Ontario Green Energy Act
Connecting Renewable Resources

NPCC Governmental/Regulatory Affairs Advisory Group

Roundtable Discussion

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May 5, 2010 – 3:00 – 3:30

Topics for Discussion

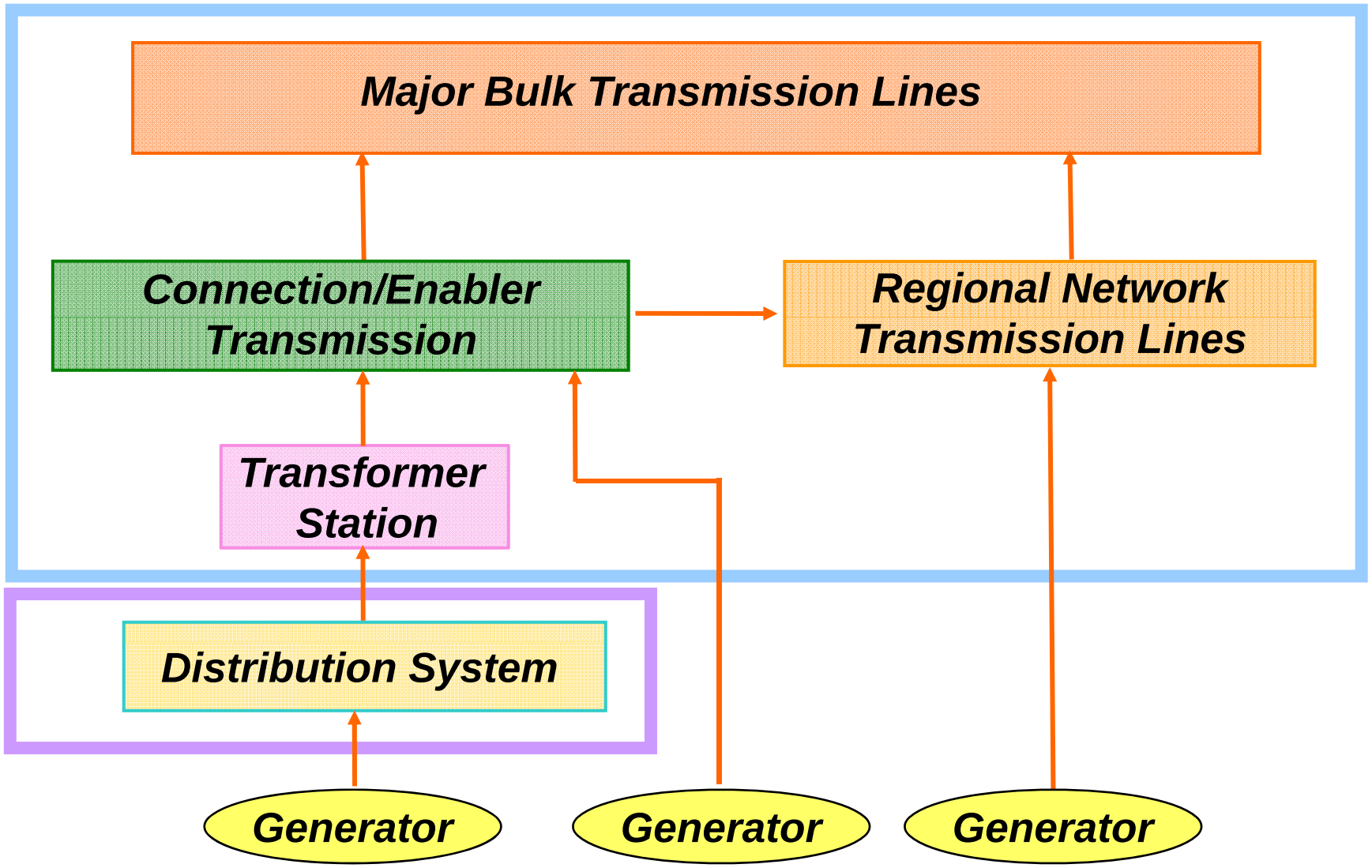
- Government Policy
- Regulatory Initiatives (Transmission & Distribution)
  - Cost Responsibility
- The connection process in Ontario
- Technical Issues and their regulatory treatment
- Experiences in other NPCC jurisdictions

POLICY

Ontario Green Energy Act

- Passed May 14, 2009
- Attract new investment, create new green economy jobs & better protect the environment.
- Position Ontario as renewable energy leader, and to create a culture of conservation
- Streamlined approvals for renewable energy projects
- Home energy audits
- Feed-in-tariff (FIT): Guaranteed prices for renewable energy projects

Generation Connections



Regulatory Initiatives

Connection of Renewables to Transmission and Distribution Systems

- **New cost responsibility policy** for “Enabler Facilities”
- **Revised cost responsibilities** for connection of renewables
- **New processes** for connection of renewable generation facilities
- **Revised billing** for generator customers’ choice of metering

Amendments to Transmission System Code

Enabler Facility

- *A line connection facility or a transformation connection facility;*
- *constructed, owned and operated by a transmitter; and*
- *to which 2 or more generation facilities will be connected, that are part of a renewable resource cluster*

Amendments to Transmission System Code

Hybrid Cost Model for Enabler Facilities

- Costs pooled temporarily
- Each connecting generator to make capital contribution
- Pro-rata contribution reflects capacity share
- Outstanding costs for “unsubscribed” portions recovered from transmission ratepayers.
- These assets would previously not have been part of rate base.

Distribution Cost Responsibility Amendments
Three Distribution Asset Investment Categories

- Connection Assets
- Renewable Energy Expansions
- Renewable Enabling Improvements (REI)

Distribution Cost Responsibility Amendments Summary
Cost Responsibility for Various Assets

Distribution Investment Type	Previous Cost Responsibility	Revised Cost Responsibility
Distribution Connection Assets	Generator	**Generator** (no change)
Distribution Expansions	Generator	Costs up to a "Renewable Expansion Cost Cap" of $90,000 per MW: **Distributor** Costs in excess of Cap: **Generator** Costs of expansions included in an OEB-approved plan: **Distributor**
Renewable Enabling Improvements	Generator	**Distributor**

The connection process in Ontario

1. Transmission Availability Test
2. Distribution Availability Test
3. Economic Connection Test
4. System Impact Assessment (Transmission)
5. Customer Impact Assessment (Transmission)
6. Connection Impact Assessment (Distribution)

1-2. Transmission / Distribution Availability Test

- Screening assessment: Is project likely to fit in the existing system?
- Sufficient capacity available on the existing system to connect project ?
- Focus on connection and transformation capacity, network transfer capability, congestion and system security
- Considers the complete delivery path from the FIT project's point of connection to the main Ontario bulk transmission system

3. Economic Connection Test

- Consider system expansion, facility requirements network reinforcement needs and related cost issues

4. Transmission System Impact Assessment

5. Transmission Customer Impact Assessment

- Impact on GRID and mitigation measures. It considers the impact on
  - transfer capabilities
  - fault (short circuit) levels
  - protection systems
- Customer Impact Assessment assesses impact on other transmission customers
  - Impact on fault level and voltage at customers' location
  - 30-day customer review period of draft report

Typical Recommendations

- Required facility (e.g.. Line) upgrades
- Acceptably or changes to connection arrangement
- Installation or enhancement to Special Protection Systems
- Required static & dynamic Var resources
- Mitigation measures for fault level issues
- Protection or connection changes to mitigate protection issues
- Measures (e.g. grounding reactors) to resolve fault level issues
- Reactive devices (e.g. shunt capacitors) to resolve customer voltage issues

6. Distribution Connection Impact Assessment

- Completed within 60 days
- Identifies impacts of project on distribution system due to voltage impacts, current loading, and fault currents.
- Provides connection requirements
- Detailed analysis based on detailed generator electrical data

Technical Issues

- Hydro One Distribution has connected approximately 30 generators in the last 2 years
- Connecting generators to distribution is a new experience:
  - Generation connected to long feeders
  - Transformer station capacity
  - Dual Secondary Winding Transformers
  - Short circuit considerations
  - Protection Considerations

Hydro One Distribution
Experience With Long Feeders

- As distance of the connection from the station increases, voltage becomes more sensitive to changes in injected power
- Large generators far from the station can have significant impact on voltage levels in the vicinity of the connection as their power injection fluctuates
- Experience has shown that large changes in voltage (both over- and under-voltage) can occur and impact customers
- Further aggravated when the connected load on the feeder is small, the generation is intermittent and the electrical system strength is weak

Station Capacity

- Substations were designed, rated and operated as step-down substation with power flowing from higher to lower system voltage
- Large accumulation of distribution connected generation on these stations could result in reversal of normal power flows
- There was a reduction in minimum system load
- Limit determined by Hydro One: Reverse power flow not to exceed 60% of station capacity considering 1 transformer out of service

Dual Secondary Winding Transformers

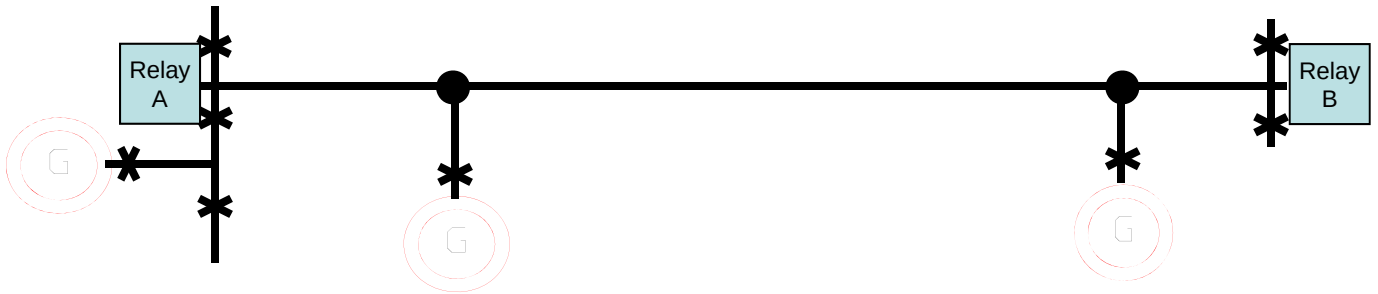
- Equal reverse flow in the two secondary windings cannot be assumed
- Some dual secondary winding transformers do not allow for reverse power flow conditions
- Based on manufacturer information, we determined that dual secondary winding transformers cannot withstand forward flow in one secondary winding while there is reverse flow in the other secondary winding
- Imbalance between the two secondary windings causes overheating in the transformer

Short Circuit

- Distribution connected generation on substations increases the Short Circuit level at low voltage bus
- Short Circuit levels are already high at some stations
- The short circuit contribution of a generator at a station depends on the following parameters:
  - Generator technology (inverter, rotating machine)
  - Distance from the station (greater distance results in lower short circuit contribution)
- Short Circuit levels at the station low voltage bus must be within regulatory requirements

Protection Considerations

There are known protection issues with multiple generation projects using tap connections to transmission lines.



Possible Protection Solutions

- Change settings on existing protections
- Add blocking to existing protections
- Replace with advanced protection system
- Add a station for in-line breakers or a ring bus

Discussion

- Assessments are intensive
- Experience still being gained
- Communication is key
- What do other jurisdictions encounter?
- What are the regulatory implications?