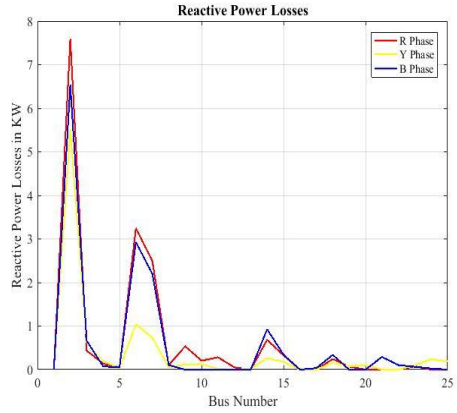

Figure 10. Reactive power losses at each bus

4. CONCLUSIONS

In this paper, an innovative and effective power flow algorithm has been presented to solve URDNs. The distribution system components have been modelled by using network theory concepts. The suggested technique has good convergence property for any realistic distribution networks with practical Resistance to Reactance ratio. The advantage of the suggested technique is the data is stored in vector format, so it will save the computer memory when tested for large realistic systems. This technique can be used efficiently with SCADA and DAC.

REFERENCES

[1] Zimmerman RD, Chiang HD. (1995). Fast decoupled power flow for unbalanced radial distribution systems. IEEE-PES Winter Meeting, paper (95). New York.

[2] Goswami SK, Basu SK. (1991). Direct solution of distribution systems. IEE Proc. C 188(1): 78-88.

[3] Thukaram D, Wijekoon Banda HM, Jerome J. (1999). A Robust three phase power flow algorithm for radial distribution systems. Electric Power System Research 50(3): 227-236.

[4] Garcia PAN, Pereira JLR, Carnerio S, Da Costa VM, Martins N. (2000). Three-Phase power flow calculations using the current injection method. IEEE Trans. on Power Systems 15(2): 508-514.

[5] Garcia PAN, Pereira JLR, Carneiro S, Jr. (2001). Voltage control devices models for distribution power flow analysis. IEEE Trans. Power Syst 16(4): 586–594.

[6] Garcia PAN, Pereira JLR, Carneiro SJr. (2004). Improvements in the representation of PV buses on three-phase distribution power flow. IEEE Trans. Power Del 19(2): 894–896.

[7] Chen TH. (1991). Distribution system power flow analysis-a rigid approach. Power Delivery. IEEE Transactions on 6(3): 1146-1152.

[8] Baran M, Wu FF. (1989). Optimal sizing of capacitors placed on a radial distribution system. Power Delivery, IEEE Transactions on 4(1): 735-743.

[9] Garcia PAN, JLRP, Carneiro S, Da Costa VM, Martins N. (2000). Three-phase power flow calculations using the current injection method. IEEE Transactions on Power Systems 15(2).

[10] Da Costa VM, NM, Pereira JLR. (1999). Developments in Newton Raphson power flow formulation based on current injections. IEEE Transactions on Power System. 14(4).

[11] Chen TH, Yang NC. (2009). Three-phase power-flow by direct ZBR method for unbalanced radial distribution systems. Generation, Transmission & Distribution, IET 3(10): 903-910.

[12] Kersting WH. (2002). Distribution System Modeling and Analysis. CRC Press.

[13] Abdel-Akher M, Nor KM, Rashid AHA. (2005). Improved three-phase power-flow methods using sequence components. power systems. IEEE Transactions on 20(3): 1389-1397.

[14] Kamh MZ, Iravani R. (2010). Unbalanced model and power-flow analysis of microgrids and active distribution systems. Power Delivery, IEEE Transactions on 25(4): 2851- 2858.

[15] Kamh MZAI, R. (2011). A unified three phase power flow analysis model for electronically coupled distributed energy resources. IEEE Trans. Power Deliv. 26(2): 899-909.

[16] Yu S, Nguyen HD, Turitsyn KS. (2015). Simple certificate of solvability of power flow equations for distribution systems in Proc. IEEE PES General Meeting 1–5.

[17] Subrahmanyam JBV, Radhakrishna C. (2010). A simple approach of three phase distribution system modeling for power flow calculations. World Academy of Science, Engineering and Technology 39.

[18] Kersting WH, Mendive DL. (1976). An application of ladder theory to the solution of three-phase radial load-flow problem. IEEE Transactions on Power Apparatus and Systems PAS-98(7): 1060–1067.

[19] Kersting WH. (1984). A method to teach the design and operation of a distribution system. IEEE Transactions on Power Apparatus and Systems PAS-103(7): 1945-1952.

[20] Kersting WH. (2002). Distribution System Modeling and Analysis. CRC Press. www.mathworks.com/products/matlab.

NOMENCLATURE

E_p^{Phase}	Voltage between phase (r,y & b) and neutral at bus p.
E_p^{ry}	Voltage between r phase and y phase at bus p.
E_0^{Phase}	Nominal Voltage between phase (r,y & b) and neutral.
Z_{pq}^{ryb}	Phase Impedance matrix.
I_{pq}^{ryb}	Current at phase (r,y & b) flowing from bus p to bus q.
IL_p^{ryb}	Load Current at phase (r,y & b) at p^{th} bus
PL_{q0}^r, QL_{q0}^r & SL_{q0}^r	Nominal Real, Reactive and Apparent power loads at phase r at q^{th} bus.
PL_q^r, QL_q^r & SL_q^r	Real, Reactive and Apparent power loads at phase r at q^{th} bus.
LP_{pq}^r, LQ_{pq}^r & LS_{pq}^r	Real, Reactive and Apparent power loss in the branch pq.
URDN	Unbalanced Radial Distribution Network.