The maximal loss per traded volume ratio *(LpTVr)* in OLM (over trading periods where only local market (OLM) is active) [%] varied between 0% and 1.2% as displayed in Fig. 4.

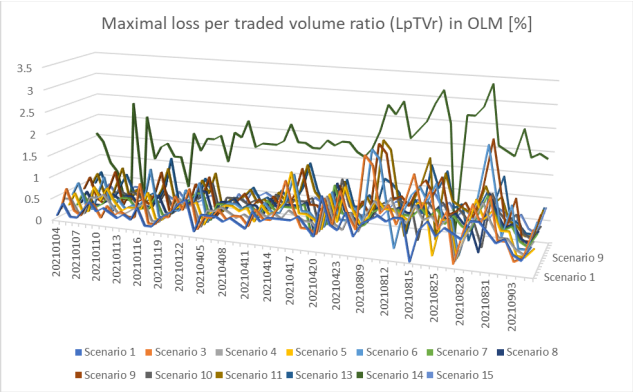

Fig. 4. Maximal loss per traded volume ratio

Figure 5 shows the maximal voltage deviation (VD) in OLM [V] (over all prosumers and periods) varied between 1 V and 9 V. Mostly there are no significant differences between the scenarios here either. There is, however, one significant difference between the scenarios – as in scenario 14 the values are significantly higher, and at this level the voltage deviation could have a significant impact on the network. Determining the cause of this phenomenon requires further examination.

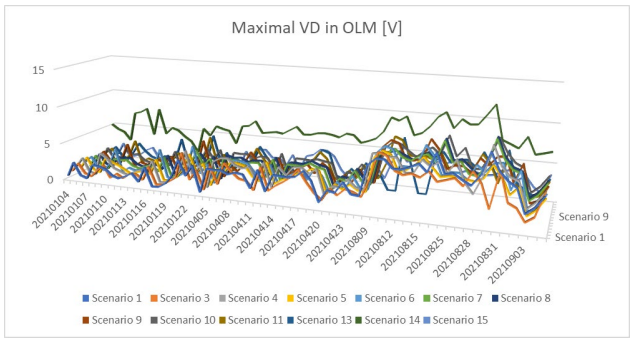

Fig. 4. Maximal voltage deviation in OLM scenario [V]

The first results show the capability of the simulation framework on assessing P2P local market demonstration results. DSOs evaluate the results and give feedback on which strategies should be further investigated with new bidding strategies.

5. Conclusion

This paper described a P2P local market concept which is applicable for distribution networks. The opportunities with the proliferation of such local P2P markets were described. The INTERRFACE simulation framework was introduced from the viewpoint of demonstration analysis. The basic concept of the market operation and DNUT was presented.
Thanks to the dynamic network usage tariff (DNUT) facilitating transactions which result in desired flows according to the actual state of the distribution grid, several measures describing the efficiency of operation are expected to improve during the simulated operation of the local market. The loss compared to total trading volume is expected to be reduced.
Line congestions and near-overload of system components (e.g., transformers) are expected to be alleviated, in an ideal case, the load of the network will be more balanced. Voltage regulation measures are expected to improve (in the case of the corresponding DNUT calculation – the DNUT does not always include elements related to voltage stability).
The results showed that the framework is capable of providing data for evaluation of the local P2P market. However, in the first scenarios, there are not large differences due to the bidding strategies. Further simulations with increased activity could show the potential of the developed tool.
The proposed local energy market provides an opportunity for participants to translate their flexibility potential to local transactions financially beneficial for them. If a consumer participant is ready to reschedule some of its peak load, and energy is available at the local market at an appropriate price, the peak-shaving of overall consumption patterns may be realized via the result of such transactions.

References

[1] Nikolaidis AI, Charalambous CA, Mancarella P. A graph-based loss allocation framework for transactive energy markets in unbalanced radial distribution networks. IEEE Trans Power Syst 2019;34(5):4109–18.

[2] Lezama, F., Soares, J., Hernandez-Leal, P., et al.: 'Local Energy Markets: Paving the Path Toward Fully Transactive Energy Systems', IEEE Trans. on Power Systems, 2019, 34, (5), pp. 4081–4088.

[3] Horta, J., Kofman, D., Menga D., Silva, A.: 'Novel market approach for locally balancing renewable energy production and flexible demand', 2017, IEEE Int. Conf. on Smart Grid Communications, Dresden, Germany, 2017, pp. 533–539.

[4] Mengelkamp, E., Staudt, P., Garttner, J., Weinhardt, C.: 'Trading on local energy markets: A comparison of market designs and bidding strategies', Int. Conf. on the European Energy Market, Dresden, Germany, 2017, pp. 1–6.

[5] Olivella-Rosell P. et al.: 'Day-ahead micro-market design for distributed energy resources', IEEE Int. Energy Conf., Leuven, Belgium, 2016, pp. 1–6.

[6] Di Silvestre ML, Gallo P, Ippolito MG, Sanseverino ER, Zizzo G. A technical approach to the energy blockchain in microgrids. IEEE Trans Ind Inf 2018;14(11):4792–803.

[7] Paudel A, Sampath LPMI, Yang J, Gooi HB. Peer-to-peer energy trading in smart grid considering power losses and network fees. IEEE Trans Smart Grid 2020;11(6):4727–37.

[8] Hayes B, Thakur S, Breslin J. Co-simulation of electricity distribution networks and peer to peer energy trading platforms. Int J Electr Power Energy Syst 2020;115:105419.

[9] Orlandini T, Soares T, Sousa T, Pinson P. Coordinating consumer-centric market and grid operation on distribution grid. In: 2019 16th International Conference on the European Energy Market (EEM). 2019, p. 1–6.

[10] Azim MI, Pourmousavi SA, Tushar W, Saha TK. Feasibility study of financial P2P energy trading in a grid-tied power network. In: 2019 IEEE Power Energy Society General Meeting (PESGM). 2019, p. 1–5.

[11] Polgári, B., Sütő, B., Divényi, D., Sőrés, P., Vokony, I., Hartmann, B.. Local electricity market design for peer-to-peer transactions with dynamic grid usage pricing, CIRED 2020 Berlin Workshop, 2020,