Electric Power Systems Research xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Electric Power Systems Research

journal homepage: www.elsevier.com/locate/epsr

Review

Optimal operation of smart distribution networks: A review of models, methods and future research

Vasileios A. Evangelopoulos, Pavlos S. Georgilakis*, Nikos D. Hatziargyriou

School of Electrical and Computer Engineering, National Technical University of Athens (NTUA), GR 15780 Athens, Greece

ARTICLE INFO

Article history:
Received 7 September 2015
Received in revised form 23 January 2016
Accepted 17 June 2016
Available online xxx

Keywords:
Active network management
Distributed energy resources
Distributed generation
Demand side management
Energy storage systems
Optimal operation of smart distribution networks

ABSTRACT

The management of distributed energy resources (DER) in power distribution systems and the concept of demand side management (DSM) are becoming increasingly important in recent years, provided that emerging communication technologies contribute to the formation of smart distribution networks of the future. Several methods have been proposed in the literature for the optimal operation of smart distribution networks (OOSDN) with renewables and/or non-renewable DER, DSM and energy storage systems. The main scope of this paper is to review the most significant papers in the area of OOSDN and to introduce a taxonomy of models and optimization methods that are applied to the OOSDN problem. Moreover, the basic schemes for active network management are briefly presented. The article also discusses challenges and areas for future research in the field of OOSDN.

Contents

* Corresponding author. Tel.: +30 210 772 4378; fax: +30 210 772 3659.
E-mail addresses: vevangel@power.ece.ntua.gr (V.A. Evangelopoulos), pgeorg@power.ece.ntua.gr (P.S. Georgilakis), nh@power.ece.ntua.gr (N.D. Hatziargyriou).

http://dx.doi.org/10.1016/j.epsr.2016.06.035
0378-7796/

Nomenclature

Acronyms

AMI	advanced metering infrastructure
ANM	active network management
APFC	adaptive power factor control
AROPF	active-reactive optimal power flow
BB	branch and bound
BSS	battery storage system
CHP	combined heat and power
CSP	constrained satisfaction problem
CVC	coordinated voltage control
DER	distributed energy resource
DERC	distributed energy resource control
DG	distributed generation
DMS	distribution management system
DP	dynamic programming
DR	demand response
DSM	demand side management
DSO	distribution system operator
EA	evolutionary algorithm
EENS	expected energy not supplied
EMS	energy management system
ESAIFI	expected system average interruption frequency index
ESM	energy storage management
ESS	energy storage system
FD	flexible demand
FDG	fuelled distributed generation
GA	genetic algorithm
GC	generation curtailment
GT	gas turbine
ICE	internal combustion engine
ICT	Information and Communication Technologies
IED	intelligent electronic device
IP	interior point
LP	linear programming
MAS	Multi-Agent System
MILP	mixed integer linear programming
MINLP	mixed integer non-linear programming
MIQC	mixed integer quadratic constrained
MPC	model predictive control
MRCGA	matrix real coded genetic algorithm
NLP	non-linear programming
NRM	network reconfiguration management
OLTC	on-load tap changer
OOSDN	optimal operation of smart distribution network
OPF	optimal power flow
PCC	point of common coupling
PEM	point estimate method
PPF	probabilistic power flow
PV	photovoltaics
QP	quadratic programming
RCS	remote control of tie switches
RES	renewable energy source
RL	responsive load
RM	reserve management
RPC	reactive power compensation
RTU	remote terminal unit
SA	simulated annealing
SCADA	supervisory control and data acquisition
SDN	smart distribution network
ShC	shunt capacitor
ShR	shunt reactor
SVC	static var compensator
SVR	step voltage regulator
TN	transmission network
VSF	voltage-sensitivity factor
VUF	voltage unbalance factor
VVO	volt/var optimization
WT	wind turbine

1. Introduction

Power distribution networks are in a transformation from passive to active distribution networks, also called smart distribution networks (SDNs), owing to the fast development of emerging Information and Communication Technologies (ICT), and the integration of advanced metering infrastructure (AMI). Supervisory control and data acquisition (SCADA) systems are used for monitoring the power distribution system, while distribution management

Please cite this article in press as: V.A. Evangelopoulos, et al., Optimal operation of smart distribution networks: A review of models, methods and future research, Electr. Power Syst. Res. (2016), http://dx.doi.org/10.1016/j.epsr.2016.06.035