High Penetration PV Control Comparisons

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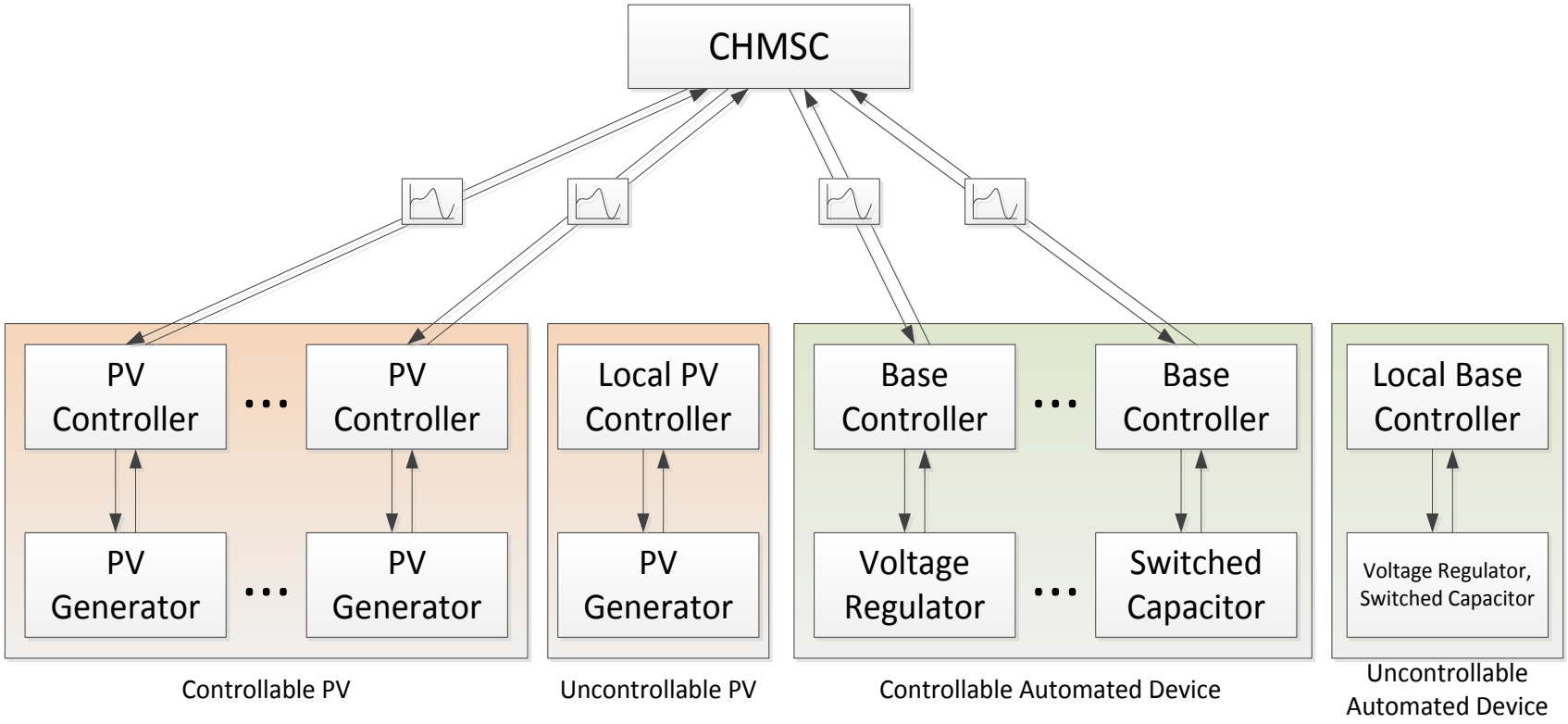
Robert Broadwater
Jaesung Jung
dew@edd-us.com
www.edd-us.com

CHMSC Objectives

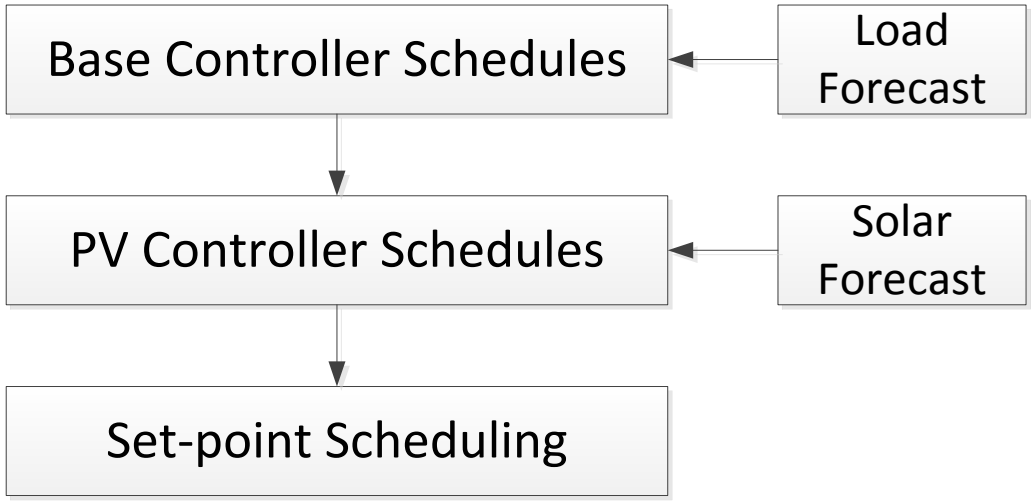
- Configurable, Hierarchical, Model-based, Scheduling Control
- Collects circuit-wide information and uses model to calculate set-points for control devices
- Sends control set-points to both utility control devices and PV controllers
- Strives to maintain the voltage profile that exists without PV generation while minimizing circuit losses and also while reducing the motion of utility control devices

CHMSC Control Architecture



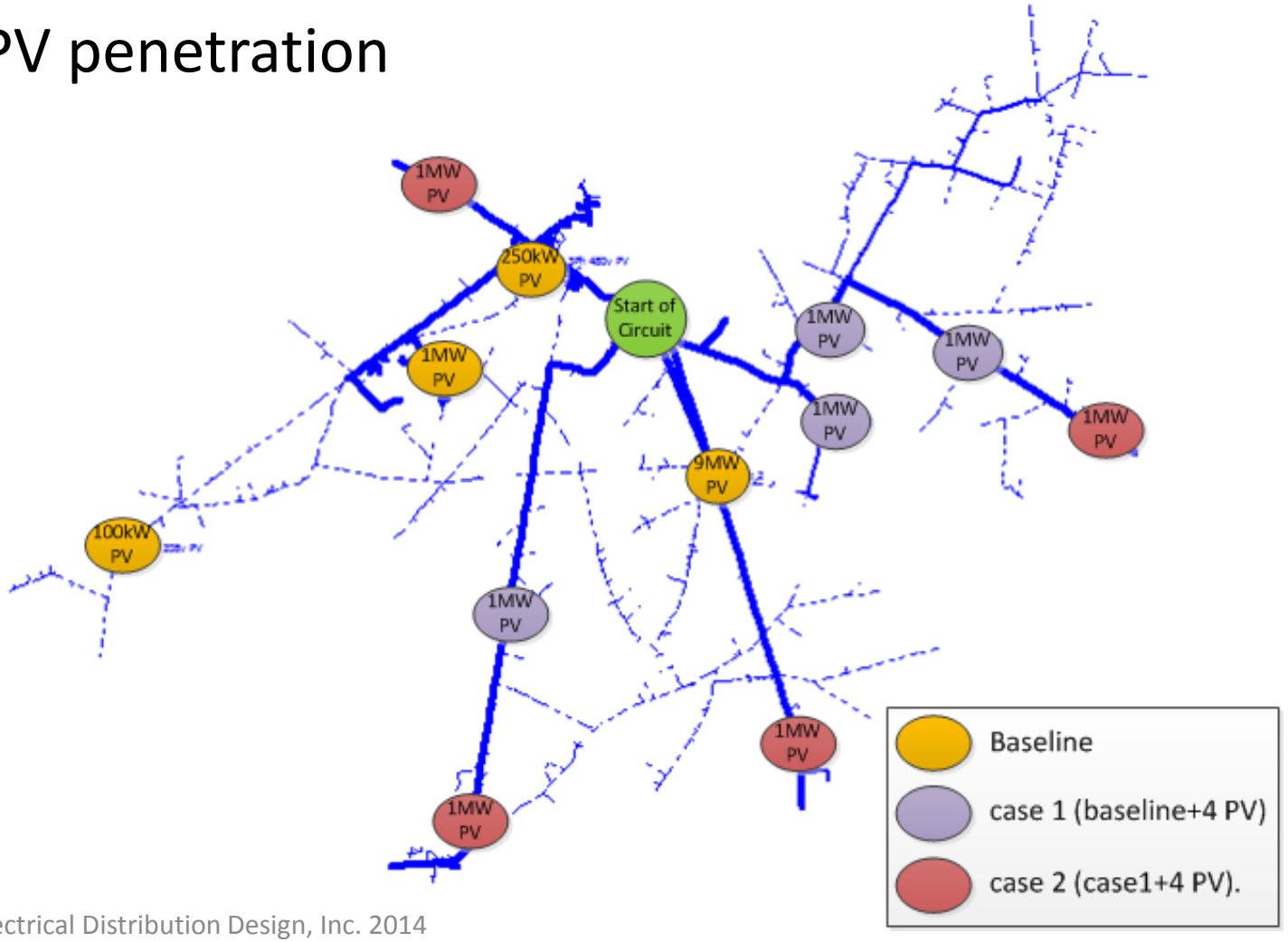
CHMSC Algorithm

- ✓ Updates periodically, where every five minutes is currently used
- ✓ Updates set-point schedules for base and/or PV control only if schedules change significantly
- ✓ If a communication failure occurs, the local controllers continue to work against the previously provided schedule as long as local constraint violations do not occur

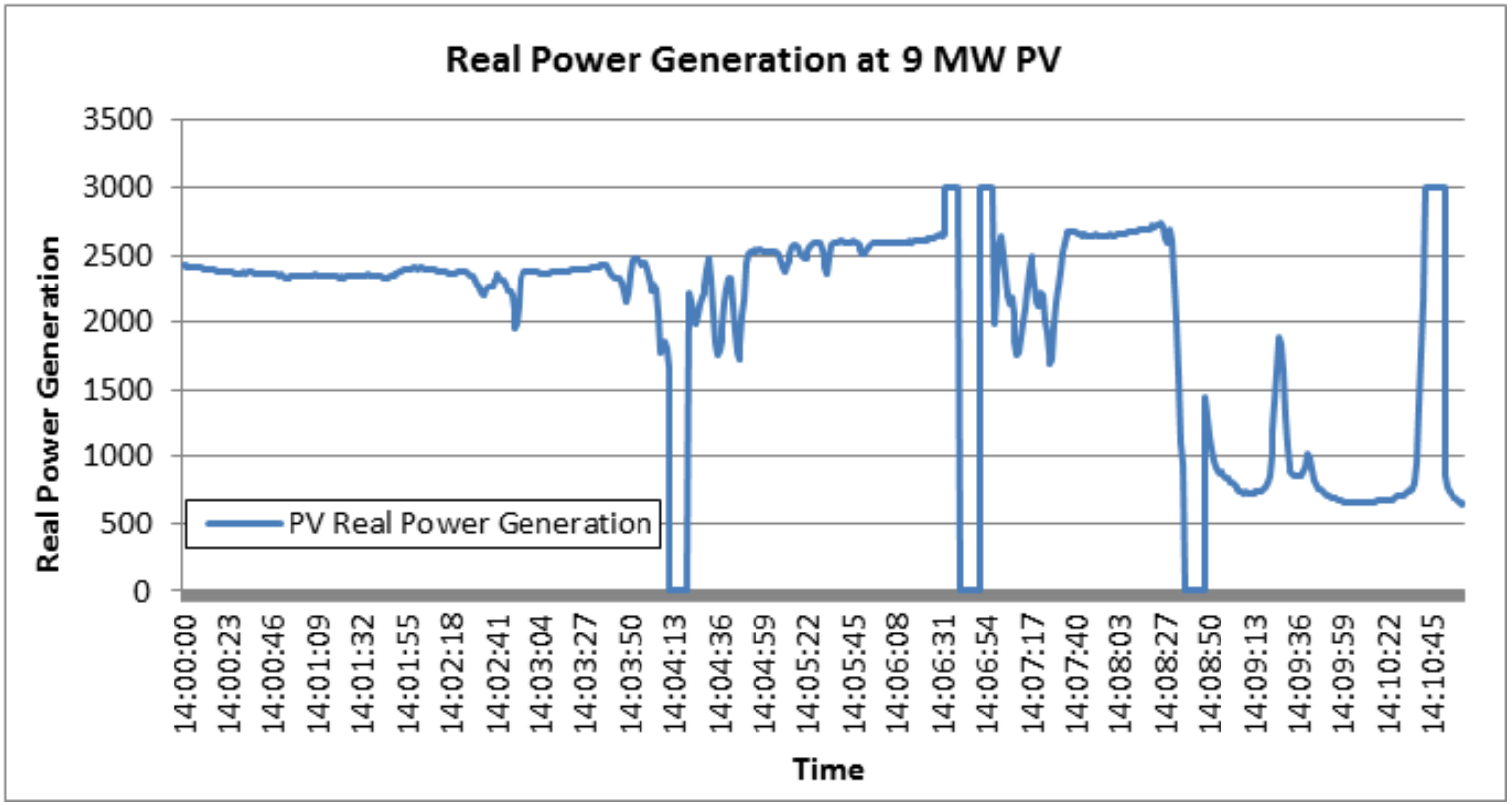


Circuit Model

123% PV penetration



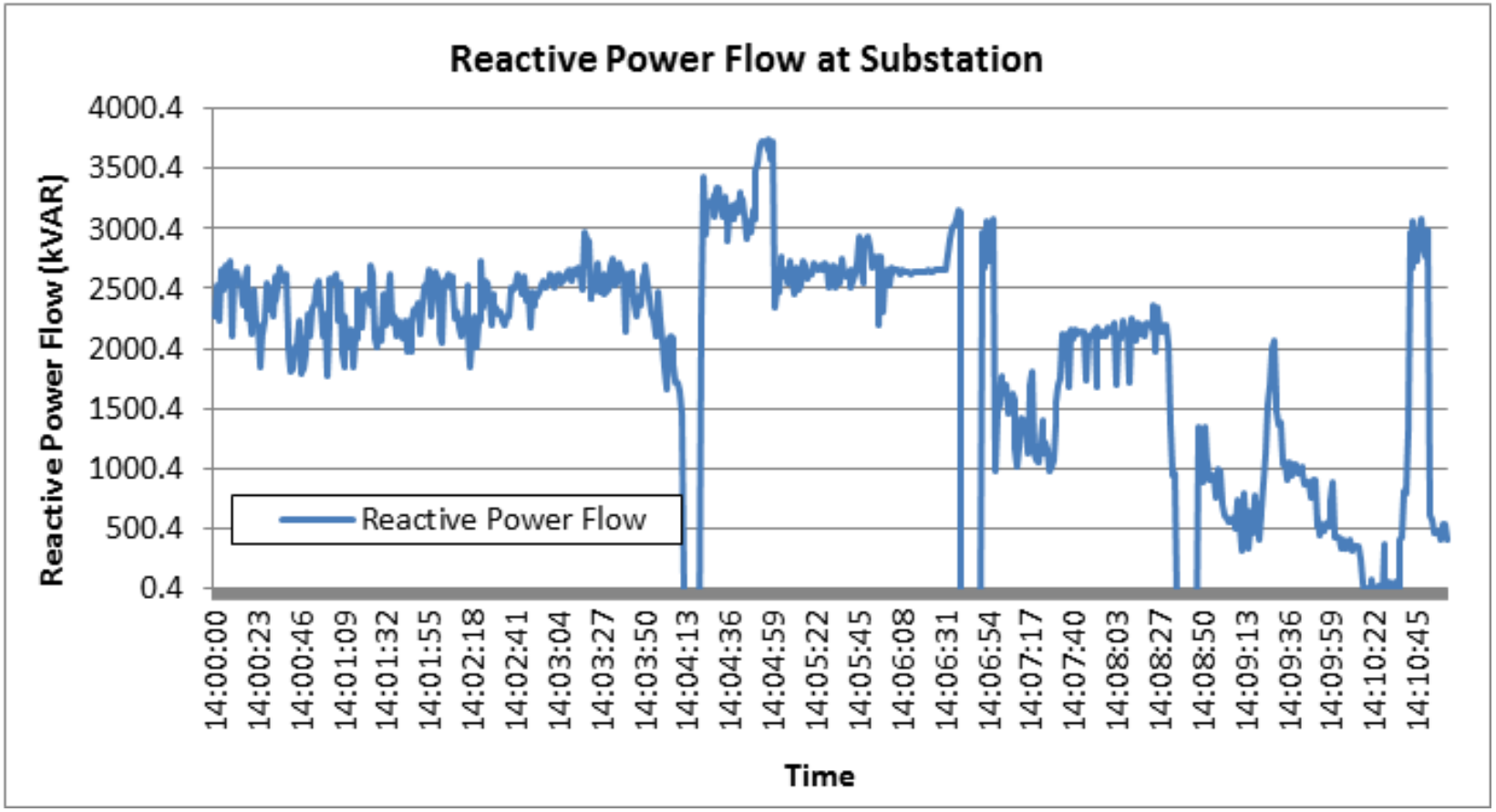
1 Second PV Generation Data



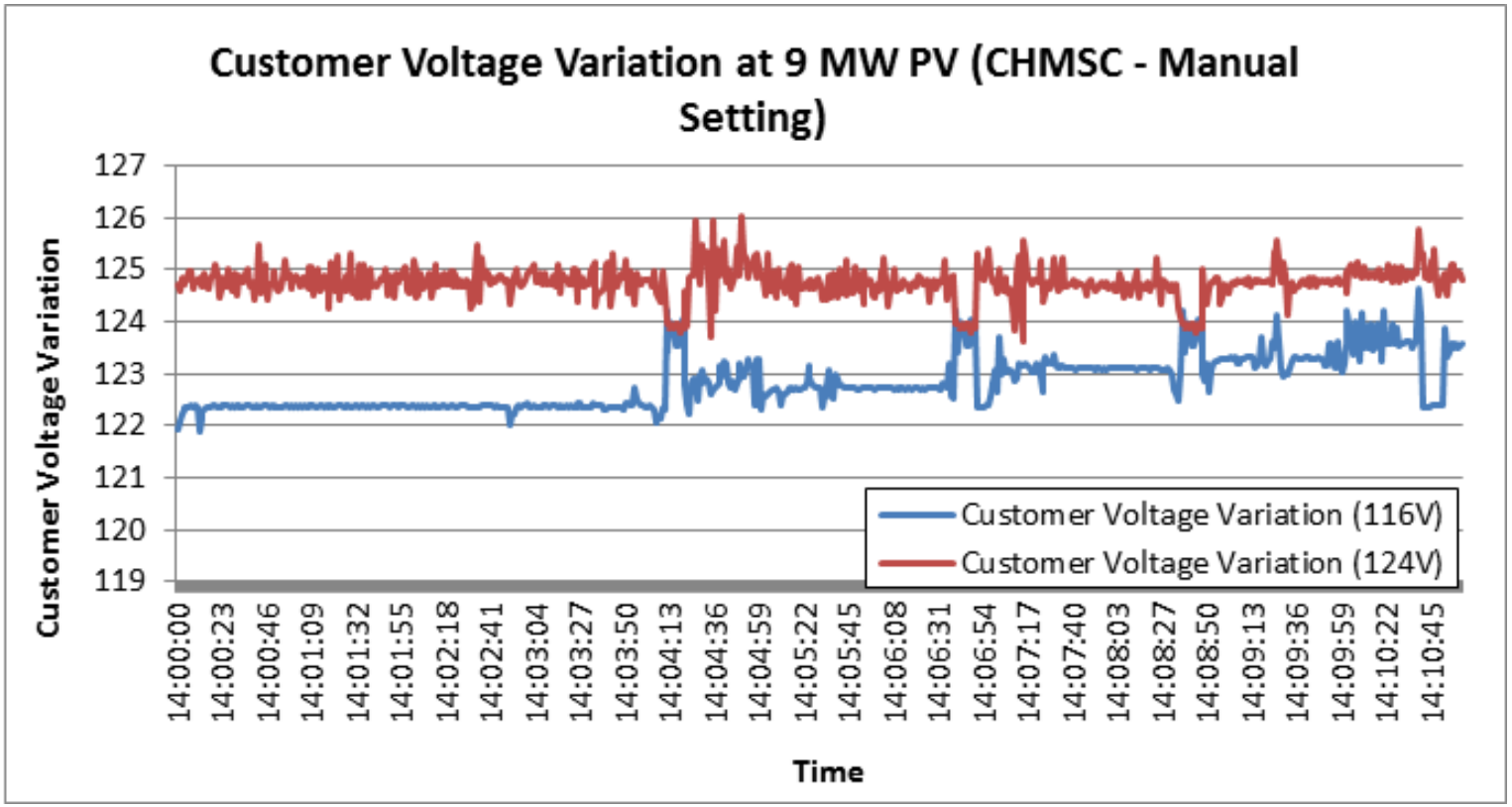
Controls Evaluated

- ✓ **CHMSC**: Feeder losses and utility controller motion are minimized and voltage set-points are used for PV generators
- ✓ **CHMSC – 116V**: Average customer voltage set-point at 116V
- ✓ **CHMSC – 124V**: Average customer voltage set-point at 124V
- ✓ **CHMSC (PF set)**: Power factor set-points used for PV generators
- ✓ **CHMSC – 116V (PF set)**: Average customer voltage set-point at 116V with power factor set-points provided to PV generators
- ✓ **CHMSC – 124V (PF set)**: Average customer voltage set-point at 124V with power factor set-points provided to PV generators
- ✓ **Local control only (116V)**: 116V set-point used by all PV generators
- ✓ **Local control only (124V)**: 124V set-point used by all of PV generators

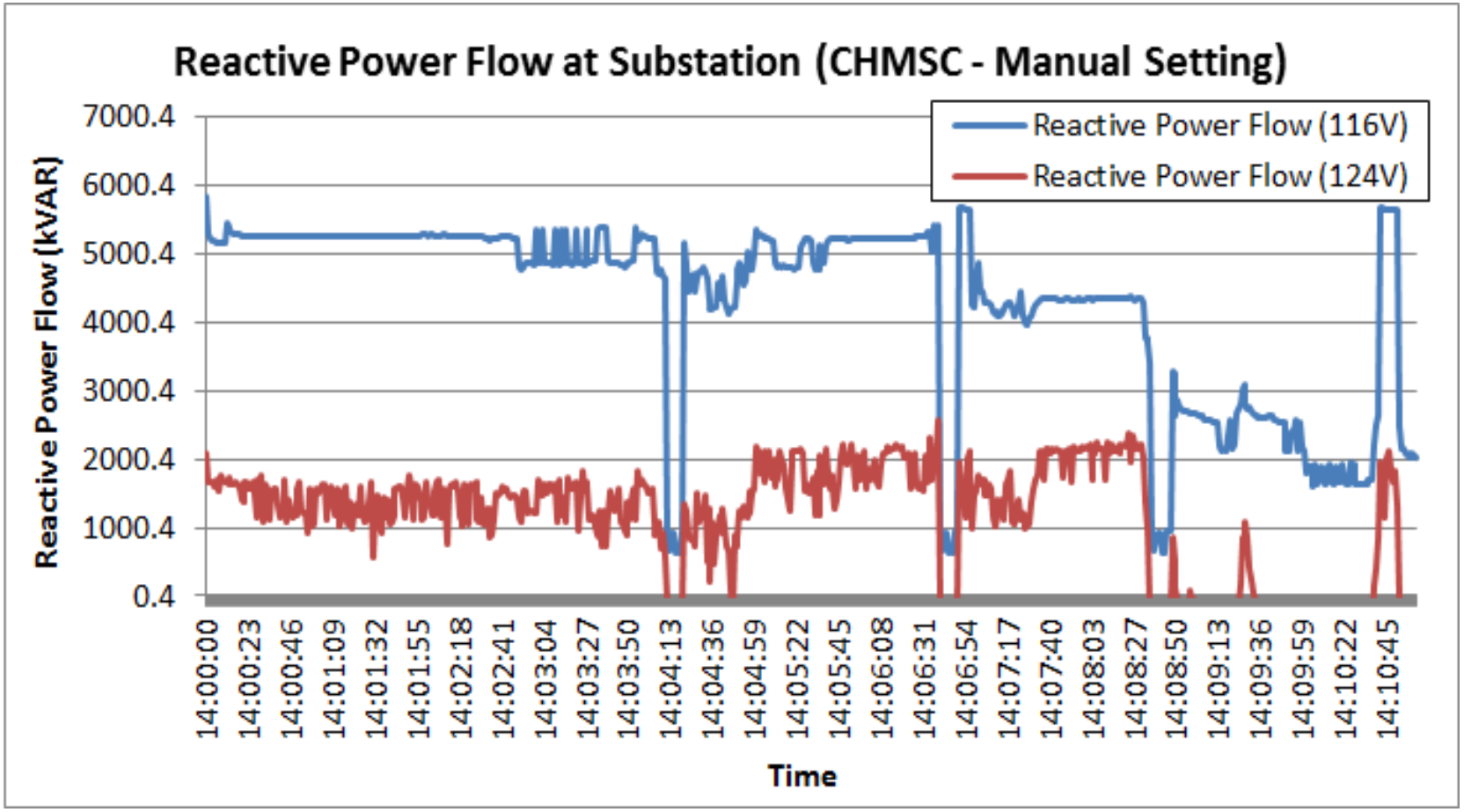
CHMSC Results: Sub Q Flow



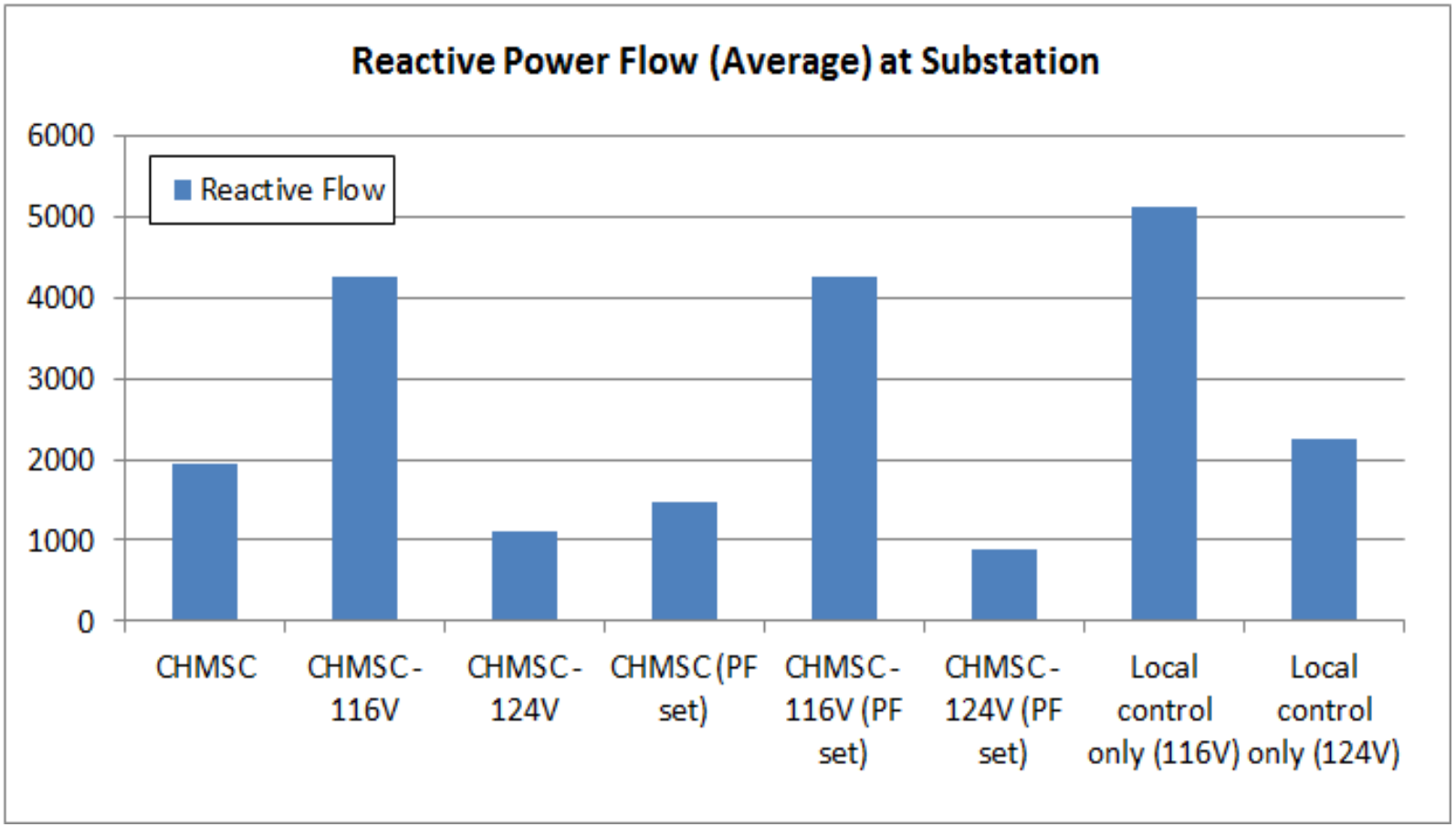
CHMSC with 116V/124V SPs



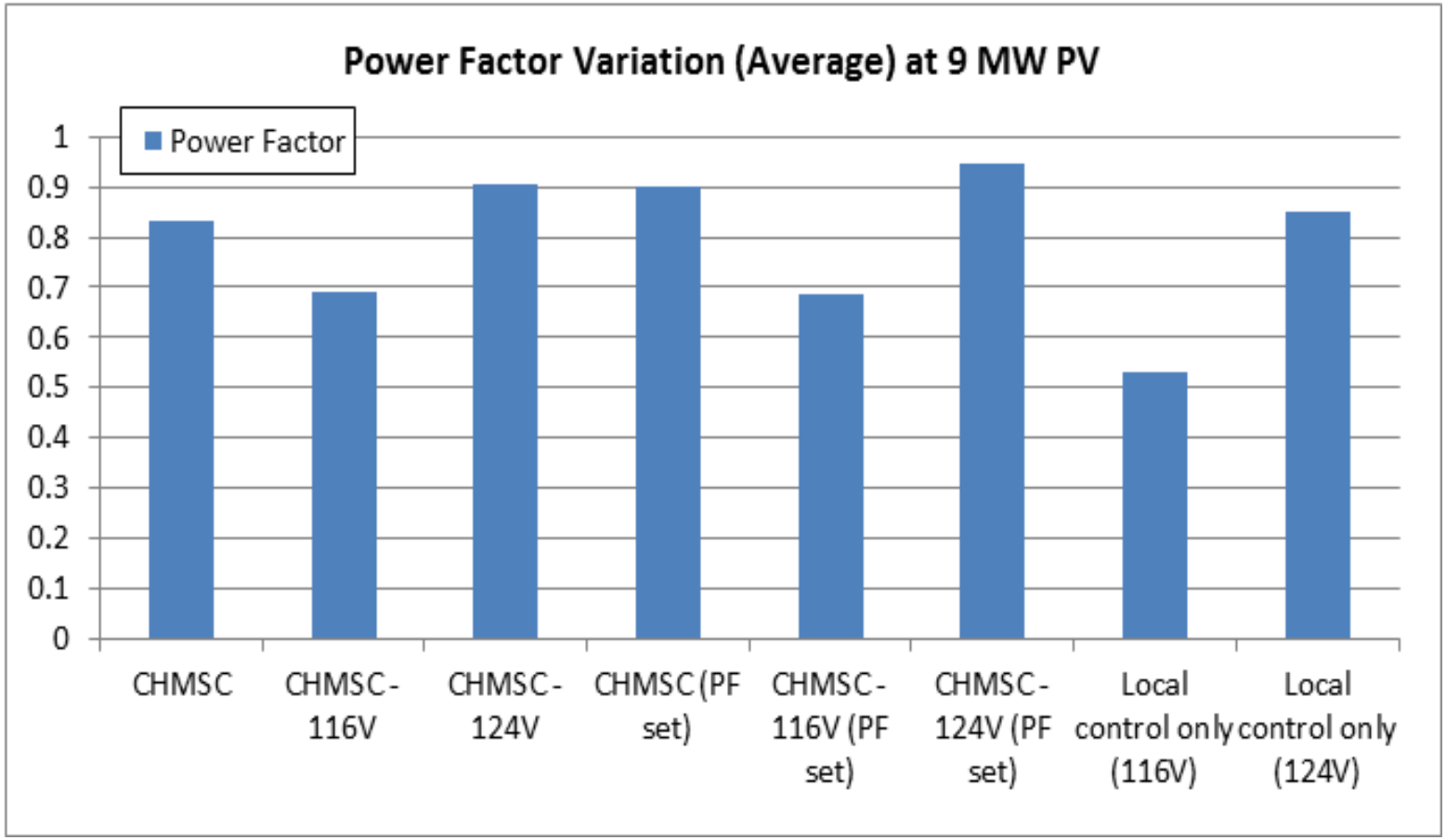
CHMSC with 116V/124V SPs: Sub Q Flow



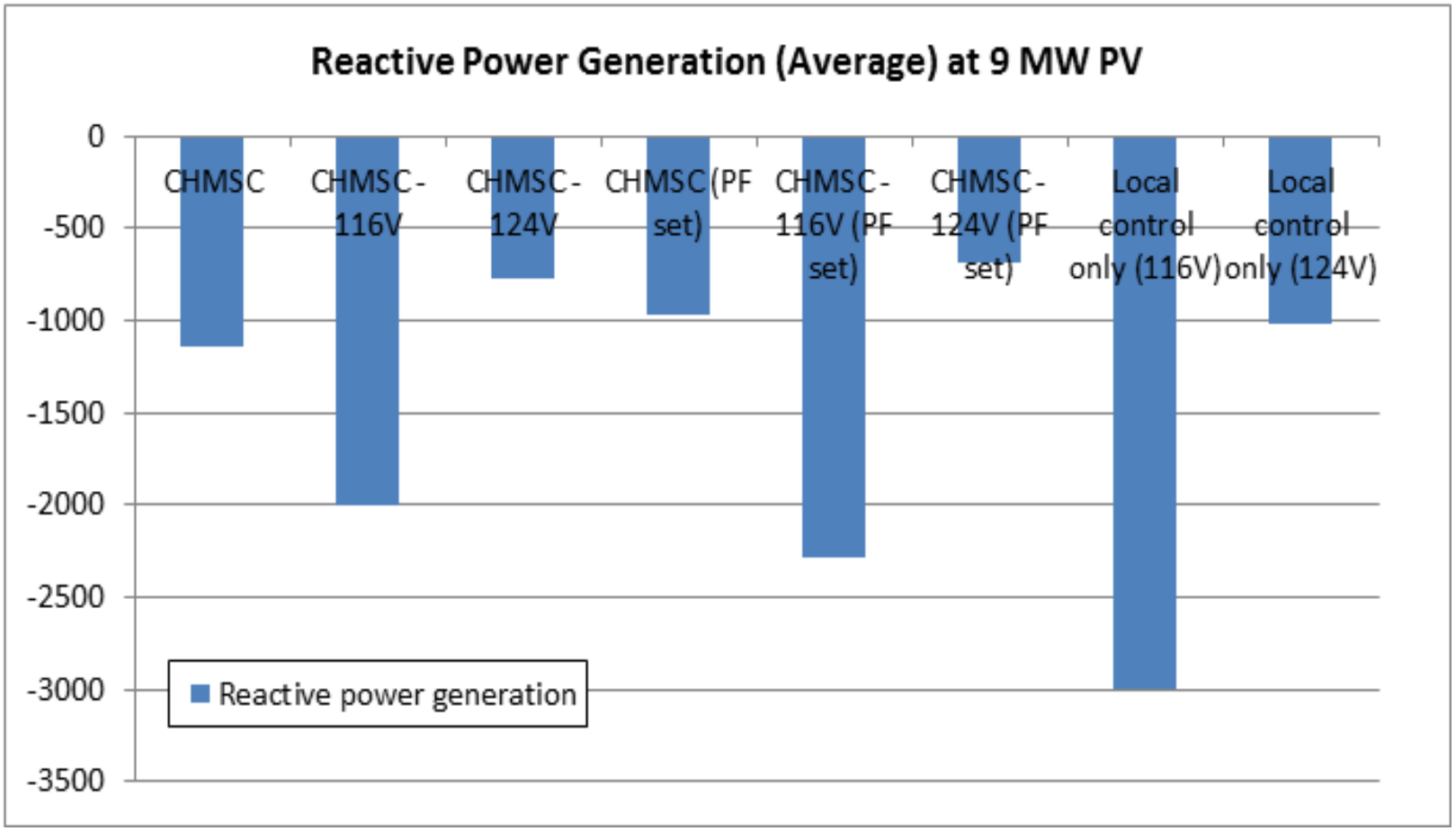
Sub Q Flow Comparison



Average PF Results Comparison



Average Q Generation Comparison



Conclusions

- ✓ CHMSC requires less reactive power flow at substation if same control settings are used
- ✓ CHMSC provides higher power factor at PV if same control settings are used
- ✓ CHMSC has less reactive power generation at PV generator if same control settings are used
- ✓ CHMSC results in lower circuit loss and fewer utility device controller steps