IMPACT OF IMPLEMENTATION OF RES AND ELECTROMOBILITY ON ELECTRICAL PARAMETERS IN LV DISTRIBUTION NETWORK

Jan Vojtech
Bachelor Degree Programme (3), FEEC BUT
E-mail: xvojte11@stud.feec.vutbr.cz

Supervised by: Michal Ptacek
E-mail: ptacekm@vut.cz

Abstract: This paper is focused on the evaluation of electrical parameters in low voltage distribution network for proposed scenarios based on the future strategic plans of European Union and some Czech National Action Plans. The results of the analysis demonstrate the influence of implementation of renewable sources and electromobility to voltage, voltage drops, current loads etc.

Keywords: distribution network, smart grids, electromobility, renewable sources, charging stations

1 INTRODUCTION

European Union (EU) has long term target in decreasing greenhouse gasses emissions with increasing effort to reach climatic neutrality before 2050. To reach the goal, innovations must be done in the whole electric energy process including generation, transfer, and consumption. The biggest priority is dramatical decreasing emissions in traffic, because it is the biggest source of air pollution in cities. Development of electric vehicles (EV) and decentralised sources (DECE) is tightly connected with demands on projecting and controlling of distribution network (DN).

2 NATIONAL ACTION PLANS OF CZECH REPUBLIC

National action plans (NAP) are established with reference to EU plans and strategic planning of Czech Republic (CZE). These NAP are focused on suggested plans in detail to reach targets set in CZE and are regularly updated to correspond with new and more strict demands of EU. The most important measures for DN are in renewable sources (RES) and electromobility sectors because of their potential impact on reliable and safe management of DN.

2.1 RENEWABLE ENERGY

National Renewable Energy Action Plan [1] contains plans until 2020 without future. So, it is better to look on plans in this sector from The National Energy and Climate Plan of the Czech Republic [2]. This document is expecting 22% share of RES on gross final electrical energy consumption, which is rise of 9 percentage points compared to 2020.

2.2 CLEAN MOBILITY

National Action Plan for Clean Mobility (NAPCM) [3] was updated in April 2020 and contains Green Deal targets from 2019 [4], which means reaching climatic neutrality before 2050. NAPCM sets EV as the main tool for reaching clean mobility, even though it is remarked that it is not the only and universal usable solution. Compared to other technologies are EV usable nowadays which is their main advantage. However, EV development is limited by sparse charging station networks.
But higher EV sales will probably be the cause of new and more strict emission limits. It is expected that there will be from 220 000 to 500 000 EV in CZE in 2030 which means 3-7 % of all cars in CZE.

2.3 Smart Grids

National Action Plan for Smart Grids (NAPSG) (updated 2019) puts a huge importance on development of smart grids (SG). Reaching full smart grids concept can help distribution network operators (DNO) to lower costs of network development. SG can be characterized in short as safe, reliable, and automated network with real-time control ability. However, RES should be developed mostly by DECE with real-time measures and remote-control ability according to NAPSG. [5]

According to a study mentioned in NAPSG [6], EV should be charged by slow chargers from low voltage (LV) network at small consumers, i. e. home small consumer (HSC) and workplace small consumer (WSC). Private charging station networks should consist of 95 % chargers with output up to 11 kW and 5 % chargers with output of up to 22 kW.

3 DNO TERMS

DNO could determine conditions for connecting new sources and consumption points in its DN area. These conditions partly correspondent with Energy Regulatory Office conditions. Nowadays new conditions of EG.D, a.s. company are discussed (but not public yet). Latest version of conditions contains these conditions:

1. EV charger with power input up to 100 kW must be capable of 1 level power regulation (on/off), EV charger which power input up to 250 kW must be capable of 4 level power regulation and EV charger which power input above 250 kW must be equipped with voltage measuring and active and reactive power measuring.

2. DECE with power output up to 100 kW must be capable of active power regulation by relay (on/off), DECE with power output up to 630 kVA must be capable of continuous output regulation of active and reactive power and must be equipped with voltage measuring, active and reactive measuring and selected DECE must be equipped also with other measuring like temperature, wind speed and sun exposure.

4 DN DESCRIPTION, SCENARIO INTRODUCTION AND ANALYSIS

4.1 DN DESCRIPTION

For demonstration of the impact of RES and EV chargers implementation into LV DN was chosen DN in Jinačovice village with 779 residents in Brno-venkov district. Basic typology with analysis is on the Fig. 1. Distribution lines consists of cable lines only. Most of cable lines were built in the 1980s and 1990s. The most frequent types of cables in DN are AYKY 3x185+95 and AYKY 3x120+70. DN is powered by 6 distribution transformer stations (DTS) with nominal power 4x 630 kVA and 2x 400 kVA. DS 338 consumers, therefrom 294 HSC and 44 WSC. DN also includes 13 photovoltaic systems (PVS) in power range from 2,2 kW to 20 kW. No EV chargers with power input 3,7 kW or more are recorded.

4.2 SCENARIO INTRODUCTION

Chosen scenarios represent different implementation levels of DECE and EV chargers. Target of chosen scenarios is to analyse the impact of the implementation level on electrical parameters of DN including recommendations for DNO. The following scenarios were analysed:

A. Current state 1 – dominant consumption of HSC, low WSC electricity consumption, PVS are not considered, EV chargers are not considered
B. Current state – low consumption of HSC, dominant WSC electricity consumption, maximum power output of present PVS, EV chargers are not present

C. PVS – DN model contains evenly distributed new 7 kW PVS (long-term average according to DNO private statistics) covering 22 % of village consumption – low HSC electricity consumption, dominant WSC electricity consumption, maximum power output of present and new PVS, EV chargers are not considered

D. EV – DN model contains new 11 kW consumption points (average power of chargers on market), number of new consumption points is equal to 7 % of vehicles in the village – dominant HSC electricity consumption and EV chargers, low WSC electricity consumption, PVS are not considered

E. Concentrated PVS – PVS from scenario C power one (DTS)

F. Concentrated EV – all EV from scenario D are powered from one DTS

DAISY Bizon Projektant was chosen as software analysis tool for demonstration of the impact of implementation level of PVS and electromobility. This software analysis tool is commonly used for basic steady state calculations of DN by DNO (EG.D, a.s. company).

4.3 ANALYSIS AND RESULTS

This paper includes scenario A analysis. The left part of Fig. 1 displays voltage levels in DN, the lowest voltage levels are represented by dark green colour. The right part of Fig. 1 displays current load (CL) related to nominal current load, the highest RCL is represented by green colour. Lowest CL in this analysis is 87 % and lowest voltage level in DN is 360 V. Related power load of DTS varies from 29 % to 68 %.

![Fig. 1: Scenario A analysis](image)

The calculations of current state show, that during extreme load of DN voltage level can drop to nominal voltage tolerance limit ± 10 %. This state can be improved by replacing current cable lines with new cables with larger diameter in parts of DN with highest RCL and by adding new cable to make cable line from DTS to consumer with low voltage level shorter. Nominal power of current DTS is sufficient.

5 CONCLUSION

Current state of DN was analysed and will be used as default state for future calculations of DN. Results shown it is necessary to improve DN before the implementation of new EV chargers. Oth-
otherwise, voltage level in some parts of DN could drop under voltage level tolerance limit. Further analysis will be focused on proving DN in extreme conditions. In connection with future results new and larger measures will be recommended.

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REFERENCES


