- Captus Generation
- CBC Calgary
- CDPQ
- Cenovus Energy
- CF Power
- CF Power LTD
- Chinook Development LP
- CI Global Asset Management
- CIBC
- Citadel
- City Chestermere
- Clayton Partners LLC
- Competition Bureau
- Cree Ative DataCenter Corp.
- Crusoe
- Dentons Canada LLP
- Desjardins
- Diamond T Corp.
- Diode Ventures
- Direct Energy
- Dow Chemicals Canada
- Dromore
- Dynasty Power
- EDC Associates Ltd.
- EDF Renewables
- Edmonton Global
- Enbridge
- Enerfin
- Energy Storage Canada
- Enfinite
- ENMAX
- Entropy
- Enverus
- EPCOR
- Evercore
- FortisAlberta
- G3 Partners
- General Land and Power
- Government of Alberta
- Guardian Capital
- HDR
- Hitachi Energy
- IESO
- IGB Technologies Inc.
- Imperial Oil
- Invest Alberta
- Investor Labs
- IPCCA
- IREN
- J Goldman
- JJ Power & Energy Inc.
- JouleGrid
- Just Energy
- Kalina Distributed Power Limited
- Kiewit Energy Canada
- Kineticor
- Kiwetinohk Energy Corp.
- KNW Professionals Ltd.
- KPMG
- Launch Energy Solutions
- Ledcor
- Leduc County
- Leith Wheeler Investment Counsel
- Lionstooth Energy
- M&E Legacy Renewables Inc.
- Macintosh
- MSA
- Marshall Wace
- Maskwa
- McCarthy Tetrault
- Midstream LPG
- Mihta Askiy Datacenter LP/Cree Ative Datacenter GP
- Mitsubishi Power Canada
- Morgan Stanley
- Nadia Partners
- National Bank of Canada
- Nican International Consultant
- Nira Energy
- Northland Power
- NRCan
- NRG
- Nvidia
- OPTrust
- Osler Hoskin Harcourt LLP
- PACE Canada LP
- Pembina
- PGSC
- PointState Capital LP
- Power Advisory
- POWER Engineers
- Power Grid Specialists Corp.
- PowerHouse Group
- QTS Data Centers
- Radio-Canada
- RBC Capital Markets
- Rocky View County
- Rubric Capital
- Ryan ULC
- Scotiabank
- Shepard Development Corporation
- Siemens Energy Canada Limited
- SLR Consulting
- Sovereign Digital
- Stantec
- Starlight Capital
- Stephen Avenue Marketing
- Sturgeon County
- Suncor
- Sureway Construction
- Swan Hills Synfuels LP
- TC Energy
- TD Cowen
- TDS
- TERIC Power
- Timelo Investment Management
- Tourmaline Oil Corp
- TransAlta
- UBS
- University of Calgary
- Verde Capital Management N.A. LLC
- Verition
- Volus
- Waratah Capital
- Wescott Consulting Group
- Western Power Partners
- WFG
- WiseGlow
- Wolf Midstream Ltd.
- Yaupon Capital Management
- Yes Energy
- Zenith Power

Agenda

Start Time	Who	Topic
9:30 a.m.	Rob Davidson	Introduction and Executive Summary
9:50 a.m.	Chris Connoly	Existing Connection Process
10:10 a.m.	Cam Bush	Interim Large Load Connection Limit
10:30 a.m.	Chris Connoly	The Limit Assignment Process
10:50 a.m.	Chris Connoly	Next Steps
11:00 a.m.	All	Questions

Executive Summary

Background: Data Centre Load Growth and Grid Impact

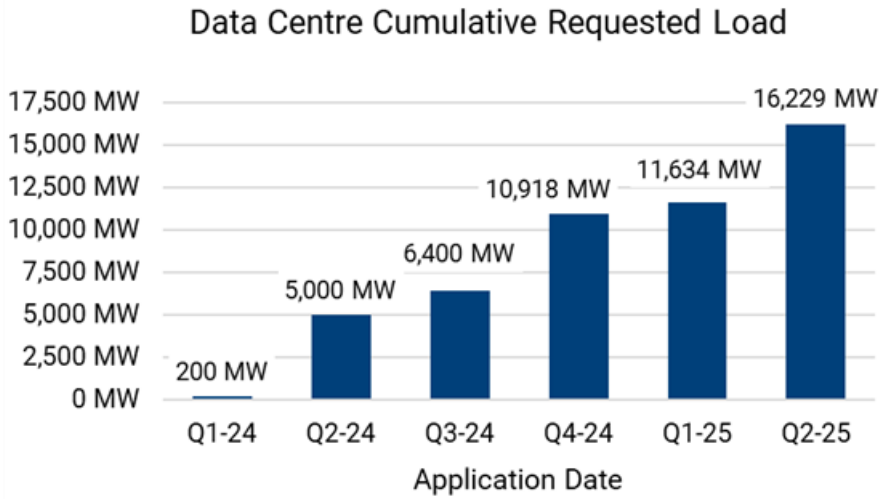
- Large load (AI data centre) developer project connection applications have ballooned
  - Exceeding 16 GW in firm Demand Transmission Service (“DTS”) applications
  - Alberta’s peak load of just over 12 GW
- Alberta cannot possibly connect all proposed data centre projects in the short-term
- Data Centres introduce complex load behaviours unlike traditional demand
- A new fit-for-purpose solution is urgently needed
  - Current connection process was designed at a time with very different realities
  - Load application volume, size and timing is outpacing generation
- Opportunity for substantial industry investment and growth as early as 2027/2028

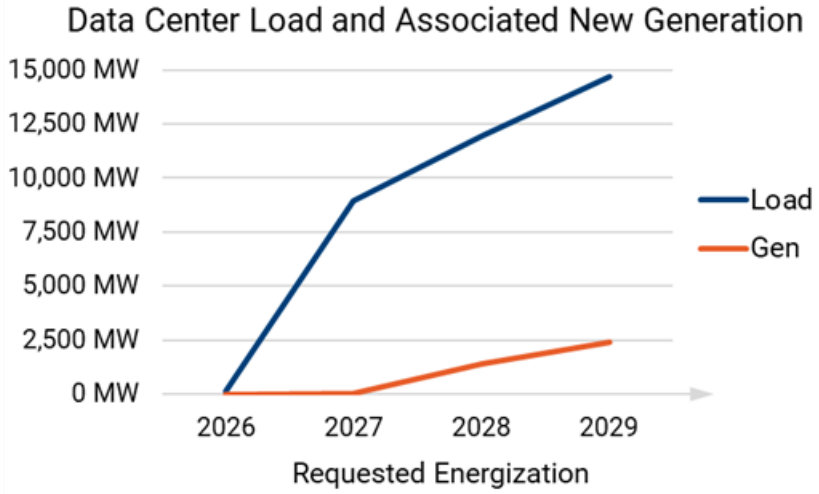
Background: Phased Approach to Enable Data Centre Integration

- AESO will prioritize projects that are well advanced in the AESO's connection process and ready for near-term connection
- AESO will implement a two-phased approach:
  - **Phase 1**: Connect large loads using current framework and available grid capacity
  - **Phase 2**: Connect future large loads based on a to-be-developed large load framework
- Purpose behind the phased approach
  - Enable large load development by 2027/2028 without negatively impacting grid reliability
- AESO has made two key decisions:
  - Set a **reliability-based** cumulative grid limit (MW) for large loads
  - Established a method to assign this limit to large load developers

Short-Term Reliability Risk: Data Centre Integration

- The grid cannot support all data centre requests without risking grid reliability
  - Increased risk of energy emergency alerts during peak load periods or significant temperature conditions
    - Public appeals and controlled load shed
  - Grid becomes more vulnerable to unexpected outages or high-impact weather events
- High DTS requests
  - 29 data centre applications totaling 16,229 MW
  - Most lack sufficient or timely new generation
  - Exceeding both existing and expected new supply
- AESO winter peak load (January 2024): 12,384 MW
- Immediate action is needed to manage risk and maintain grid reliability





AESO's Mandate and Approach to Enabling Data Centres

- AESO's mandate prioritizes grid reliability in the public interest of Alberta
- Our approach supports responsible, fair and reasonable integration of large loads
- Phase 1: Interim Measures (Current Framework)
  - Set Interim Limit: Define a reliability-based cumulative connection limit
  - Assign DTS Capacity: Develop a fair, timely and efficient method to assign limited capacity to large loads
  - Develop Technical Requirements: Establish interconnection standards and modeling requirements
- Phase 2 (Long-term): Develop sustainable framework
  - NERC Standards: Implement forthcoming NERC Large Load standards
  - ISO Tariff Redesign: Explore changes to:
    - Interruptible rate classes
    - Terms for load shed, demand response and backup generation supply
    - Cost causation for ancillary services and network upgrades
  - Transmission Planning: Enhance long-term planning and forecasting to include growth of data centres

The Outcomes

1,200 MW

Reliability-based Interim Large Load Connection Limit

The transmission grid can reliably serve 1,200 MW of large load for 2027/2028

Project Applicability and Qualification

Projects which are well advanced meeting certain connection process milestones

AESO further qualifies projects based upon financial security and letters of support

Pro Rata Assignment of the Available 1,200 MW

Assignment will be based on a project developer's share of total qualified MW

Timelines

Qualification will be done by end of June with contracts executed by end of July

Timelines are tight to support the most advanced project developers

The Existing Connection Process

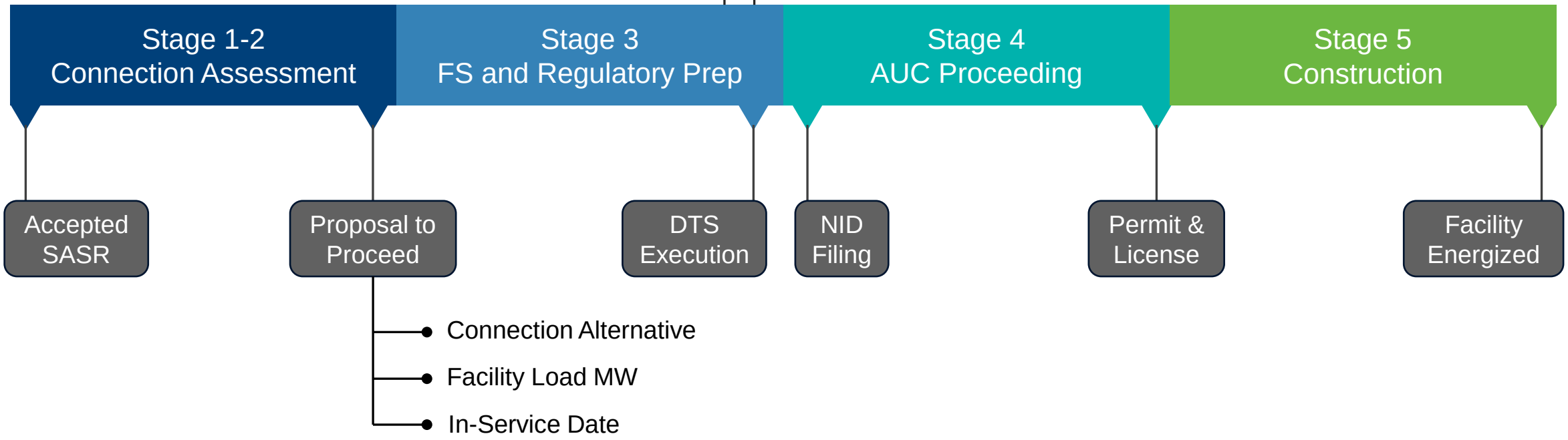
Typical Connection Process For Loads

Initial Security

Security for two months of **zero-energy** DTS payments is collected prior to DTS execution

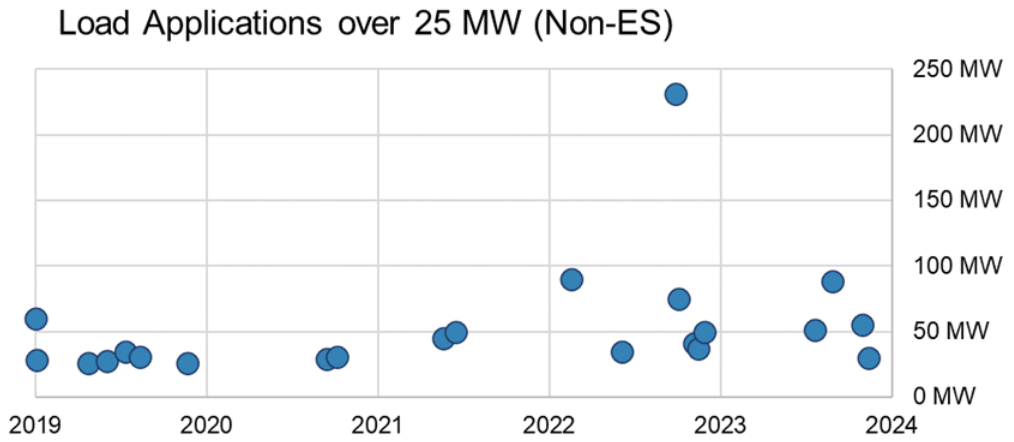
PILON[1] Obligation

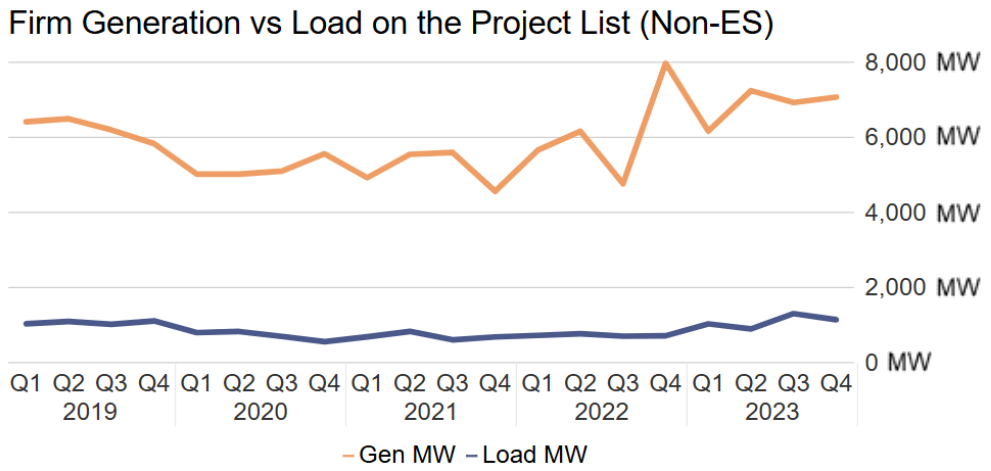
Execution of the DTS obligates the MP to the terms of PILON for cancellation or delays of less than five years notice



[1]A Payment in Lieu of Notice (PILON) is required if a project developer fails to give a full 5 years notice before cancellation, delay, or reduction of their DTS contract.

History of Load Projects in the Connection Process





Minimal Load Projects

22 projects and 1.2 GW over 5 years

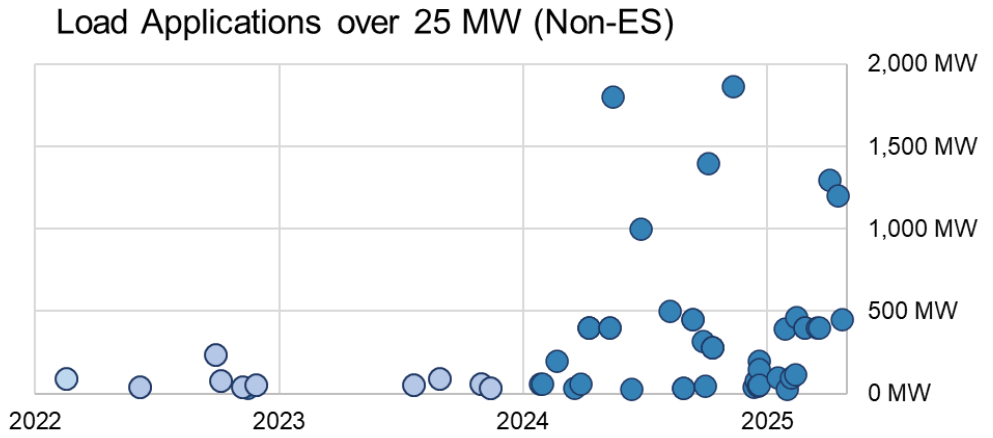
Loads have historically been smaller and sporadic, proceeding through the process staggered and independently

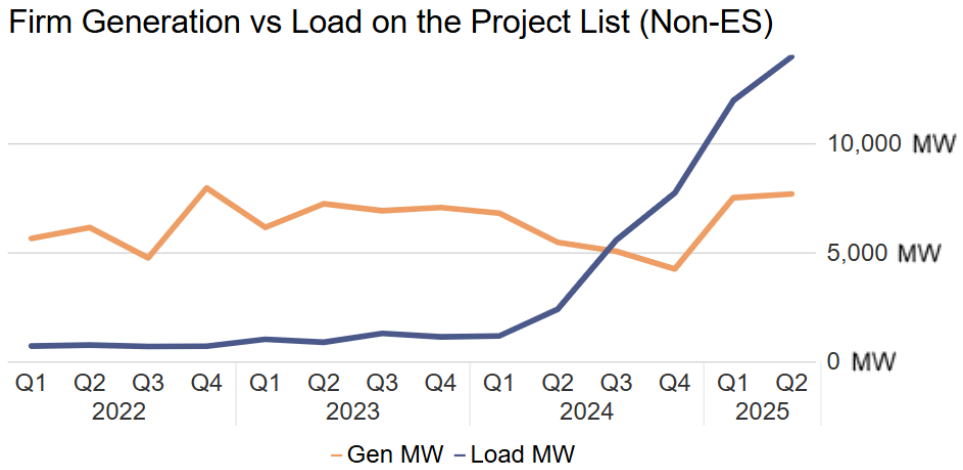
Load Service Assumed

4-6 GW surplus of supply requests

With far more generation requested than load, ability to serve load requests has not been in question

A Wave of Large Load Applications





A Steep Increase in Loads

44 projects and 17 GW over 16 months

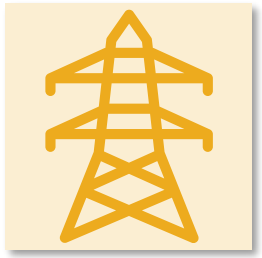
A surge in the size and volume of load applications has led to a clustering of projects seeking access to the transmission grid

Load Service in Question

Currently 6 GW deficit of supply requests

With load requests now greatly surpassing generation, the grid's ability to reliably serve the load can no longer be assumed

Challenges with Existing Connection Process



Proposal To Proceed

Cannot be issued without planning for a connection that can be reliably served by the grid

Individual Stage-Gate Process

Cannot advance projects independently when they are clustered together with significant impacts on each other

DTS Contract Execution

Cannot be issued without ensuring that terms and conditions for a firm load service can be met

NID Filing

Cannot be filed without study results demonstrating that the connection is safe and reliable

Reliable load service is now a limited resource, and the process must adapt

The Steps for Change

The AESO has taken the following approach to address these challenges, to advance projects efficiently while ensuring a safe, reliable, and affordable grid

1. Develop a methodology for determining the volume (MW) of large loads that can be reliably served in the immediate term (the Limit)

2. Develop a process for assigning the Limit MW to the large load projects currently requesting system access in the connection process

3. Move current projects ahead while establishing an enhanced long-term framework for connecting large loads in alignment with government policy

Interim Large Load Connection Limit Calculation

Planning Principles

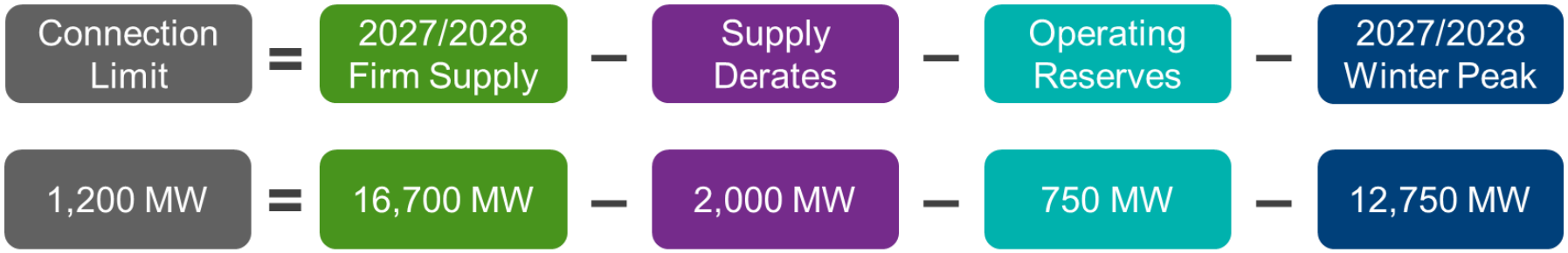
- Set a **reliability-based** large load cumulative connection limit
- The limit is solely for connection planning to ensure grid reliability representing that the AESO commits to serve DTS contracted load
- Interim threshold to guide connection planning only for Phase 1 connections in the 2027-2028 timeframe
- Implementable based on sound engineering, operational and regulatory judgement

Reasonable Conservative Planning Scenario

- Limit to be based on a reasonable, conservative scenario
  - Severe conditions grounded in plausible assumptions
  - Not extremely rare / unpredictable conditions
- Winter peak 2027/2028 with an error margin
  - Historically, the previous winter peak sets the maximum for the following 11 months
- Avoid energy emergency actions
  - E.g., no gen > MC, voltage reduction, lift ATC constraints, [public appeals, utilization of operating reserves, shedding firm load
- Utilize all reasonably expected firm generation to estimated available capability

Limit Calculation

A deterministic calculation is used to explicitly identify the risks being represented:



2027/2028 Firm Supply

The assumed base capacity of supply available to serve all loads at winter peak

Supply Derates

Planned and unplanned reductions in availability of the firm supply

Operating Reserves

A portion of the firm supply set aside for managing operating emergencies

2027/2028 Winter Peak

The maximum load expected to be served that does not include large load additions

2027/2028 Firm Supply Details – Dispatchable

2027/2028 Firm Supply = 16,700 MW

- Total existing dispatchable supply maximum capability (MC)
  - Includes gas, hydro, biomass and energy storage
  - Assumes generation currently mothballed returns to service
  - No wind or solar generation
    - Winter peak occurs in the evening so no solar
    - Extreme cold conditions have historically had little to no wind generation
- Total new dispatchable supply maximum capability MC
  - Projects meeting inclusion criteria for certainty in the connection process

2027/2028 Firm Supply Details – Interties

2027/2028 Firm Supply = 16,700 MW

- BC and Montana interties available up to frequency response limitation (i.e., no fast frequency response [FFR])
  - Energy storage is modelled to serve peak demand in the energy market rather than FFR in the ancillary services market
- No McNeill imports due to asset reliability concerns

Supply Derates Details

Supply Derates = 2,000 MW

- Recent average historical unavailability documented in Energy Trading System (ETS)
- Includes, but does not distinguish between:
  - Scheduled outages
  - Forced outages
  - Real time reductions in available capacity (AC)

Operating Reserves Details

Operating Reserves = 750 MW

- Operating reserves includes contingency reserves and regulating reserves
- Maintain operating reserves by subtracting from the supply

2027/2028 Winter Peak Details

2027/2028 Winter Peak = 12,750 MW

- Alberta's system peak occurs in the winter
- Forecast winter 2027/2028 peak from the 2024 Long-Term Outlook (LTO)
  - Accounts for nominal or typical load growth
- Add any large loads with an executed DTS contract that have occurred post-2024 LTO
- Includes a margin to be cautious regarding uncertain weather and a-typical load behavior

Calculation Results

- The AESO has determined 1,200 MW of large loads can be connected reliably
- In the event of extreme conditions in the 2027/2028 timeframe beyond those modelled in the limit calculation, the AESO has operating procedures to manage energy shortfalls
  - Operating procedures to manage unexpectedly severe supply conditions in real-time are contemplated in NERC's and the AESO's reliability standards and operating procedures
  - E.g., in Jan 2024, an EEA situation was experienced during which the AESO issued an appeal for the public to voluntarily reduce electricity use
- The amount of large load that can be reliably served can change if:
  - There are material changes in the assumptions (i.e., new generation becomes certain, interties increase reliability or capacity)
  - New load service rates, market products, or operating procedures become available
- Frequency of recalculations or changes to the calculation methodology will be determined as part of the Phase II work

The Limit Assignment Process

Principles

The design of the Limit Assignment Process was guided by the following principles:

Aligned with AESO Legislative Mandate and Duties

- Public Interest
- Safe & Reliable Grid
- Fair, Efficient and Openly Competitive
- Reasonable Opportunity to connect to the grid

Aligned with AESO Authoritative Documents

- ISO Rules
- ISO Tariff
- Alberta Reliability Standards

Aligned with Governing Legislation

- Electric Utilities Act
- Transmission Regulation
- FEOC Regulation

Good Design Principles

- Transparent & clearly articulated methodology
- Reasonable to implement and execute in a short timeframe

Applicability

Participation in the Limit Assignment Process is limited to large loads ready to advance in the Connection Process without impacting system reliability

There are two applicability criteria that must be met for the Limit Assignment Process:

>= 75MW Requested Aggregate Load

- Not applicable to energy storage or distribution
- Limited to load requested for 2027/2028
- Capped at a size that does not require system reinforcements

Project Currently in the "Studies" Stage of the Connection Process

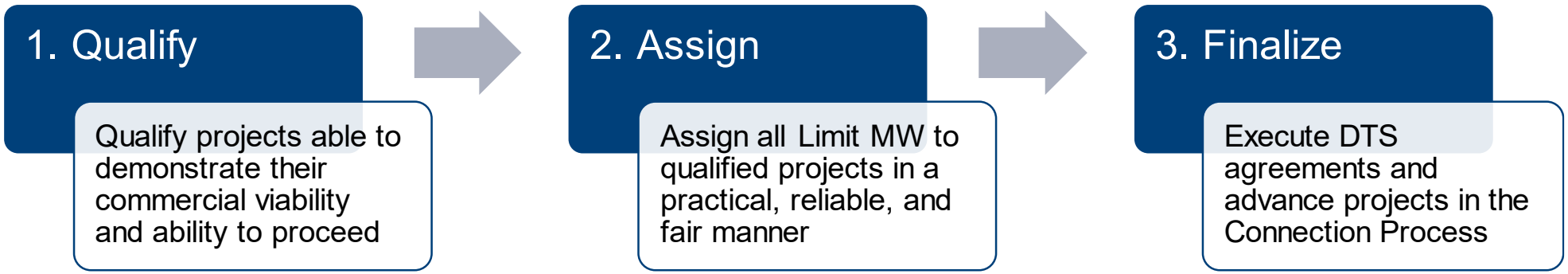
- Stage 1 for projects in the Cluster Process
- Stage 2 for projects in the Independent Process

The applicability criteria promotes reliability while balancing fairness with project progress

Process Overview

- The Limit Assignment Process is designed to provide large loads with a reasonable opportunity to connect to the grid in a fair, efficient, and openly competitive manner

The process consists of three basic steps:



The overall process balances developer participation with timely project advancement

Step 1: Qualify

The Qualify step is designed to let project developers demonstrate the readiness of their projects and willingness to commit, while confirming a reliable connection

Project developers (PDs) are required to provide:

Letter of Support

- From Municipality / County
- Zoning / Permits approved or on track

Financial Security

- 2 Months DTS plus full PILON[1] for estimated assigned MW
- ~$14M / 100 MW

Power Flow Results

- Confirmation that requested size does not require system reinforcement

Note: PDs will be provided with a letter outlining the qualification requirements for their projects

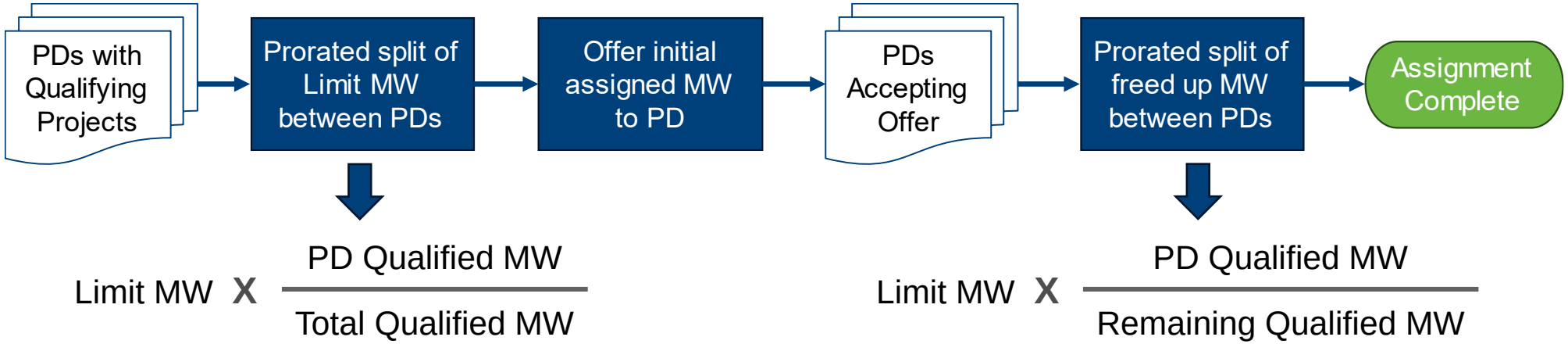
Qualification promotes a level playing field between developers requesting system access

[1] A Payment in Lieu of Notice (PILON) is required if a project developer fails to give a full 5 years notice before cancellation, delay, or reduction of their DTS contract.

Step 2: Assign

The Assign step is designed to fairly divide the Limit between developers while acknowledging the original requests and leaving flexibility for individual project DTS

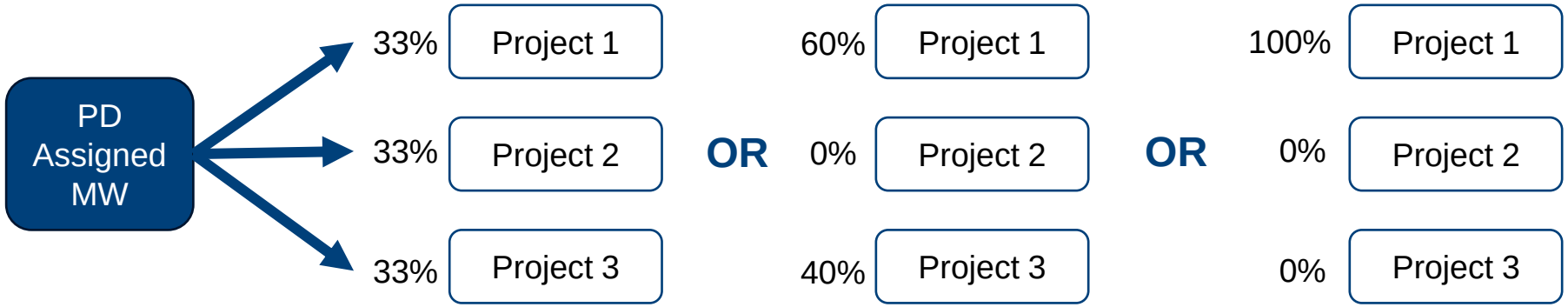
Assignment is at the PD level and includes an initial offer followed by a final assignment:



Assignment balances reasonable opportunity with a fair and practical division of the Limit MW

Step 2: Assign - Continued

- Developers may distribute their assigned MW across any of their qualified projects
  - PDs will be asked for their distribution preference with the initial offer
  - Individual projects will be limited to a maximum of the MW qualified for that project



- If the total load in an area exceeds that area's load integration capability:
  - Individual project MW in the area will be reduced on a pro rata basis until the total project load does not exceed area capability
  - PDs can choose to redistribute that MW to another project

Step 3: Finalize

The Finalize step is designed to align everything with the results of the assignment and get projects advancing in the Connection Process

Finalization consists of three primary activities:

DTS Security

- Security is adjusted as needed to align with DTS (or returned to PDs declining assignment)

DTS Contract

- Contract for assigned DTS is issued for PD execution with two-week time limit

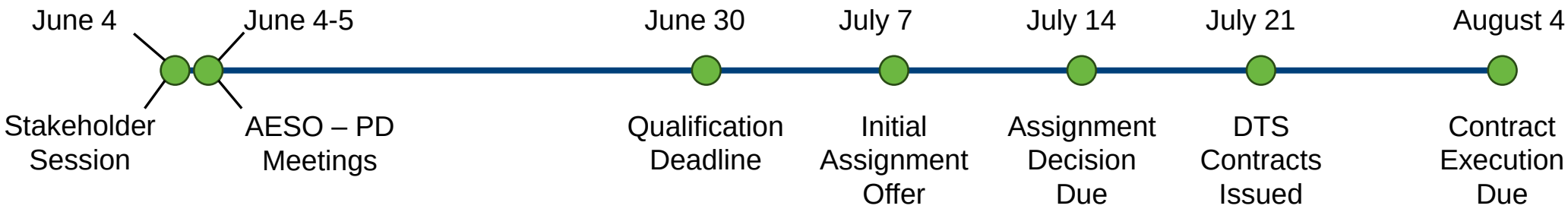
Proposal To Proceed

- Selected connection, project MW, and target in service date are provided for each project

- After executing the DTS contract, projects will:
  - Move into Stage 3 if all other Stage 2 deliverables are complete
  - Be marked as having met the inclusion criteria for project certainty

Assignment Process Timelines

- Timelines are designed to allow project developers enough time to meaningfully participate in the Limit Assignment Process, while expediting projects as quickly as possible



- Deadlines are firm and have a 5 p.m. MDT cutoff
- Project developers missing deadlines will have their MW reassigned
- Timelines can shorten if qualification completes early or all initial assignment offers are accepted

Next Steps

Projects with MW Assignments

- Projects with executed DTS contracts can continue to move through the Connection Process
  - All relevant Gate 2 deliverables must be met to progress to Stage 3
    - E.g., Stage 3/4 TFO security, order of magnitude estimates
- AESO is developing large load interconnection requirements, and will progress projects through Stage 3 in parallel
  - Some technical Gate 2 requirements will be waived or modified until Stage 3
    - E.g., dynamic model, facility design
    - The AESO project manager will communicate remaining Gate 2 requirements
  - Functional specifications will be issued with “placeholders” for requirements to be developed
    - E.g., ramp rates, load oscillation, harmonics, ride-through capabilities
- Project managers will work with project developers on schedule alignment and details for Stage 3 activities and NID filings

Paths Forward for Additional Large Load

- Connecting additional large load will require new generation, or new tariff and market tools that may become available in Phase II
- New projects or those in early stages will continue to progress through Stage 2
  - Studies will be completed for determining the grid connection and system impacts
  - Proposals to proceed will not be issued
- Projects will enter the On Hold status at the end of Stage 2
- Further advancement will be dependent on Phase II work

Phase II

- Enable a long-term framework for connecting large loads in alignment with government policy
- Assess need for new processes and authoritative documents:
  - ARS, ISO rules, Definitions
  - ISO Tariff Redesign (current engagement):
    - Interruptible rate classes
    - Terms & conditions for load shed, demand response and backup generation supply
    - Cost causation for ancillary services and network upgrades
  - Transmission Planning:
    - Enhance long-term planning and forecasting to include growth of large loads
  - Connection Process changes
- Industry and government will be engaged on Phase II work
- Anticipated to start engagement in second half of 2025

Questions

Thank You