OPTIMAL SIZING AND LOCATION OF A PV SYSTEM ON THREE-PHASE UNBALANCED RADIAL DISTRIBUTION FEEDER AVOIDING REVERSE POWER FLOW

Ammar Munir AL-Sabounchi

National Energy & Water Research Center
Abu Dhabi - UAE
Contents

INTRODUCTION

PREVIOUS WORK

OBJECTIVES

MODELING AND OPTIMIZATION CONCEPT

OPTIMIZATION PROCEDURE

APPLICATION
Introduction

Benefits of Connecting DG Units on Radial Distribution Feeders

- Reduction of line losses,
- Improvement of voltage profile,
- Relieving the feeder and substation,
- Peak load shaving,
- Postponing the upgrading requirement of the feeder,
- Improvement of system reliability,
- Reduction of global warming concerns,
Introduction

Reduction of global warming concerns

Applications of Photovoltaic Generators

Connection of Photovoltaic DG (PVDG) units to radial distribution feeders

Optimal sizing and location of PVDG units on radial distribution feeders is a matter of significant importance
Dealing with traditional DG units

Assuming Peak Matching
Previous Work

Assuming 3-phase balanced load feeder, line impedance/load demand modeling and calculations are conducted assuming balanced load conditions. On actual conditions, radial distribution feeders operate under unbalanced load conditions. This leads to repetition in calculations for energy-based quantities, which ends up with long calculations.
Objectives

Optimal sizing and location of single PVDG unit on radial distribution feeder considering

- Modeling the feeder under unbalanced load condition
- Independent changes of feeder load curve and PVDG production curve
- Peak mismatch of the load and PVDG curves
- Solving for line energy loss reduction ($\Delta$EL)
Modeling and Optimization Concept

But dealing with $\Delta EL$ needs repetition of the calculations on hourly basis, or even shorter interval, over the relevant duration.

Determination of Feasible Optimization Interval (FOI) at which the $\Delta EL$ can be rated will be very helpful.
Optimization Procedure

A Research has been conducted to develop suitable optimization procedures considering two scenarios:

- **RPF Avoidance Scenario**
  - Single PVDG unit
  - Multiple PVDG units

- **RPF Allowance Scenario**
  - Single PVDG unit
  - Multiple PVDG units
Optimization Procedure

The derivation shows that the optimal PVDG size and location result in minimum power flow area at the FOI also result in minimum energy flow along the feeder.

**Single PVDG unit avoiding RPF**
Application

In case the optimal solution cannot be applied for any practical reason - like inconvenience/limitation of land area - then there will be additional 28 feasible solutions to select from among them.
Application

- Va with no PVDG vs. Va with 1 PVDG unit
- Vb with no PVDG vs. Vb with 1 PVDG unit
- Vc with no PVDG vs. Vc with 1 PVDG unit

Node
Application

Graphs showing the comparison of currents with and without a PV DG unit, labeled as $I_a$, $I_b$, and $I_c$. The graphs plot the current values against different sections.
Following Work

Multiple PVDG units avoiding RPF

Single PVDG unit allowing RPF

Multiple PVDG unit allowing RPF
THANK YOU