Interconnection to the Alberta Interconnected Electrical System (AIES)

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Interconnecting Cogeneration Systems to the Transmission Network

Fred Ritter, Chief Engineer, AESO

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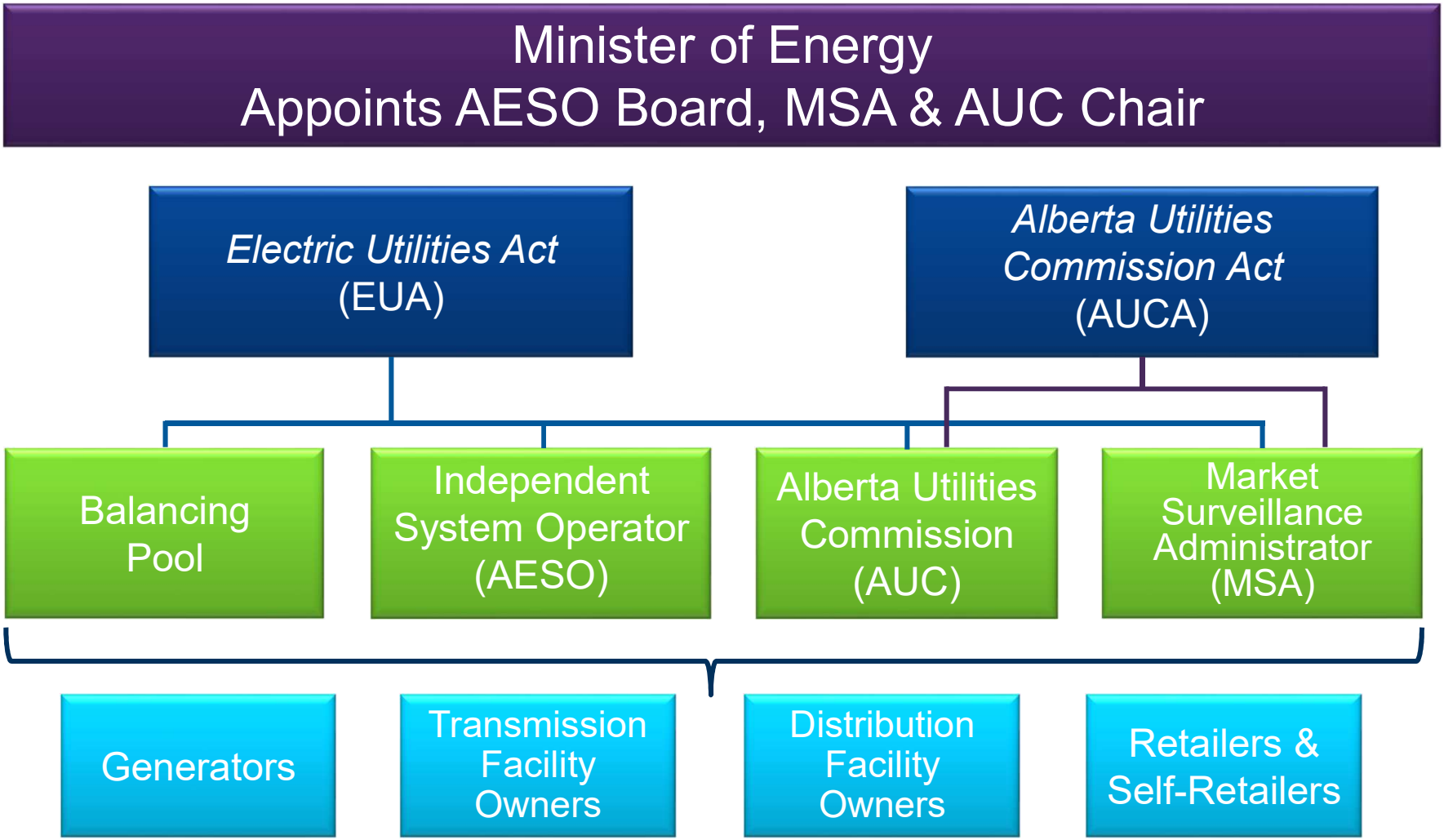
Power industry structure in Alberta



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The AESO's core functions

Transmission System Development

Plan and develop transmission system to provide reliability, facilitate competitive market and investment in new supply

System Operations

Direct reliable 24/7 operation of Alberta's power grid

Transmission System Access

Provide access for both electricity generators and large industrial customers

Market Services

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

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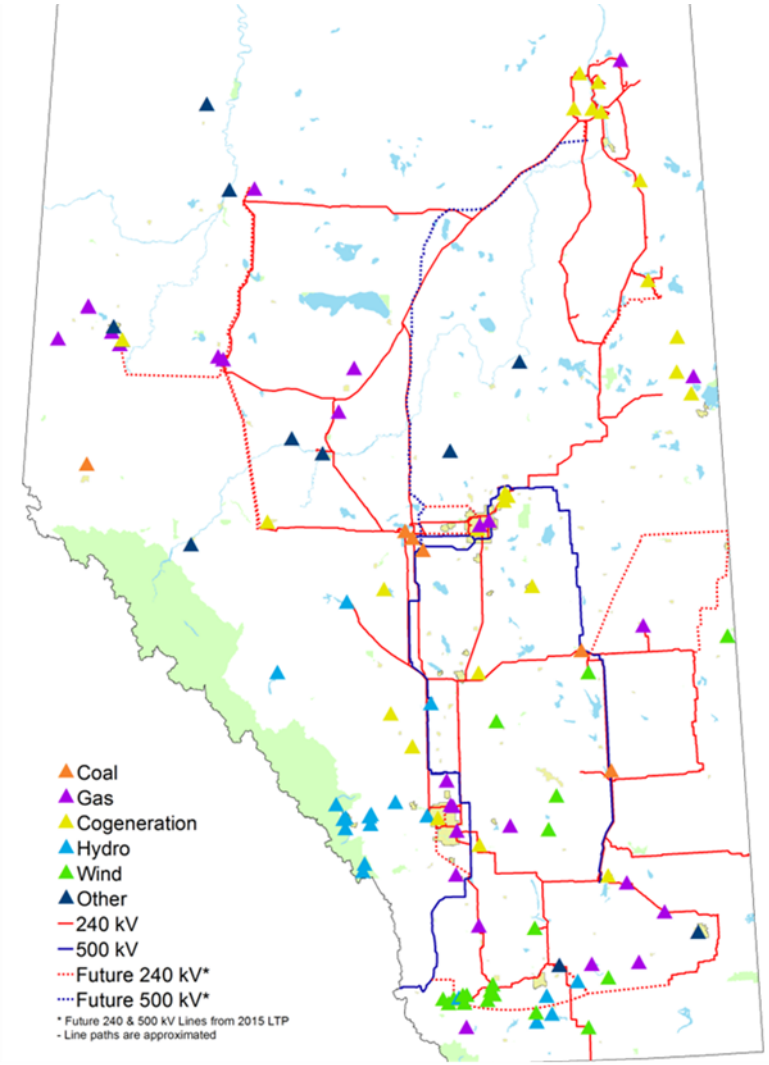
Snapshot: Alberta's power grid



- 26,000+ km of transmission
- ~235 generating units
- 16,423 MW installed generation
- 1,348 MW wind record Oct 2015
- 11,458 MW peak demand record Dec 2016
- Coal served 64% of Alberta demand for electricity in 2015
- Historical high load growth
- 200+ active connection requests

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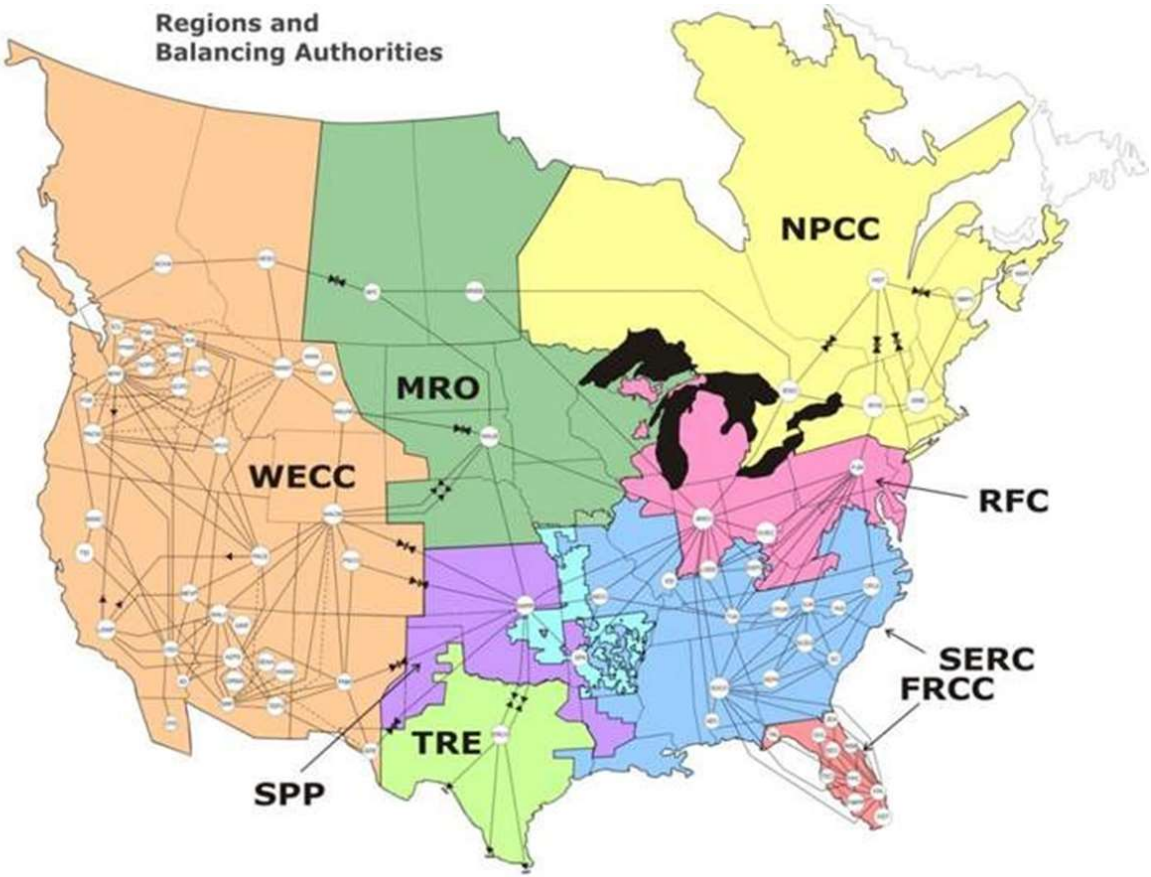
Connected to North America



- Interconnections to neighbouring jurisdictions
  - British Columbia
  - Saskatchewan
  - Montana
- Interties provide import and export capabilities

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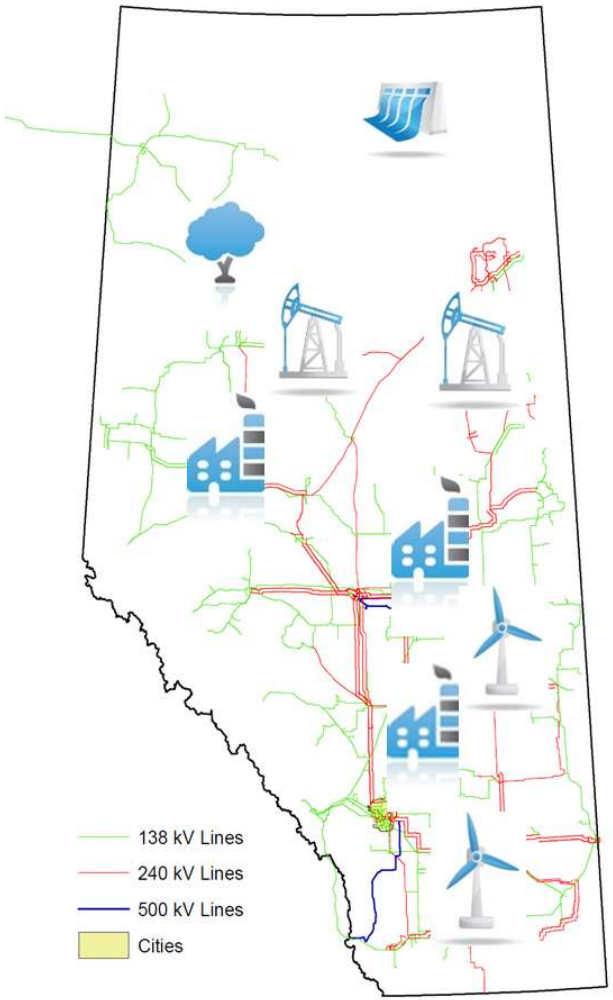
Evolving generation mix: transition from coal to renewables

Fuel		2017	2030
	Coal	6,299	0
	Cogen	4,729	5,548
	Gas	2,619	10,848
	Hydro	894	894
	Wind	1,445	5,663
	Other	437	469
	Total installed	16,423	23,422



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Evolving generation mix: transition from coal to renewables

Existing AIL peak: 11,229 MW			2030 AIL peak: 15,230 MW		
39%	Coal-fired	6,289	0%	Coal-fired	0
28%	Cogeneration	4,502	24%	Cogeneration	5,548
11%	Combined-cycle	1,716	36%	Combined-cycle	8,541
6%	Simple-cycle	996	10%	Simple-cycle	2,307
5%	Hydroelectric	894	4%	Hydroelectric	894
9%	Wind	1,463	24%	Wind	5,663
3%	Other	428	2%	Other	469
Total capacity		16,288 MW	Total capacity		23,422 MW

Existing capacity as of May 2016

** Information source: AESO*

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Alberta Reliability Standards

- Alberta Reliability Standards
  - NERC standards form the basis and cover wide range of topics
    - Resource and demand balancing, CIP, COM, emergency preparedness, design and maintenance, interchange scheduling, P&C, modelling and data, transmission operations and planning, voltage and reactive power
- Standards development process
  - AESO drafts, consults and files with AUC
- Compliance
  - AESO monitors compliance
  - WECC, by MSA agreement, monitors AESO
  - Non-compliance reported to MSA

** Information source: AESO*

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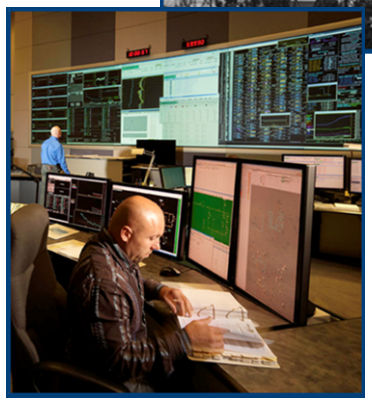
Interconnection to the AIES



- Application to the AESO
- Studies required to confirm transmission adequacy and system stability; need for good generator/load model
- Compliance with standards
- MSSC and transmission considerations
- AESO prepares FS; cogen typically dealt with as a ‘behind the fence’ type project
- Energization: ISO rule 505.3

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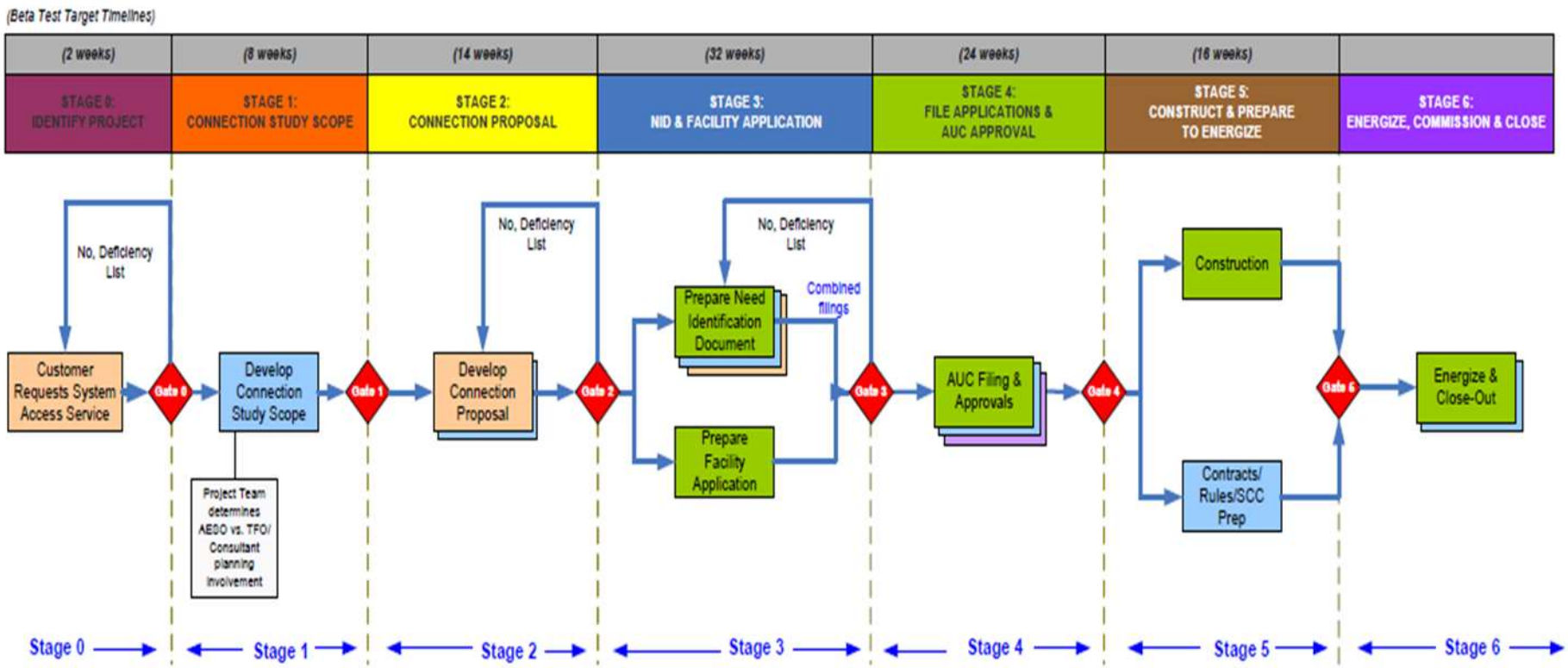
Connection process overview

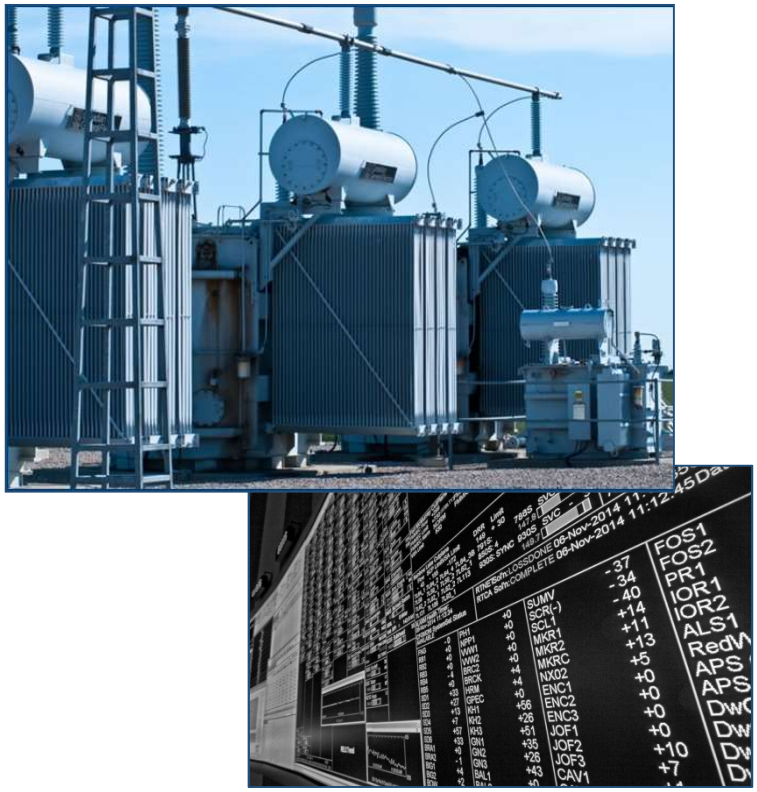


See: www.aeso.ca/grid/connecting-to-the-grid/

** Information source: AESO*

Transmission interconnection requirements

- ISO rules
  - Operational voice communication: 502.4
  - Protection: 502.3
  - Generator/load
  - Synchrophasor measurement: 502.9
  - Revenue metering
  - SCADA: 502.8
  - Transmission data



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Technical requirements: applicability to generating units

- Requirements applied to generating units to connect to AIES are found in ISO Rules
  - Section 502.5: Generating Unit Technical Requirements
  - Section 502.6: Generating Unit Operating Requirements
- Generators are considered transmission system connected if either facility or generating unit (including step-up transformer) are connected at >25 kV
- Contact local DFO for requirements to connect to those systems

** Information source: AESO*

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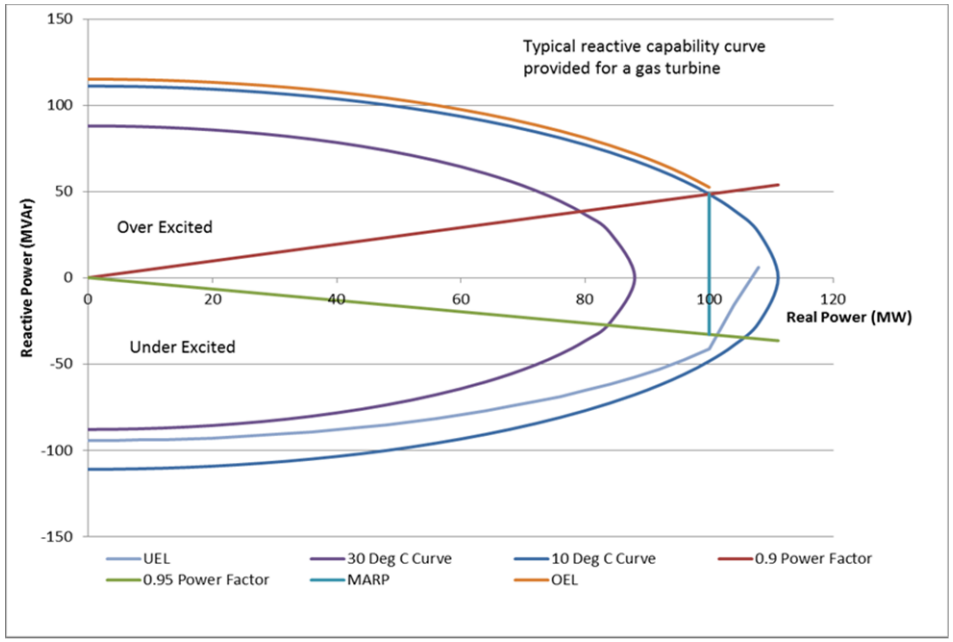
Key technical requirements: MARP and reactive power

- Maximum Authorized Real Power (MARP) is maximum output as measured at stator winding terminals under optimal conditions while meeting AESO requirements
  - Reactive power capability typically is limiting factor

- 0.9 power
  - factor
  - over-excited

- 0.95 power
  - factor
  - under-excited



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Key technical requirements: voltage control

- All generating units connected to transmission system must have Automatic Voltage Regulator (AVR)
  - AVR must have capability to be set between 0.95 and 1.05 per unit at stator terminals
  - Must be capable of maintaining voltage at 0.5% of set point
- These modes of operation are not permitted:
  - Constant VAR control
  - Constant power factor control
- Point of control cannot be on high side of transmission system step-up transformer
- Allow for continuous operation between 0.90 and 1.10 per unit as measured on high side of transmission system step-up transformer

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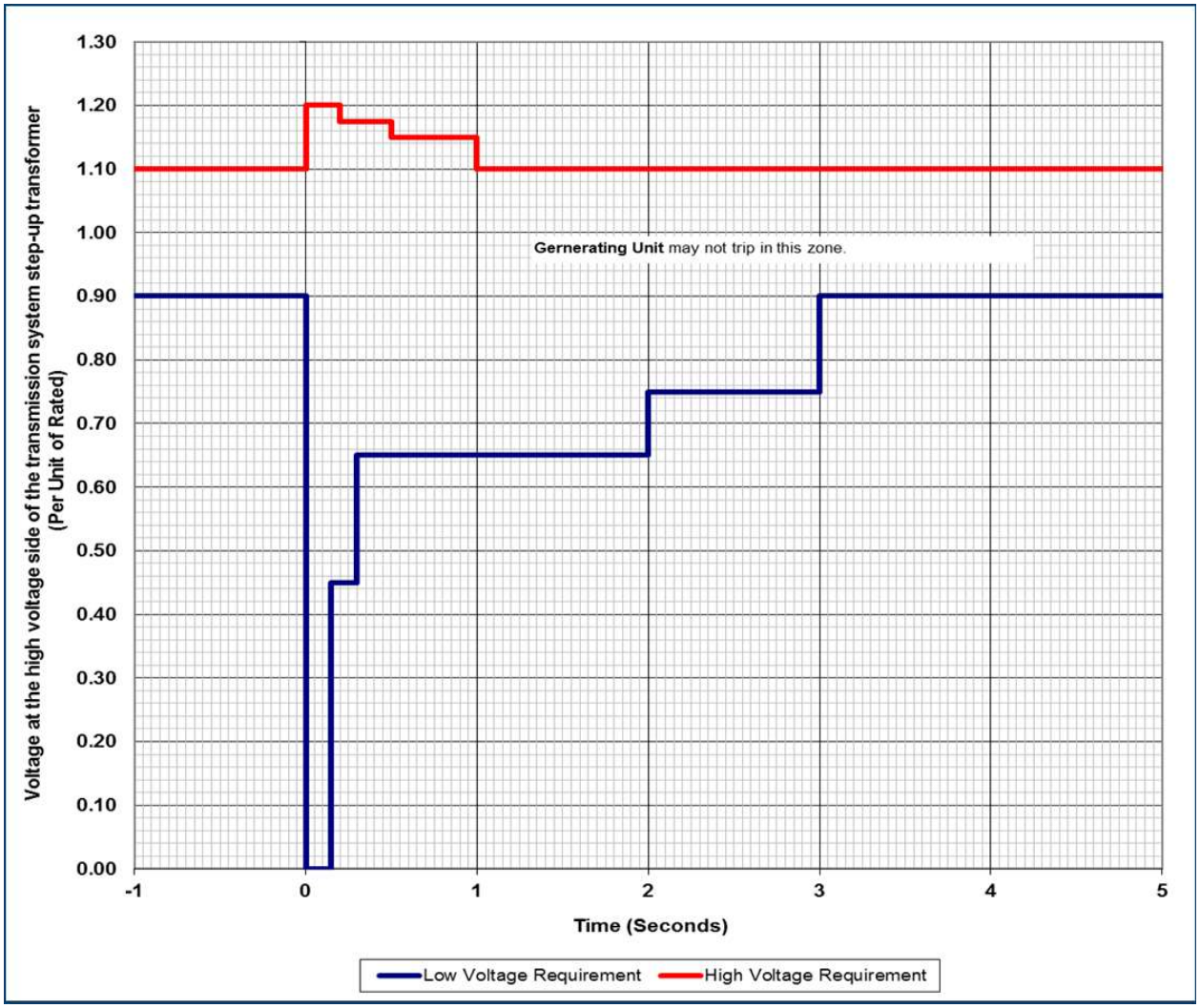
Voltage ride-through: 502.5: Appendix 2



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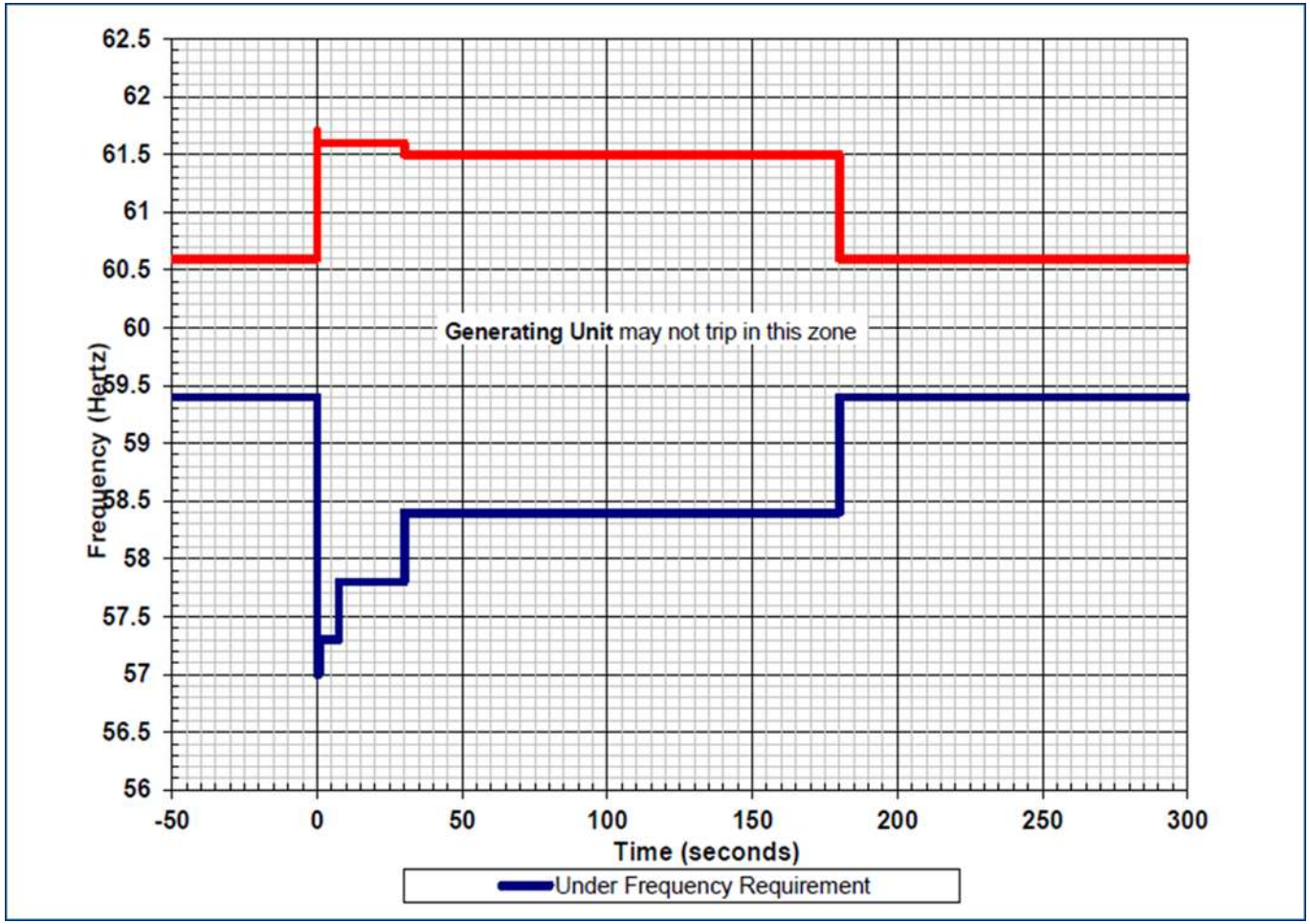
Frequency ranges: 502.5: Appendix 3



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Other technical requirements per 502.5 and 502.6

- Power system stabilizer
- Model validation (WECC) testing
- Transformer connection and sizing
- Frequency control (governor systems)
- Frequency ride-through
- Sequence-of-events recording
- Synchrophasor measurement

** Information source: AESO*

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Ancillary services an opportunity

- Qualified generators may participate in ancillary services market
- Requirements in ISO Rules Division 205: Ancillary Services Market
  - Supplemental reserve
    - 5 MW minimum
    - Able to come on-line or increase output within 10 minutes of a directive
  - Spinning reserve
    - 10 MW minimum
    - Must be on-line and responsive to frequency
    - Able to increase output within 10 minutes of a directive
  - Regulating reserve
    - 15 MW minimum
    - Must be on-line and responsive to frequency
    - Able to follow AESO's AGC signal

** Information source: AESO*

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Cogeneration snapshot: Jan. 11/17 at 2 p.m.

ASSET	MC	TNG	DCR
ATCO Scotford Upgrader (APS1)	195	105	25
Air Liquide Scotford #1 (ALS1)	96	81	6
AltaGas Harmattan (HMT1)	45	18	0
Base Plant (SCR1)	50	19	0
Bear Creek 1 (BCRK)	64	0	0
Bear Creek 2 (BCR2)	36	16	0
BuckLake (PW01)	5	5	0
CNRL Horizon (CNR5)*	203	197	0
Camrose (CRG1)*	10	9	0
Carseland Cogen (TC01)	95	76	0
Christina Lake (CL01)	101	96	0
Dow Hydrocarbon (DOWG)	326	156	40
Edson (TLM2)	13	10	0
Firebag (SCR6)	473	374	0
Foster Creek (EC04)	98	86	0
Joffre #1 (JOF1)	474	232	18
Kearl (IOR3)	84	10	0
Lindbergh (PEC1)*	16	16	0
MEG1 Christina Lake (MEG1)	202	181	0
MacKay River (MKRC)	197	199	0
Mahkeses (IOR1)	180	171	0
Muskeg River (MKR1)	202	182	12
Nabiye (IOR2)*	195	91	0
Nexen Inc #2 (NX02)	220	130	0
Poplar Creek (SCR5)	376	197	0
Primrose #1 (PR1)	100	88	0
Rainbow Lake #1 (RL1)	47	0	0
Redwater Cogen (TC02)	46	40	0
Shell Caroline (SHCG)*	19	0	0
Syncrude #1 (SCL1)*	510	432	0
U of C Generator (UOC1)*	12	14	0
University of Alberta (UOA1)*	39	15	15

** Information source: AESO*

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AESO references

- **See:** www.aeso.ca
- **ISO rules**: www.aeso.ca/rules-standards-and-tariff/iso-rules/
- **Alberta Reliability Standards:** www.aeso.ca/rules-standards-and-tariff/alberta-reliability-standards/
- **AESO transmission tariff:** www.aeso.ca/rules-standards-and-tariff/tariff/
- **AESO connection process:** www.aeso.ca/grid/connecting-to-the-grid/connection-process/
- **Loss factors:** www.aeso.ca/grid/loss-factors/
- **Grid operations:** www.aeso.ca/grid/grid-operations/

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