Impact of the Stochastic Behaviour of Renewable Resources on Power System Reliability

Mike Brian Ndawula, Ignacio Hernando Gil

Challenges of Network Operation
• Strict targets set by Security and Quality of Supply (SQS) regulation.
• Integration of renewables into conventional distribution networks introduces uncertainty about their impact on reliability performance.
• Planning, operational and commercial implications.

Integrated Quality of Supply Analysis
Conventional Monte-Carlo simulation improved by including:

- Dependency tables: 26 hourly demand classes
- Temporal variability: 3 scenarios
- Filtered load points by load class and type
- Filtering of 10% of load points

UK DNOs’ Annual Reliability: CI and CML Indices

Variability of Renewables
Renewable Energy Resources (RERs) characteristically vary both spatially and temporally.

Risk Quantification
Impact of interventions on ENS

Smaller interventions: ENS

Smart Interventions
1) Demand-side Response (DSR) for reliability improvement: demand reductions during periods with high fault-probability.
2) Uncontrolled Solar Photovoltaic (PV) energy with a 50% overall network penetration.
3) PV+DSR – to take advantage of period with highest likelihood of fault occurrence.
4) Energy Storage (ES) where daily Microgeneration (MG) output is stored during the day to provide a backup capability of 3.67 kWh per customer per fault.
5) ES + DSR – to illustrate and quantify the value of MG control.

- Reduction in ENS, SAIDI and average interruption duration.
- Accurate reliability performance assessment for distribution network planning and operation.
- Economic benefits to DNOs through OFGEM penalty/reward schemes, and to customers through reductions in electricity bills and improved quality of supply.

M.B.Ndawula@bath.ac.uk, I.Hernando.Gil@bath.ac.uk
Centre for Sustainable Power Distribution, Faculty of Engineering and Design.

UK yearly demand (Winter day) 156.24 MW

Within generation demand 82.2 MWh/customer/year

0.24

200

400

500

Base case

ES+DSR

PV+DSR

Effect of PV and DSR on ENS per load point

Average outage duration per load point

Impact of clouding effect

ENS Index

Over-estimation of 22%