CIGRE | PARIS 2022

PSI
*Smartness for a sustainable planet*

Determination of Real-Time Interdependent Flexibility on multiple Grid Connection Points in an Active Distribution Network

Andreas Kubis, Ankit Singh, Giancarlo Torres-Villarreal, Sasiphong Leksawat

PSI Software AG

Goal

One of the main goals of this work is the design and prototypical development of a SCADA/DMS monitoring and control feature for the determination and exploitation of active and reactive power flexibility of a distribution network ensuring contingency constrained security. In view of that, the control algorithm aims to determine mutual flexibility of the concerned network at a grid connection point (GCP) with respect to the other GCPs.
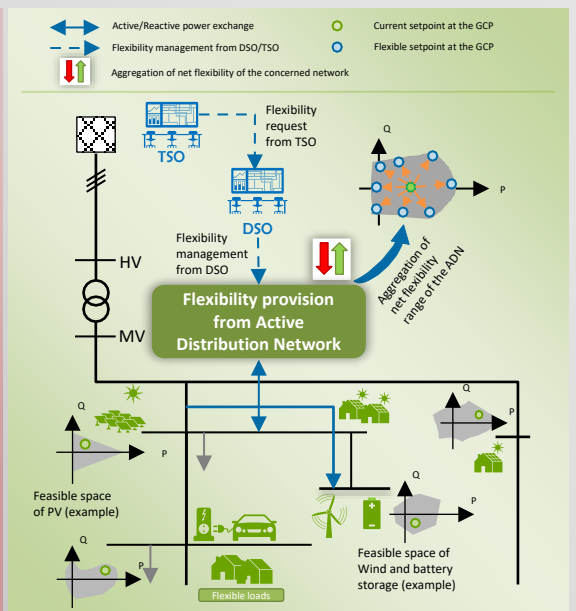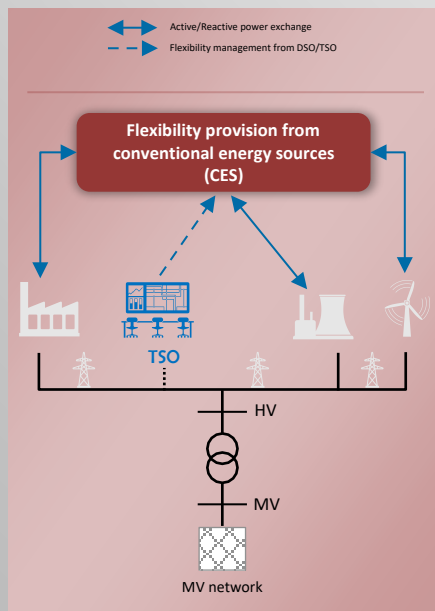
Conventional flexibility provision

Future flexibility provision

Problem

- **Penetration** of Distributed Energy Resources (**DERs**) in the distribution network can pose power system **security issues** such as **congestion** in the transmission network
- The increasing **decommissioning** of **CES** creates a **reduction** on adequate **active** and **reactive power flexibility** for ancillary services

Solution

- Active and reactive power characteristics of **DER**s give an **opportunity** for their utilization in providing ancillary services such as congestion management
- DERs can be **controllable** up to a certain extent with each offering a certain amount of active and reactive power flexibility to the grid within a **feasible space**
- **Aggregation** of the net flexibility, offered by all the DERs and flexible loads, can be used by the system operator to provide **flexibility** at the **grid connection point (GCP)** of the distribution network to the transmission network.

http://www.cigre.org

C6

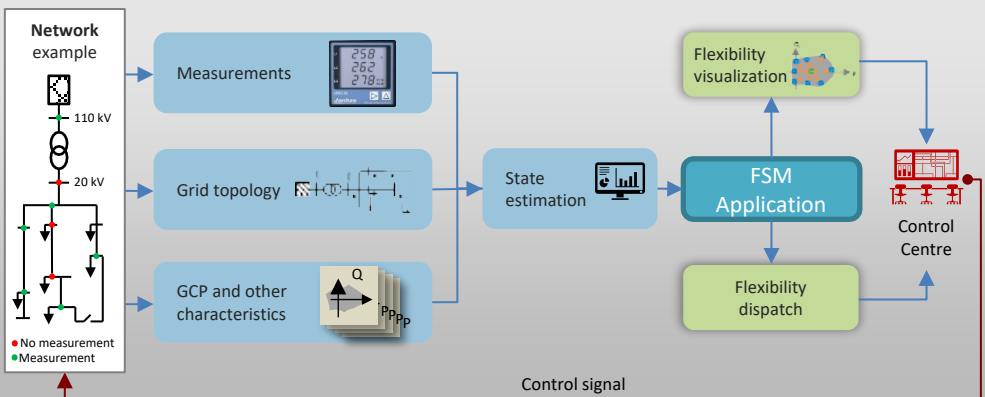Active Distribution Systems and Distributed Energy Resources

11108

Determination of Real-Time Interdependent Flexibility on multiple Grid Connection Points in an Active Distribution Network
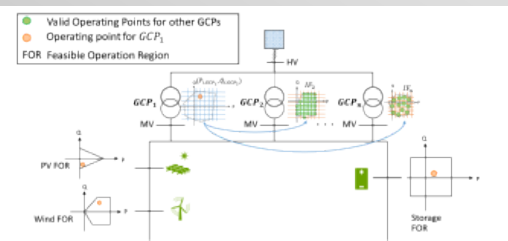
Andreas Kubis, Ankit Singh, Giancarlo Torres-Villarreal, Sasiphong Leksawat
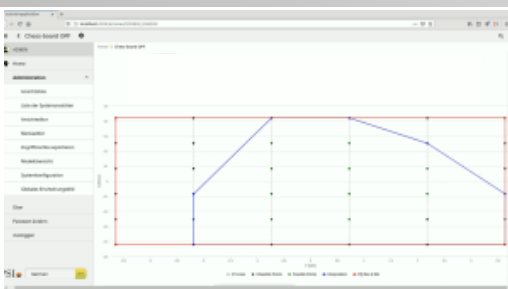
PSI Software AG

Setup

Network example

110 kV

20 kV

● No measurement
● Measurement

Measurements

Grid topology

GCP and other characteristics

State estimation

FSM Application

Flexibility visualization

Flexibility dispatch

Control Centre

Control signal

Main characteristics of real-time interdependent flexibility estimation application

● Valid Operating Points for other GCPs
● Operating point for GCP_1
FOR Feasible Operation Region

Schematic representing the mutual flexibility assessment at the GCPs

Interaction with the application via a web-based GUI

Real-time assessment

Current operating setpoint is used as a reference to calculate flexibility

Mutual flexibility

Flexibility calculation at a GCP considers mutual power flows at the other GCPs

Parallelized computation

Multiple instances of OPFs are supposed to improve computational performance

(N-1) security constraints

Preventive (N-1) security constraints takes into account line contingency into consideration

Economic setpoints

The application provides economic setpoints for flexibility dispatch

Web-based GUI

Currently the functionality of flexibility estimation can be executed via a web-based GUI

http://www.cigre.org

PSI
Smartness for a sustainable planet

C6
Active Distribution Systems and Distributed Energy Resources
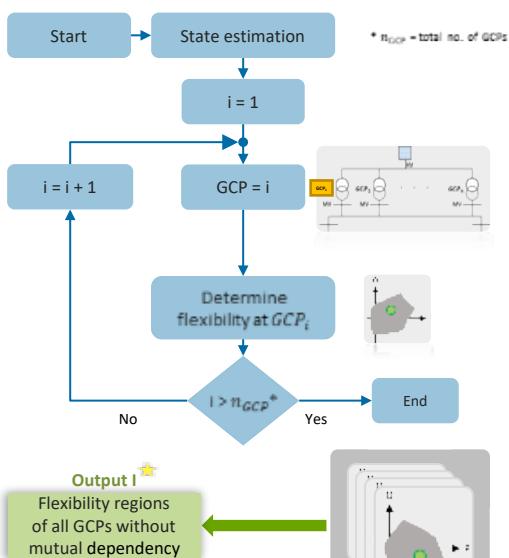11108

Determination of Real-Time Interdependent Flexibility on multiple Grid Connection Points in an Active Distribution Network

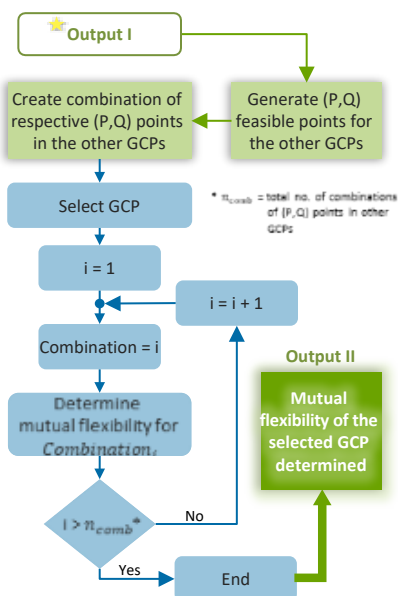Andreas Kubis, Ankit Singh, Giancarlo Torres-Villarreal, Sasiphong Leksawat
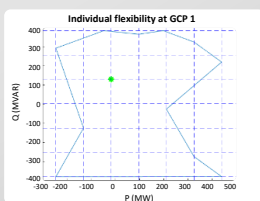
PSI Software AG

Methodology

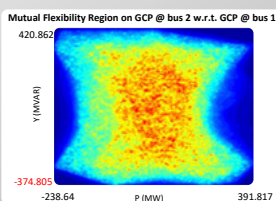**Part I – Preparation: Determine independent flexibility**

Start → State estimation

$*\ n_{GCP}$ = total no. of GCPs

i = 1

i = i + 1

GCP = i

Determine flexibility at GCP_i

I > $n_{GCP}*$ No / Yes → End

Output I
Flexibility regions of all GCPs without mutual **dependency**

Part II – Determine mutual flexibility

⭐ **Output I**

Create combination of respective (P,Q) points in the other GCPs ← Generate (P,Q) feasible points for the other GCPs

$*\ n_{comb}$ = total no. of combinations of (P,Q) points in other GCPs

Select GCP

i = 1

Combination = i

i = i + 1

Determine mutual flexibility for $Combination_i$

I > $n_{comb}*$ No / Yes → End

Output II
Mutual flexibility of the selected GCP determined

Results

Individual flexibility at GCP 1

Mutual Flexibility Region on GCP @ bus 2 w.r.t. GCP @ bus 1

420.862
Y (MVAR)
-374.805
-238.64   P (MW)   391.817

Flexibility at GCP 1 WITHOUT mutual dependency on other GCPs

Flexibility at GCP 1 WITH mutual dependency on other GCPs

Conclusion

The research work can support a system operator in terms of:

- Situational awareness
- Managing flexibility of the distribution grid
- Analysing robust region of operation at GCP by looking at mutual flexibility region
- Providing ancillary services such as congestion management

http://www.cigre.org