Chapter 3—Sao Miguel Findings

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Outline

- Complex to optimize losses by trial and error
- AC OPF must be used
- The role of optimizing generator voltages
- The role of optimizing settings of voltage-controlled transformers

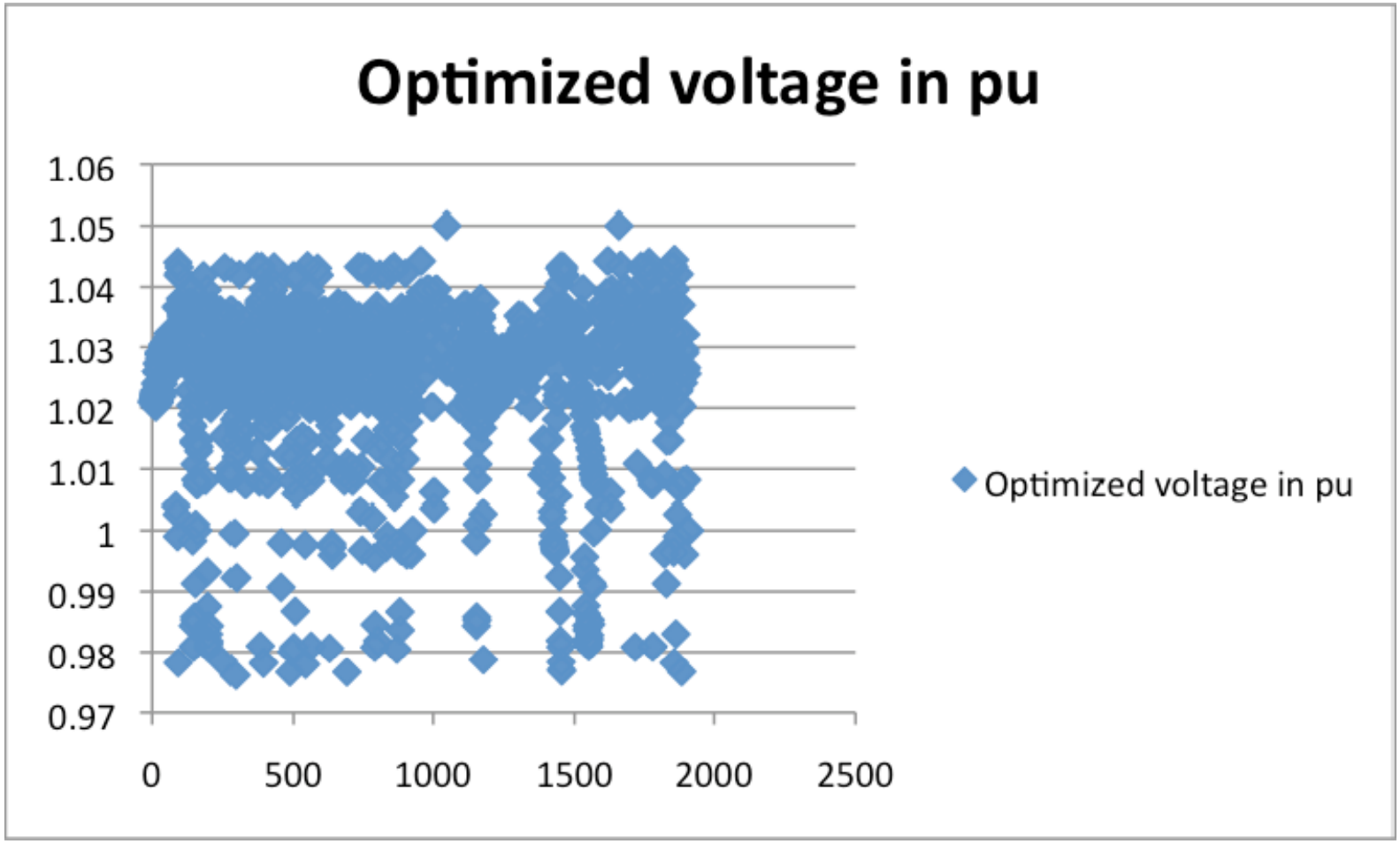
Voltage-controlled transformers in SMG

From Bus	To Bus				Min Ratio	Max Ratio
939	942	0	1	1	0.911247	1.071247
940	941	0	1	1	0.911247	1.071247
958	957	0	1	1	0.93059	1.09059
974	84	0	1	1	0.902988	1.062988
982	983	0	1	1	0.904659	1.064659
999	1000	0	1	1	0.94693	1.04693
1012	1010	0	1	1	0.914655	1.074655
1013	1011	0	1	1	0.914655	1.074655
1021	1024	0	1	1	0.970245	1.130245
1615	956	0	1	1	0.882775	1.002775
1616	959	0	1	1	0.882775	1.002775
1639	1023	0	1	1	0.94519	1.10519

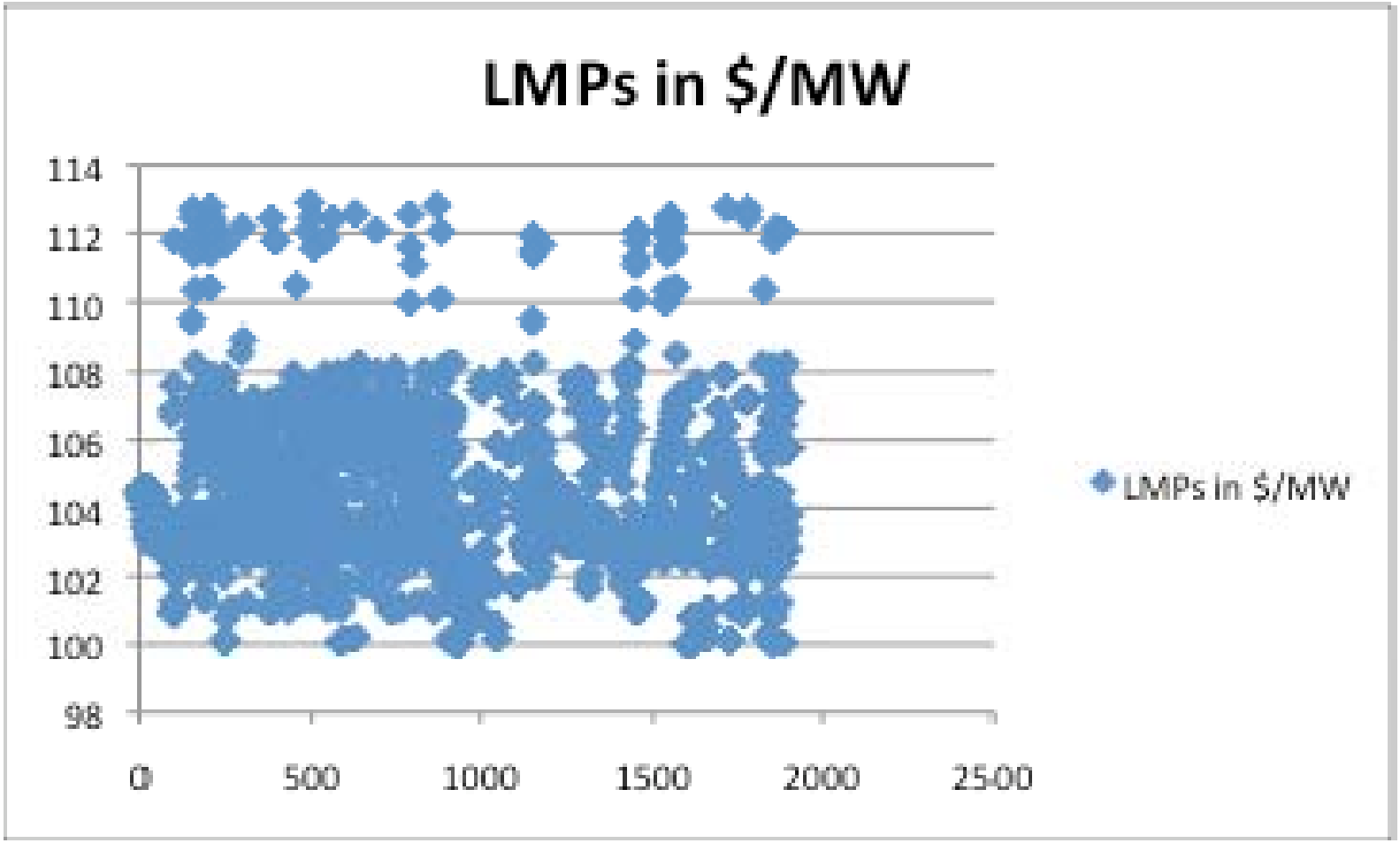
Scenarios studied

- Thermal line limits included
- Voltage limits .95-1.05pu vs. .95-1.02 pu
- Transformer ratios set to 1pu; vs. optimized within allowed limits; vs. set to 1pu +/- .01pu

Typical voltage optimized



Resulting cost sensitivites



Key findings

- Line limits observed; voltage .95-1.05pu; generator and transformer voltage optimized :

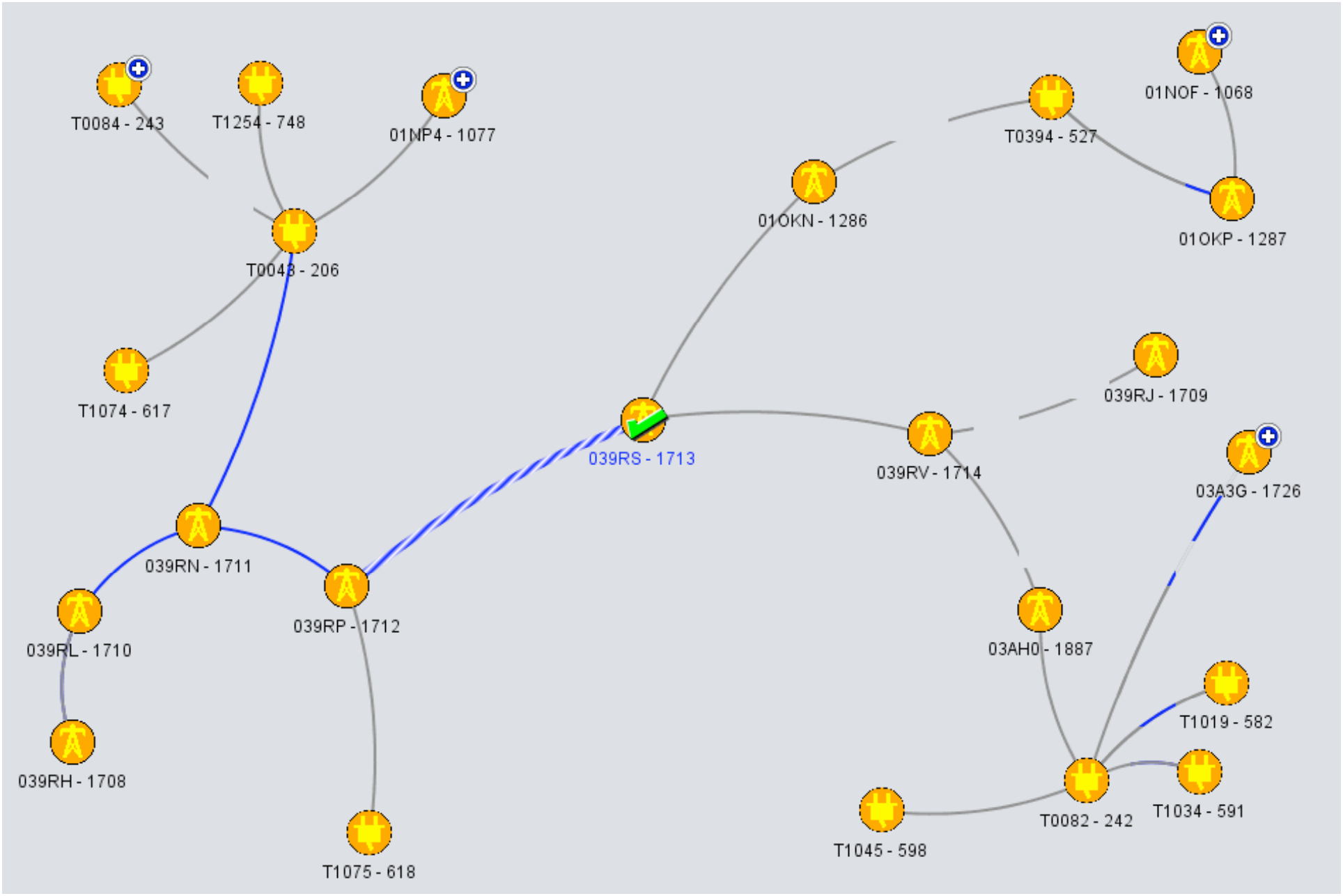
  -Total generation 69.04MW, load 67.732MW and AC line loss 1.27MW.

  - OSF of line 1887-1714 the highest, therefore this is the cause of inefficiency.

- Line 1887-1714 relaxed; voltage .95-1.05pu; generator and transformer voltage optimized.

  -Total generation 68.96MW, AC line loss 1.119MW.

  - Cost of thermal limit.


T0084 - 243
T1254 - 748
01MP4 - 1077
T0048 - 206
T1074 - 617
01OKN - 1286
T0394 - 527
01NOF - 1068
01OKP - 1287
039RJ - 1709
039RS - 1713
039RV - 1714
03A3G - 1726
039RN - 1711
039RP - 1712
039RL - 1710
039RH - 1708
T1075 - 618
03AH0 - 1887
T1019 - 582
T1034 - 591
T0082 - 242
T1045 - 598

Key findings

- Tradeoff between efficiency and reliability

- The effect of voltage-controlled transformers

  -not huge effect on system loss;

  -could be critical for feasibility of the solution (1pu does not have a solution; 1pu +/- .01 feasible)

- The effect of generation voltage optimization

  -critical for feasibility of the solution (below 1.2pu no solution);

  -voltages are generally set to the highest possible value, but not at all locations (need AC OPF to compute the actual settings)

- The use of highest optimization sensitivities of cost with respect to voltage optimized, thermal limit constraints, real and reactive power capacity limits

  -extremely useful

  -identifies where is the real problem (operations and/or planning)

Proposed approach

- Using highest optimization sensitivities decide what to optimize first
- Find first what are the optimization sensitivities of equipment under control of system operator (generator and transformer voltages); in this case these are OSVs and OSF of specific line (hard to find by analysis a 10kV LV line 1887-1714)
- Consider highest optimization sensitivities remaining (typically at LV buses, OSPs and OSQs) to decide where to build distributed generation (DGs) for loss compensation purposes
- There are generally many of these, of the very small size
- The major research question: Is this where it may be beneficial to begin to do loss compensation using DGs instead of investing in large equipment (capacitor banks)

Acknowledgment

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