

Essence of Structure Preserving (ESP) Network Reductions for Engineering and Economic Analysis of High Penetration of Renewables

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1. Project objective:

The objectives of the proposed work are to refine the network equivalencing techniques developed during the previous funding cycle and to apply these techniques to develop an improved electric power network model of the entire United States (Eastern Interconnection (EI); WECC and ERCOT.)

2. Major technical accomplishments that will be completed this year:

A dc network equivalent for the entire United States will be produced, its accuracy vetted using change cases and OPF solutions, and new improved equivalencing techniques will be developed and disseminated to the research community.

3. Deliverables and schedule for activities to be completed under FY2012 funding:

Several technical papers have been produced during the FY2012 funding cycle as shown below.

1. D. Shi and D. J. Tylavsky, "An Improved Bus Aggregation Technique for Generating Network Equivalents," IEEE PES General Meeting 2012, accepted.
2. D. Shi, D. J. Tylavsky, N. Logic, "An Adaptive Method for Detection and Correction of Errors in PMU Measurements," IEEE Transactions on Smart Grid, (Accepted.)
3. D. Shi, D. L. Shawhan, N. Li, D. J. Tylavsky, J. T. Table, R. D. Zimmerman and W. D. Schulze, "Optimal Generation Investment Planning: Pt. 1: Network Equivalents," accepted for North American Power Symposium 2012.
4. N. Li, D. Shi, D. L. Shawhan, D. J. Tylavsky, J. T. Table, R. D. Zimmerman and W. D. Schulze, "Optimal Generation Investment Planning: Pt. 2: Application to the ERCOT System," accepted for North American Power Symposium 2012.
5. Y. Qi, D. Shi, and D. J. Tylavsky, "Impact of Assumptions on DC Power Flow Model Accuracy," accepted for North American Power Symposium 2012
6. D. J. Tylavsky, "An Improved Bus Aggregation Technique for Generating Network Equivalents," University of Manchester, June 14, 2012.

Research interaction activities include attending PSERC meetings in 2011/2012 to interact with other CERTS and PSERC funded researchers and presenting a paper resulting from this research at the PES General Meeting in San Diego in July 2012. Also, some of the results of this research were presented at the University of Manchester in England in June of 2012. During FY2012, graduate students will be acquiring data sets for the entire US, eliminating/correcting bad data, building modified-Ward-equivalent dcnetwork models, vetting them for accuracy as measure by line flows under change cases and OPF cases. Graduate students will also be developing a new equivalencing technique that takes advantage of both bus aggregation techniques and Ward-type methods.

4. Risk factors affecting timely completion of planned activities:

The work on generating network equivalents of the US for use by other researchers on CERTS and PSERC projects is rather low risk and is expected to be completed according to schedule. Development of hybrid techniques that meld bus-aggregation and Ward-type equivalencing methods is a more risky proposition since these methods are very different in nature, but we do have some ideas on a path forward.

5. Early thoughts on follow-on work that should be considered for funding in FY2013

We hope to build on expected initial successes with hybrid equivalencing techniques by decreasing its computational complexity, enhancing the effectiveness of the equivalents, building network equivalents for the three-major islands in the US and validating their performance using absolute measures as well as measures that compare the performance of the hybrid equivalents with modified-Ward equivalents.