

《电网技术》

编辑委员会

主 任：刘振亚

委 员（按姓氏笔画排序）：

Wei-Jen Lee 丁 明 尹积军 文福拴

王 敏 王成山 王相勤 王益民

Haifeng Wang（王海风） 韦 化

帅军庆 伍 萱 刘广迎 刘开俊

刘开培 刘玉田 刘建明 印永华

孙 昕 汤 涌 纪延超 吴 云

吴玉生 Qinghua Wu（吴青华）

张文亮 张丽英 张启平 张运洲

张春城 张智刚 李卫东 李文毅

李向荣 李庆林 李成榕 李群湛

杜至刚 杨 庆 肖世杰 肖立业

陈 峰 陈月明 周 浩 郑宝森

K L Lo（罗国麟）段献忠 赵庆波

Wilsun Xu（徐文远） 索南加乐

栾 军 郭剑波 康重庆 曹一家

曹均正 曹志安 黄 强 程浩忠

舒印彪 葛正翔 路书军 廖瑞金

穆 钢 鞠 平

顾问委员会

主 任：陆延昌

副主任：周孝信 郑健超

委 员（按姓氏笔画排序）：

马伟明 王锡凡 卢 强 孙才新

朱英浩 严陆光 余贻鑫 宋永华

Felix Wu（吴复立） 杨奇逊 汪慜生

沈国荣 邱爱慈 陆佑楣 陈清泉

赵遵廉 唐任远 顾国彪 黄其励

程时杰 韩祯祥 潘家铮 薛禹胜

目 次

· 弹性配电网的评估、规划与运行基础理论 (特约专栏主编 王守相、吴磊) ·

面向高精度状态感知的配电系统微型同步相量测量单元优化配置

.....田家辉, 梁栋, 葛磊蛟, 李奎, 王守相, 李占凯 (2235)

考虑冰灾环境的配电网态势感知和薄弱环节辨识方法

.....刘鑫蕊, 李欣, 孙秋野, 金鹏 (2243)

计及城市发展程度的多阶段空间负荷预测方法

.....肖白, 穆冠男, 姜卓, 施永刚, 孙德强 (2251)

配电网分布式电源接纳能力评估方法与提升技术研究综述

.....董逸超, 王守相, 闫秉科 (2258)

变电站容量和 DG 置信容量概率规划

.....谭笑, 王主丁, 李强, 孙皓, 吕路, 王瑜 (2267)

考虑多次转供的配电网最大供电能力评估方法

.....朱嘉麒, 董树锋, 徐成司, 朱炳铨, 倪秋龙, 徐奇锋 (2275)

考虑投资成本的配电网预安排停电管理水平评价指标量化方法

.....刘科研, 王宏刚, 刘杨涛, 杜松怀, 胡丽娟, 苏娟 (2282)

基于复合储能系统的矿区电网频率弹性提升方法

.....钟睿, 滕松, 梁睿, 沈兴来 (2291)

基于改进模糊 C 均值聚类时段划分的配电网动态重构

.....董志辉, 林凌雪 (2299)

考虑微能源网支撑作用的配电网弹性提升策略

.....葛少云, 张成昊, 刘洪, 徐正阳 (2306)

考虑通信影响的配网恢复力评估及提升措施研究.....陈彬, 于继来 (2314)

考虑二次转供的配电网负荷转供方案多目标优选技术

.....章立宗, 吴磊, 蒋玮, 张锋明, 张心心, 蒋正威 (2321)

提升配电网弹性的微网差异化恢复运行方法

.....彭寒梅, 王小豪, 魏宁, 李帅虎, 李辉 (2328)

· 电网信息物理系统(特约专栏主编 高昆仑、郭庆来、刘东) ·

目标冲突下电力信息物理协同攻击分析

.....田猛, 董政呈, 王先培, 赵乐, 简子倪 (2336)

考虑信息攻击的配电网信息物理运行风险分析

.....安宇, 刘东, 陈飞, 徐玮群 (2345)

面向协同信息攻击的物理电力系统安全风险评估与防御资源分配

.....陈武晖, 陈文淦, 薛安成 (2353)

电力信息物理相依网络统一建模分析.....金家瑶, 谭阳红 (2361)

基于节点映射模型的电力信息物理系统实时仿真平台

.....孙充勃, 成晟, 原凯, 孙军, 宋毅, 吴在军, 杨雄, 施玉祥 (2368)

电力调频系统的信息物理融合建模及其在容错控制中的应用

.....陈冠宏, 刘东, 翁嘉明 (2376)

图计算在电网 CPS 中的应用场景研究.....王迪, 郭庆来, 孙宏斌 (2384)

基于业务优先级和 SRLG 的电力需求响应业务调度优化算法

.....祁兵, 刘思放, 李彬, 陈宋宋, 李德智, 景栋盛, 张杨, 奚培锋 (2393)

主动配电信息物理系统可靠性建模与评估方法综述

.....郭经, 刘文霞, 张建华, 马铁 (2403)

面向完全分布式控制的微电网信息物理系统建模与可靠性评估

.....王振刚, 陈渊睿, 曾君, 陈剑龙, 刘俊峰 (2413)

基于 HLA 的舰船综合电力系统信息物理混合仿真

.....吴优,付立军,马凡,肖雄波,郝晓亮(2422)

· 国家重点研发计划 ·

含分布式电源及灵活负荷的配电网电量合约市场

.....曹子健,林今,宋永华(2430)

配电网安全域的 $N \times N$ 形式维度肖峻,苏亚贝,张宝强,余步鑫(2441)

风光水互补发电系统与需求侧数据中心联动的优化调度方法

.....温正楠,刘继春(2449)

计及碳交易机制的核-火-虚拟电厂三阶段联合调峰策略研究

.....李旭东,艾欣,胡俊杰,周泊宇,林章岁(2460)

基于 K-means MCMC 算法的中长期风电时间序列建模方法研究

.....黄越辉,曲凯,李驰,司刚全(2469)

风力发电机组防雷技术进展综述

.....施广全,张义军,陈绍东,张阳,郑栋(2477)

柔性多状态开关改进型下垂控制策略

.....蔡云琦,屈子森,杨欢,赵荣祥,等(2488)

· 可再生能源发电与综合消纳技术 ·

基于 PSASP 的综合能源仿真分析系统

.....李亚楼,李芳,刘赫川,高鹏飞,翟江,杨小煜,安宁,周孝信(2498)

基于综合需求响应和博弈的区域综合能源系统多主体日内联合优化调度

.....徐业琰,廖清芬,刘涤尘,彭思成,杨铮,邹宏亮,张黎明(2506)

基于风电消纳需求的综合能源服务商源荷协同运行策略

.....林俐,蔡雪瑄(2517)

基于可再生能源配额制的风电并网节能经济调度

.....梁吉,左艺,张玉琢,赵新刚(2528)

结合风功率预测及储能能量状态的模糊控制策略平滑风电出力

.....刘颖明,王维,王晓东,彭朝阳(2535)

计及电动汽车不确定性的家庭微电网实时能量调度策略

.....孙韩,陈宗海,武骥(2544)

集群电动汽车平抑光伏波动实时调度策略

.....胡俊杰,周华嫣然,李阳(2552)

· 电力系统 ·

两阶段频率和电压协调校正方法

.....许鹏飞,宋墩文,杨铖,汤伟,马世英(2561)

智能建筑群电能日前优化共享

.....任文诗,高红均,刘友波,刘俊勇,李驰宇,刘向龙(2568)

配电侧多微电网日前电能交易纳什议价方法

.....芮涛,李国丽,王群京,胡存刚,张进,丁津津(2576)

基于全波电流关联性的线路差动保护算法

.....吴沛锋,张国云,孔令号(2584)

基于自适应虚拟谐波阻抗控制的孤岛微电网谐波均流策略

.....任碧莹,孙凯歌,马保慧,孙向东(2592)

特高压换流站直流分压器二次侧过电压保护

.....孙哲,李彦斌,张兆华,张民(2601)

基于波阻抗的多端直流电网快速保护方案李岩,龚雁峰,姜斌(2609)

混合多端直流输电系统线路保护方案研究

.....陈争光,周泽昕,王兴国,詹清清,郝晓亮(2617)

一种基于直流断路器两端电压的混合级联多端直流输电断路器自适应重

合闸方法陈争光,周泽昕,王兴国,杜丁香,温伟杰,等(2623)

考虑桥臂多谐波耦合的模块化多电平换流器直流侧阻抗建模方法

.....许冬,王璋,陈东,尹太元,尹诗媛(2632)

直流电抗器对 VSC-MTDC 输电系统稳定性的影响分析

.....李慧,罗奇,张柏林,范新桥(2641)

《工程索引》(EI) 收录核心期刊
2015 和 2017 年度中国“百强报刊”
中国最具国际影响力学术期刊
中国百种杰出学术期刊
中国精品科技期刊
全国中文核心期刊
RCCSE 中国权威学术期刊
《科学文摘》(SA) 收录期刊
《文摘杂志》(AJ) 收录期刊
中国科学引文数据库(CSCD)
中国期刊方阵双效期刊
电力行业优秀科技期刊

《电网技术》(月刊)

第 43 卷 第 7 期(总第 428 期)

主 管: 国家电网有限公司

主 办: 国家电网有限公司

编 辑: 中国电科院期刊中心

《电网技术》编辑部

出 版: 《电网技术》杂志社有限公司

主 编: 张文亮

副主编: 郭剑波 汤 涌

编辑部副主任: 李兰欣 010-82812543

广告部经理: 齐 华 010-58386112

发 行: 闫 嶝 010-82812465

编 辑: 010-82812523/2672/2981/2982

网上投稿: <http://www.dwjs.com.cn>

电力系统内部电话: 91862+后四位

传 真: 010-82812980

地 址: 100192 北京清河小营东路 15 号

中国电力科学研究院有限公司内

印 刷: 北京科信印刷有限公司

北京市昌平区七北路马连店甲 6 号

总发行: 北京报刊发行局

国外发行: 中国国际图书贸易总公司

订 阅: 全国各地邮局

邮发代号: 国内 82-604 国外 1474M

中国标准连续出版物号: ISSN 1000-3673

CN 11-2410/TM

广告经营许可证号: 京海工商广字第 0168 号

期刊基本参数: CN 11-2410/TM * 1957 * M * A4 * 414 * zh * P * ¥80.00 * 20000 * 49 * 2019-07 版权所有 未经许可不得转载及上网

POWER SYSTEM TECHNOLOGY

2019, Vol. 43 No. 7 (Ser. 428)

Contents

• Fundamental Theory of Assessment, Planning and Operation for Resilient Distribution Network •

- Placement of Micro-phasor Measurement Units in Distribution Systems for Highly Accurate State Perception**
..... Tian Jiahui, Liang Dong, Ge Leijiao, Li Kui, Wang Shouxiang, Li Zhankai (2235)
- A New Method for Situation Awareness and Weakness Identification of Distribution Network Considering Ice Disaster**
..... Liu Xinrui, Li Xin, Sun Qiuye, Jin Peng (2243)
- Multi-stage Spatial Load Forecasting Method Based on Urban Development Degree**
..... Xiao Bai, Mu Guannan, Jiang Zhuo, Shi Yonggang, Sun Deqiang (2251)
- Review on Evaluation Methods and Improvement Techniques of DG Hosting Capacity in Distribution Network**
..... Dong Yichao, Wang Shouxiang, Yan Bingke (2258)
- Probabilistic Planning of Substation Capacity and Capacity Credit of Distribution Generators**
..... Tan Xiao, Wang Zhuding, Li Qiang, Sun Hao, Lü Lu, Wang Yu (2267)
- Evaluation Model of Total Supply Capability of Distribution Network Considering Multiple Transfers**
..... Zhu Jiaqi, Dong Shufeng, Xu Chengsi, Zhu Bingquan, Ni Qiulong, Xu Qifeng (2275)
- A Quantitative Method for Evaluating Management Level of Distribution Network Planned Outages Considering Investment**
..... Liu Keyan, Wang Honggang, Liu Yangtao, Du Songhuai, Hu Lijuan, Su Juan (2282)
- Research on Frequency Elasticity Enhancement Method of Mining Area Power Grid Based on Hybrid Energy Storage System**
..... Zhong Rui, Teng Song, Liang Rui, Shen Xinglai (2291)
- Dynamic Reconfiguration of Distribution Network Based on Improved Fuzzy C-means Clustering of Time Division**
..... Dong Zhihui, Lin Lingxue (2299)
- Resilience Enhancement Strategy for Distribution Network Considering Supporting Role of Micro Energy Grid**
..... Ge Shaoyun, Zhang Chenghao, Liu Hong, Xu Zhengyang (2306)
- Research on Resilience Assessment and Improvement Measures of Distribution Network Considering the Influence of Communication System** Chen Bin, Yu Jilai (2314)
- Research on Distribution Network Load Transfer Scheme Based on Multi-objective Optimization Considering Secondary Re-sale Strategy** Zhang Lizong, Wu Lei, Jiang Wei, Zhang Fengming, Zhang Xinxin, Jiang Zhengwei (2321)
- Microgrid Differentiated Recovery Operation for Enhancing Distribution System Resilience**
..... Peng Hanmei, Wang Xiaohao, Wei Ning, Li Shuaihu, Li Hui (2328)

• Power Grid Cyber-Physical Systems •

- Analysis of Electrical Coordinated Cyber Physical Attacks Under Goal Conflict**
..... Tian Meng, Dong Zhengcheng, Wang Xianpei, Zhao Le, Jian Zini (2336)
- Risk Analysis of Cyber Physical Distribution Network Operation Considering Cyber Attack**
..... An Yu, Liu Dong, Chen Fei, Xu Weiwei (2345)
- Security Risk Assessment and Defense Resource Allocation of Power System Under Synergetic Cyber Attacks**
..... Chen Wuhui, Chen Wengan, Xue Ancheng (2353)
- Unified Modeling Analysis of Electrical Cyber-physical Interdependent Networks** Jin Jiayao, Tan Yanghong (2361)
- Real Time Simulation Platform of Power Cyber-physical System Based on Node Mapping Model**
..... Sun Chongbo, Cheng Sheng, Yuan Kai, Sun Jun, Song Yi, Wu Zaijun, Yang Xiong, Shi Yuxiang (2368)
- Cyber Physical Modeling of Power Frequency Control System and Its Application in Fault-tolerant Control**
..... Chen Guanhong, Liu Dong, Weng Jiaming (2376)
- Study on Application of Graph Processing in Power Grid Cyber-physical System** Wang Di, Guo Qinglai, Sun Hongbin (2384)
- Optimized Scheduling Algorithm for Power Demand Response Service Based on Multi-priority Services and SRLG**
..... Qi Bing, Liu Sifang, Li Bin, Chen Songsong, Li Dezhi, Jing Dongsheng, Zhang Yang, Xi Peifeng (2393)
- A Survey of Reliability Modeling and Evaluation Methods for Active Distribution Cyber-physics Systems**
..... Guo Jing, Liu Wenxia, Zhang Jianhua, Ma Tie (2403)
- Modeling and Reliability Assessment of Completely Distributed Microgrid Cyber Physical System**
..... Wang Zhengang, Chen Yuanrui, Zeng Jun, Chen Jianlong, Liu Junfeng (2413)
- Cyber-physical Co-simulation of Vessel Integrated Power System Based on HLA**
..... Wu You, Fu Lijun, Ma Fan, Xiao Xiongbo, Hao Xiaoliang (2422)

• National Key Research and Development Program of China •

- Electricity Contract Market for Distribution Network With Distributed Generations and Flexible Loads**
..... Cao Zijian, Lin Jin, Song Yonghua (2430)
- $N \times N$ Form Dimension of Distribution System Security Region** Xiao Jun, Su Yabei, Zhang Baoqiang, She Buxin (2441)

A Optimal Scheduling Method for Hybrid Wind-solar-hydro Power Generation System With Data Center in Demand Side	Wen Zhengnan, Liu Jichun (2449)
Three-stage Combined Peak Regulation Strategy for Nuclear-thermal-virtual Power Plant Considering Carbon Trading Mechanism	Li Xudong, Ai Xin, Hu Junjie, Zhou Boyu, Lin Zhangsui (2460)
Research on Modeling Method of Medium-and long-term Wind Power Time Series Based on K-means MCMC Algorithm	Huang Yuehui, Qu Kai, Li Chi, Si Gangquan (2469)
Review of Lightning Protection Technique Progress of Wind Turbines	Shi Guangquan, Zhang Yijun, Chen Shaodong, Zhang Yang, Zheng Dong (2477)
Research on Improved Droop Control Strategy for Soft Open Point	Cai Yunyi, Qu Zisen, Yang Huan, Zhao Rongxiang, et al (2488)
• Renewable Energy Generation and Integration •	
Framework Design of Simulation System for Integrated Energy Systems Based on PSASP	Li Yalou, Li Fang, Liu Hechuan, Gao Pengfei, Zhai Jiang, Yang Xiaoyu, An Ning, Zhou Xiaoxin (2498)
Multi-player Intraday Optimal Dispatch of Integrated Energy System Based on Integrated Demand Response and Games	Xu Yeyan, Liao Qingfen, Liu Dichen, Peng Sicheng, Yang Zheng, Zou Hongliang, Zhang Liming (2506)
Source-load Cooperative Operation Strategy of Integrated Energy Service Provider Based on Wind Power Accommodation Demand	Lin Li, Cai Xuexuan (2517)
Energy-saving and Economic Dispatch of Power System Containing Wind Power Integration Under Renewable Portfolio Standard	Liang Ji, Zuo Yi, Zhang Yuzhuo, Zhao Xingang (2528)
A Fuzzy Control Strategy Combined With Wind Power Prediction and Energy Storage SOE for Smoothing Wind Power Output	Liu Yingming, Wang Wei, Wang Xiaodong, Peng Chaoyang (2535)
Online Energy Dispatch Strategy for Residential Microgrid Considering Uncertainty of Electric Vehicle	Sun Han, Chen Zonghai, Wu Ji (2544)
Real-time Dispatching Strategy for Aggregated Electric Vehicles to Smooth Power Fluctuation of Photovoltaics	Hu Junjie, Zhou Huayanran, Li Yang (2552)
• Power System •	
Two-stage Frequency and Voltage Coordinated Correction Method	Xu Pengfei, Song Dunwen, Yang Cheng, Tang Wei, Ma Shiyang (2561)
Optimal Day-ahead Electricity Scheduling and Sharing for Smart Building Cluster	Ren Wenshi, Gao Hongjun, Liu Youbo, Liu Junyong, Li Chiyu, Liu Xianglong (2568)
Nash Bargaining Method for Multi-microgrid Energy Trading in Distribution Network	Rui Tao, Li Guoli, Wang Qunjing, Hu Cungang, Zhang Jin, Ding Jinjin (2576)
A New Line Differential Protection Principle Based on Correlation of Full Wave Current Data	Wu Peifeng, Zhang Guoyun, Kong Linghao (2584)
Harmonic Current Sharing Strategy in Islanding Microgrid Based on Adaptive Virtual Harmonic Impedance Control	Ren Biying, Sun Kaige, Ma Baohui, Sun Xiangdong (2592)
Study on Surge Protection of DC Divider Secondary Side in UHV Converter Station	Sun Zhe, Li Yanbin, Zhang Zhaohua, Zhang Min (2601)
A Fast Protection Scheme for Multi-terminal HVDC Grid Based on Surge Impedance	Li Yan, Gong Yanfeng, Jiang Bin (2609)
Research on Protection Scheme of Hybrid Multi-terminal DC Transmission Lines	Chen Zhengguang, Zhou Zexin, Wang Xingguo, Zhan Qingqing, Hao Liangliang (2617)
An Adaptive Reclosure Method for Hybrid Cascade Multi-terminal HVDC Circuit Breaker Based on Two-terminal Voltage of DC Circuit Breaker	Chen Zhengguang, Zhou Zexin, Wang Xingguo, Du Dingxiang, Wen Weijie, et al (2623)
DC Side Impedance Modeling Method of Modular Multi-level Converter Considering Multiple Harmonic Coupling on Arm	Xu Dong, Wang Zhang, Chen Dong, Yin Taiyuan, Yin Shiyuan (2632)
Impact of DC Reactors on Stability of VSC-MTDC Transmission System	Li Hui, Luo Qi, Zhang Bolin, Fan Xinqiao (2641)

Sponsor: State Grid Corporation of China

In Cooperation with: China Electric Power Research Institute (CEPRI)

Chairman of Editorial Committee: Liu Zhenya

Editor-in-Chief: Zhang Wenliang

Editor and Publisher: Power System Technology Press

Associate Director of Editorial Board: Li Lanxin

Publication Number: ISSN 1000-3673

CODEN: DIJIES **Devey#:** 621.31

Address: China Electric Power Research Institute, Qinghe, Beijing 100192, China

Tel/Fax: 86-10-82812980

E-mail: pst@epri.sgcc.com.cn <http://www.dwjs.com.cn>

Agent of Subscriptions Abroad: China International Book Trading Corporation (GUOJISHUDIAN) P.O.Box 399, Beijing, China