Evaluating the Impact of Tie-Point Controllers on the Distribution Grid

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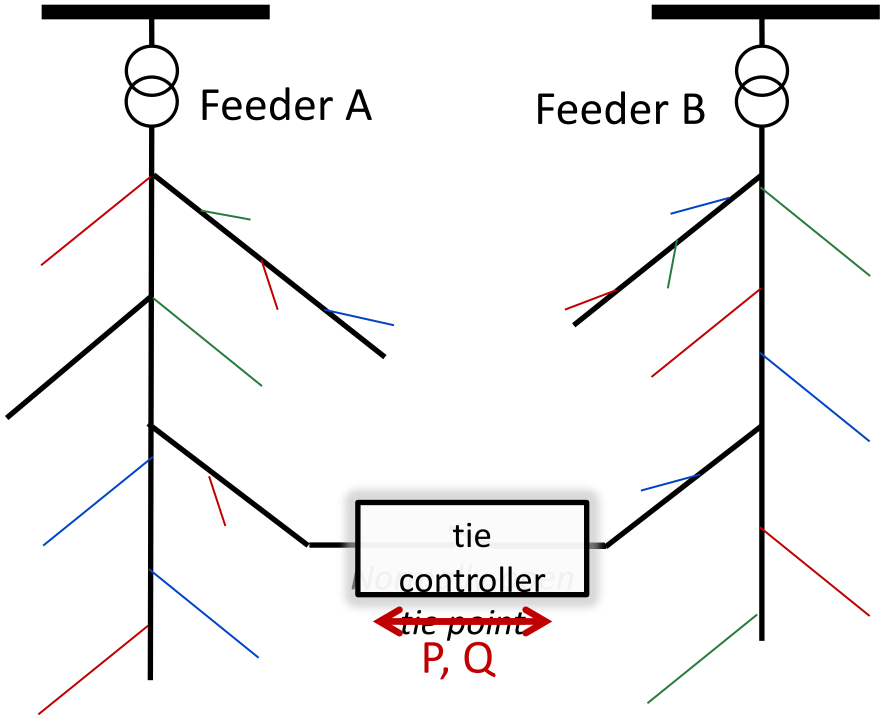
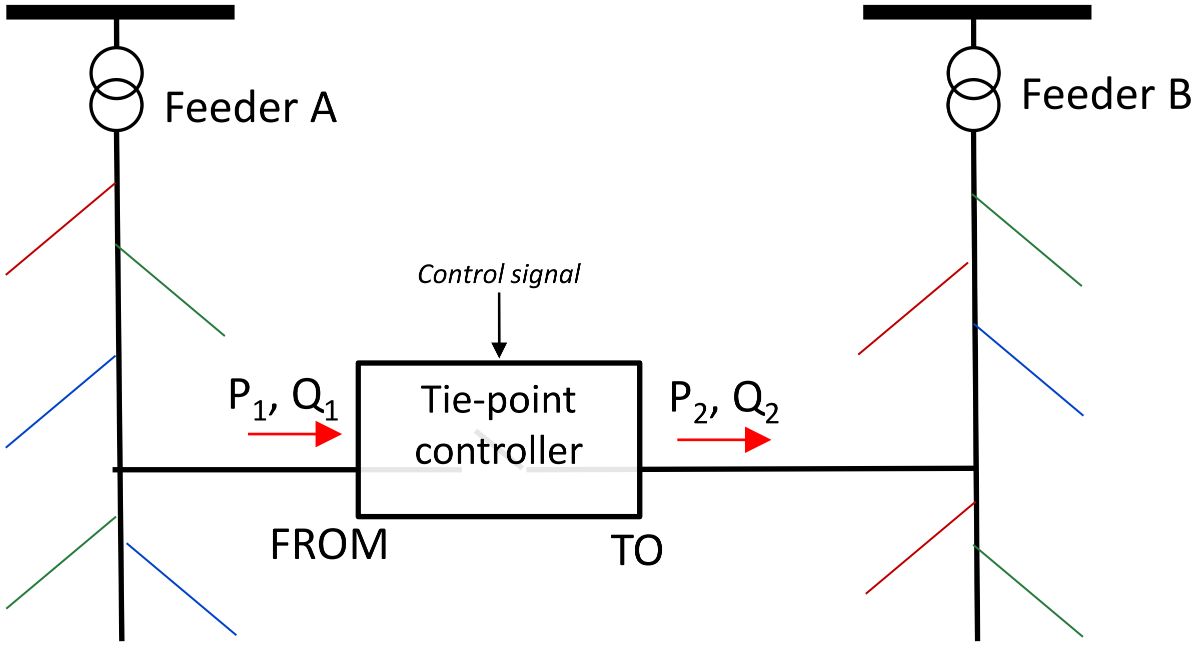
Introduction

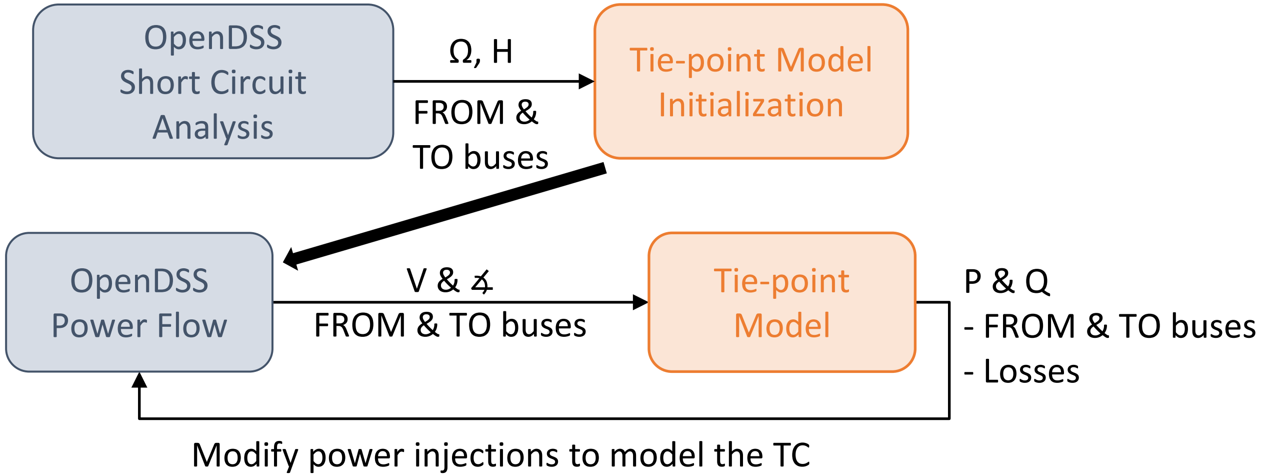
- Electric distribution systems in the US are operated radially.
- Normally-open/closed tie points between distribution feeders can be leveraged to reconfigure the system.
- Reconfiguring to shift demand from one feeder to another can either be done for addressing feeder conditions or as a temporary solution to a fault on the system.
- The amount of power shifted between feeders is dependent on the configuration of the system.

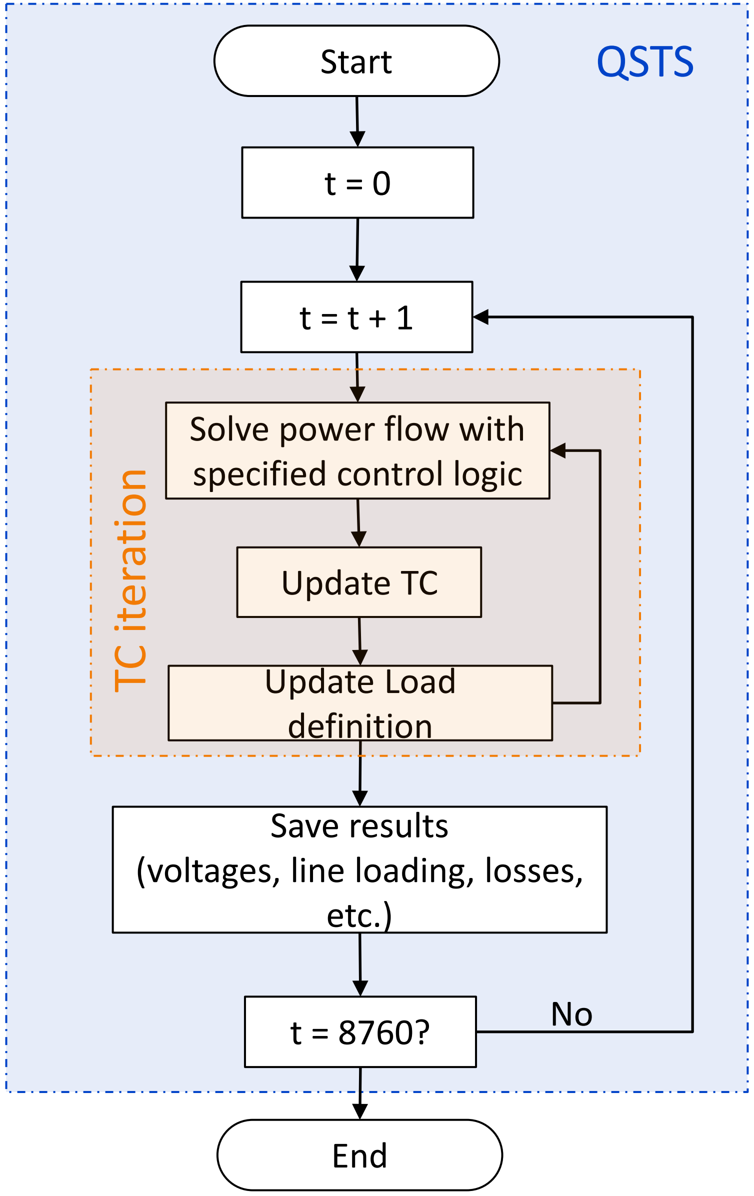


- Dynamic tie: power-electronic-based device that would enable to throttle the power from one feeder to another without creating a loop in the system.

Methodology | Power Flow Simulation







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Modelling and Simulation

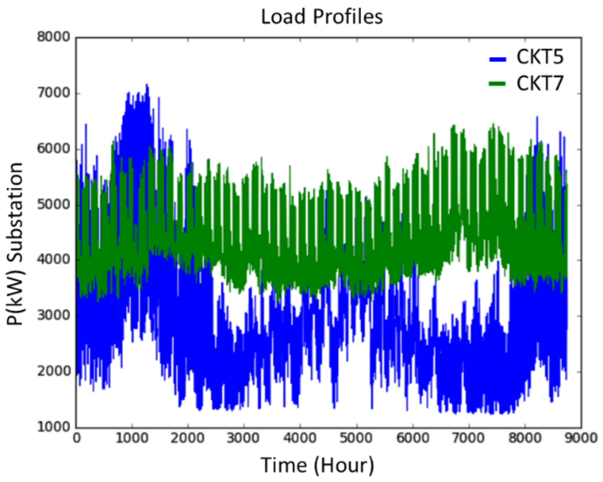
‘Base-Case’ : time series simulation is executed without the operation of the tie-point controller. Captures the severity of issues on either system during their normal yearly operation and it’s used as a reference to understand any benefit the tie-point controller can provide.

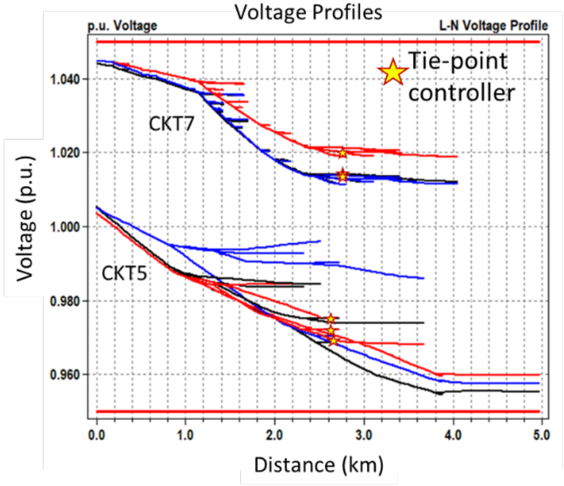
‘Peak-Shaving’ : monitors the highest loaded line in one circuit and exchanges power to alleviate the congestion and avoid thermal issues. The peak-shaving logic assesses the current through an identified critical line and outputs the real power needed to avoid current magnitudes exceeding a defined threshold. The power transferred maintains a constant unity power factor.

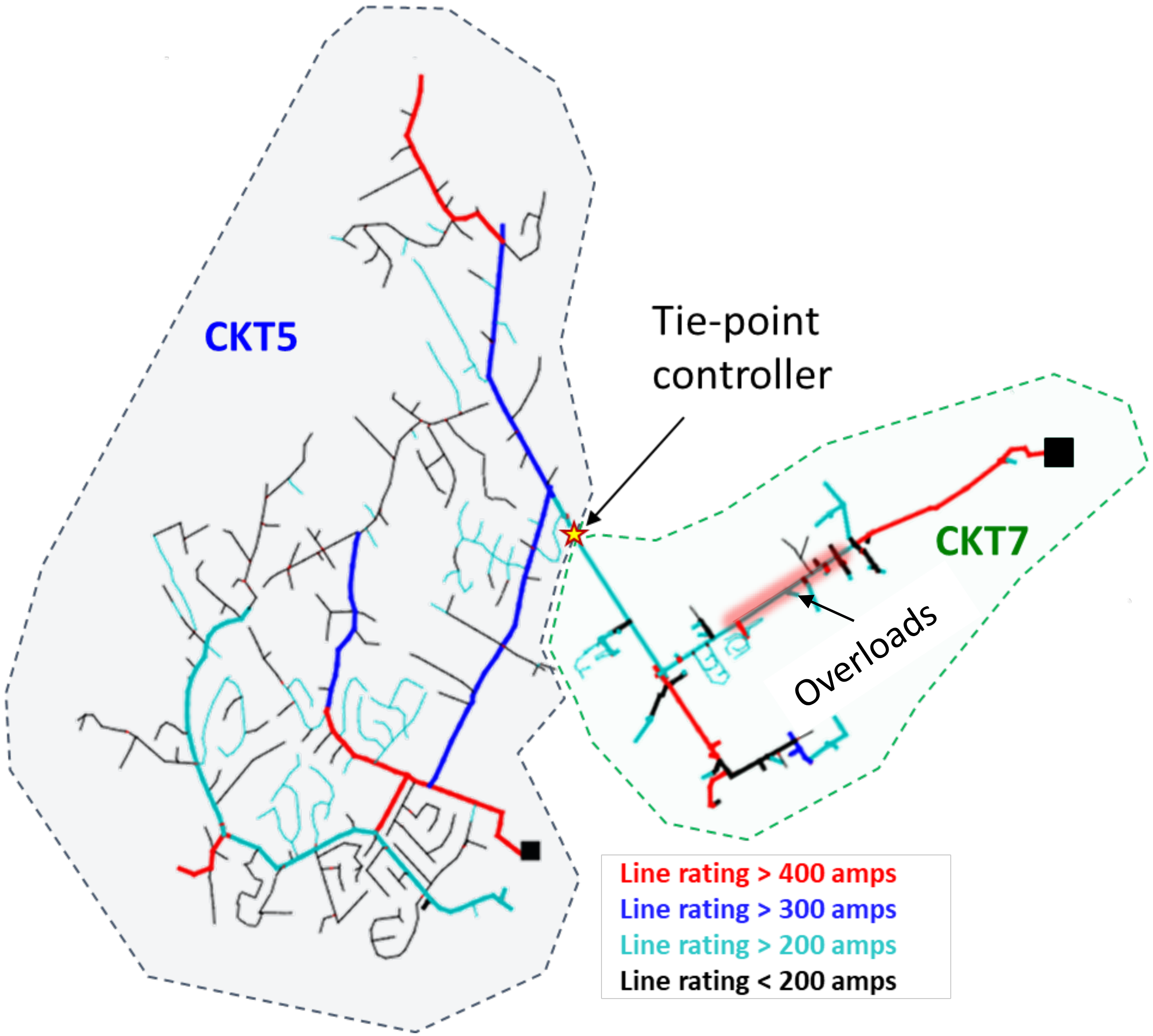
‘Voltage-Control’ : addresses the thermal violation as discussed in the ‘*Peak-shaving*’ simulation however, in this case the reactive power is controlled such as to not cause any voltage issues due to the power transferred from Feeder A

Modelling and Simulation

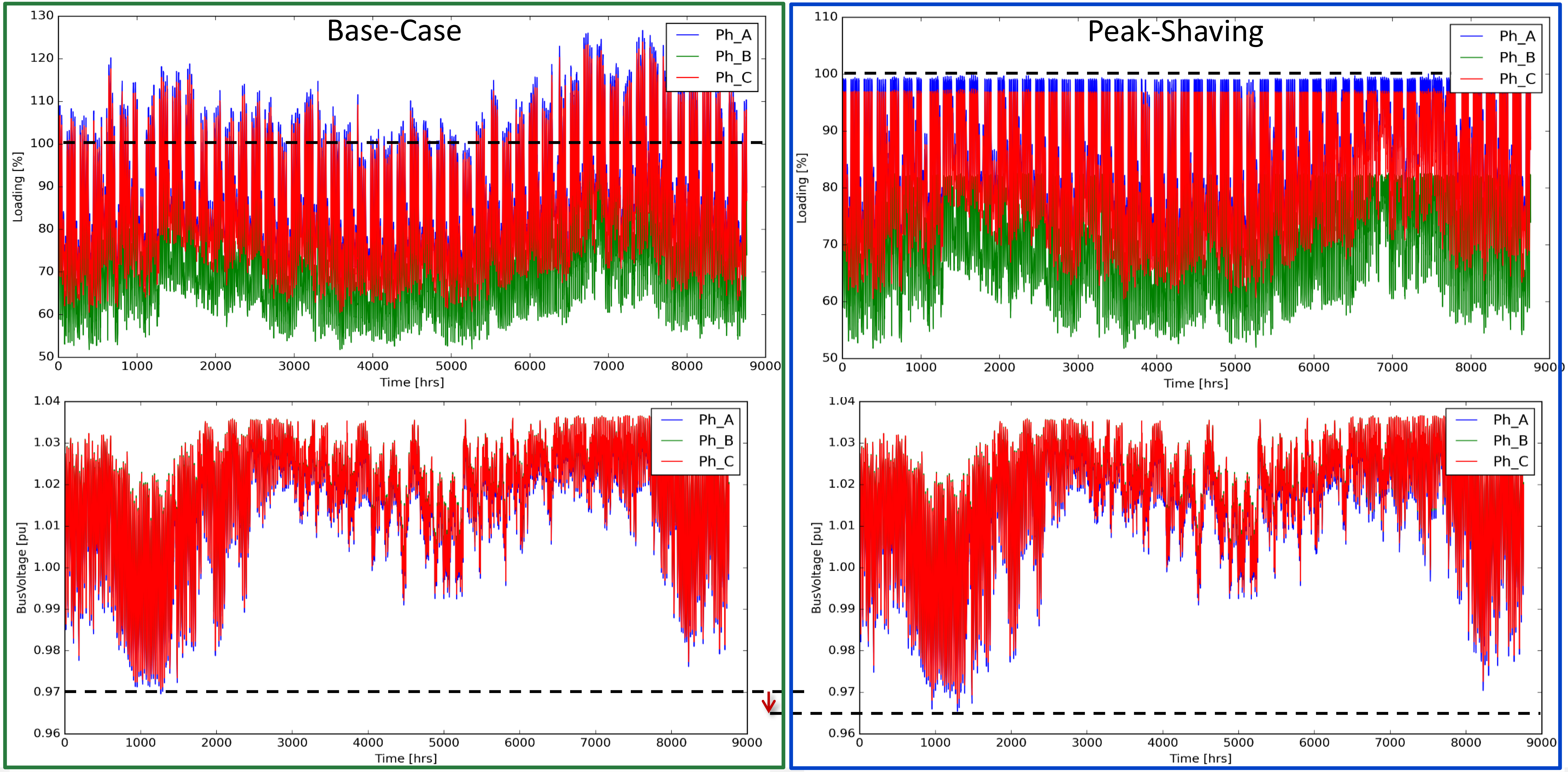
- The yearly time-series load flow simulations were performed emulating a planning study considering CKT7 would experience a thermal constraint to be addressed in which the additional load capabilities of CKT5 could be leveraged.
- The base-case scenario was utilized as a benchmark to compare the tie-point controller deployment under different control logics: peak-shaving and voltage-control.



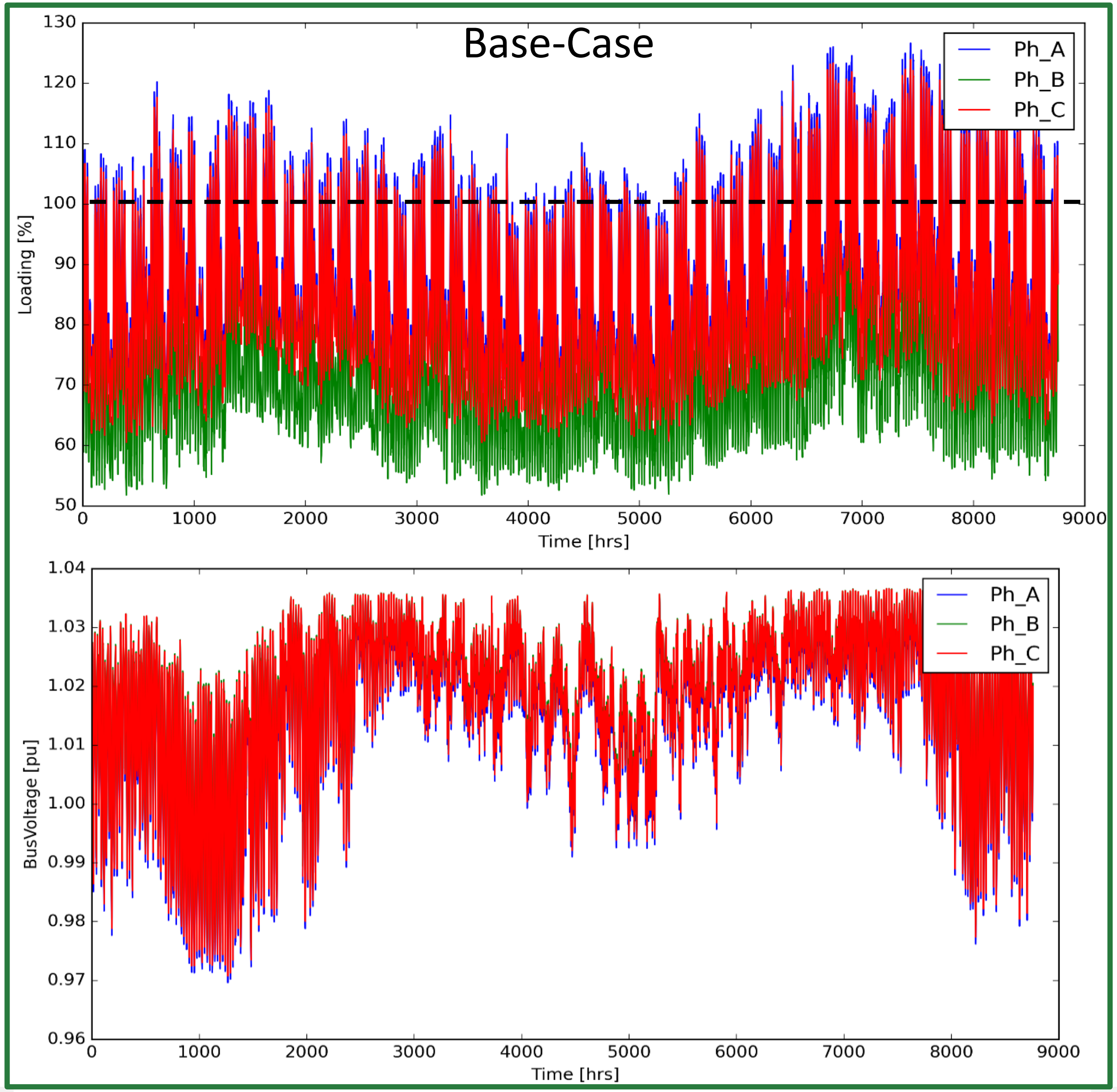


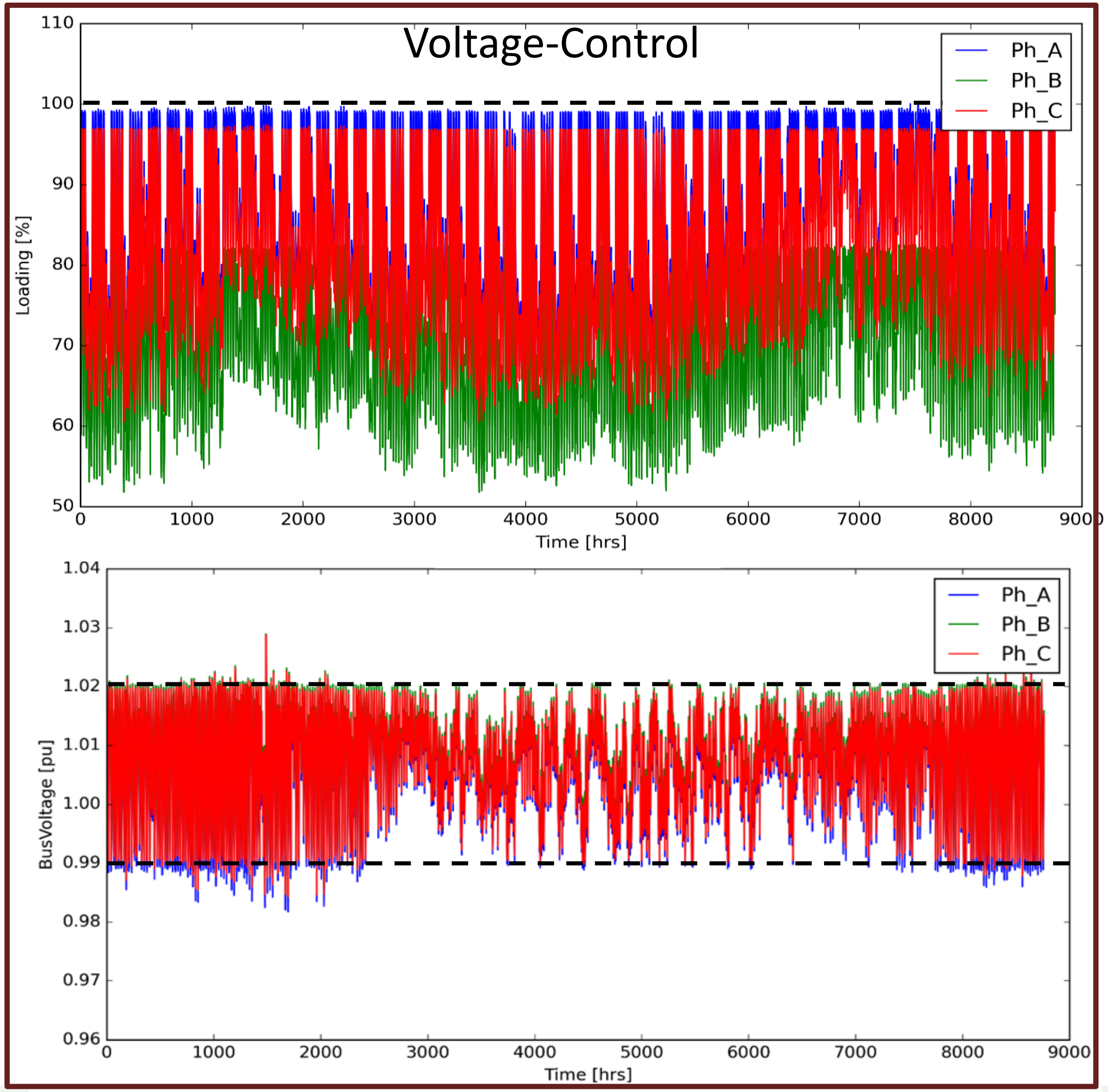


Modelling and Simulation | Results

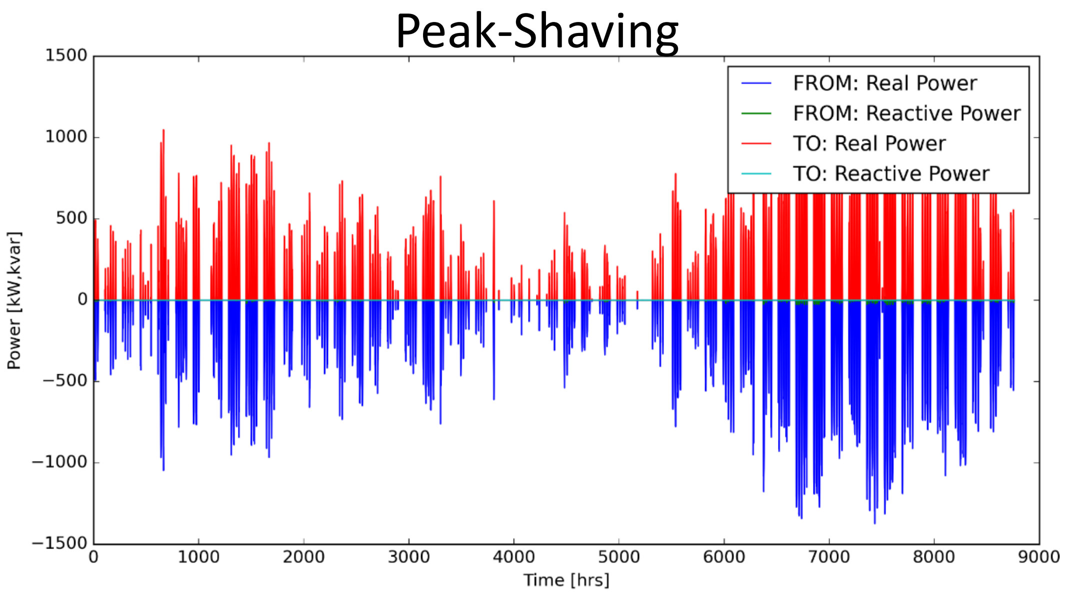


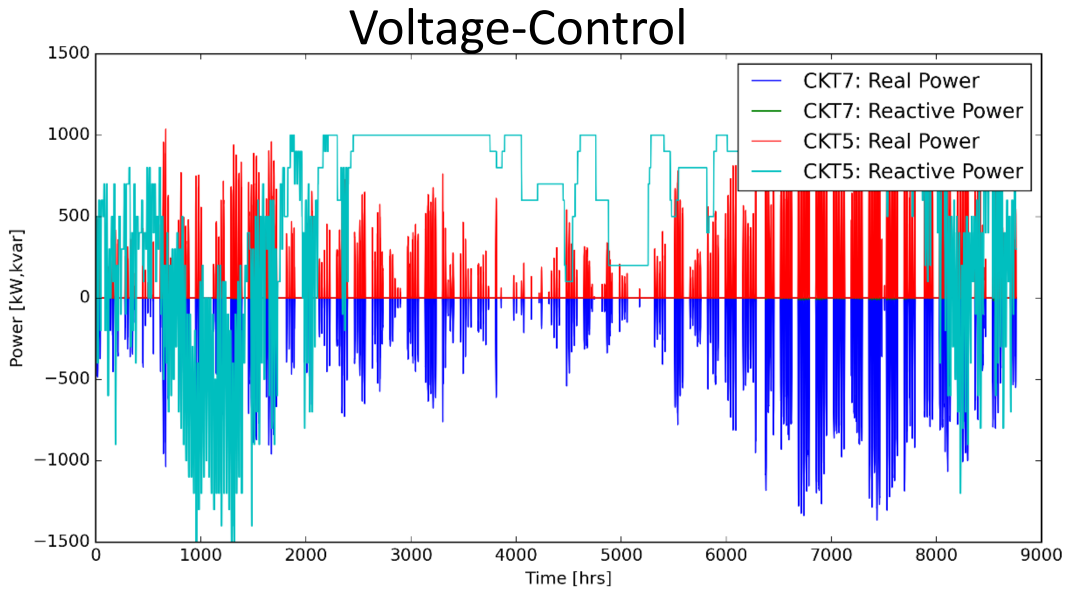
Modelling and Simulation | Results





Modelling and Simulation | Results





		Base-Case	Peak-Shaving	Voltage-Control
Lines	Hours Overloaded	2,049	0	0
	Total number overloaded	23	0	0
Transformers	Hours Overloaded	731	731	731
	Total number overloaded	10	10	10
	Total Tap changes	98	24	24
Voltages	Average voltage	1.021	1.021	1.017
	Over voltage violations	26,120	0	0
	Under voltage violations	20,952	27,802	3,149
Losses	Total P Losses (MWh)	2,624	2,619	2,670
	Total Q Losses (Mvarh)	6,295	6,426	6,657

Key Findings

- Dynamic tie controllers can:
  - provide additional controllability for distribution operators to manage their system.
  - provide the ability to leverage capacity across two distribution feeders to accommodate additional resources.
  - enable not only controlled real power transfer but also controlled reactive power injection, separately.
  - enable power transfer between feeders with mismatching voltage levels or phase angles.
  - can enable the transfer significant real power from one feeder to another without significantly impacting the voltage profile of the 'providing' feeder due to its ability to control reactive power flow

Thank You