Equipment in the PV plant for an optimal grid management

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WORKSHOP

NON-DISPATCHABLE RENEWABLE ENERGIES INTEGRATION INTO THE GRID

Lusaka, 5-6 September 2018

Equipment in the PV plant for an optimal grid management

Presentation Overview

1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP
2. SCADA system for the Renewable plants
3. Renewable Storage
4. Renewable energy experience in Zambia- Ngonye PV Solar plant

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Introduction

The integration of Renewable power plant (PV, wind) into the grid is always guided by the grid technical requirements outlined by network owners as it is done with the conversional hydro/thermal power plants. System Operators and Network owners require developers to prove that the Renewable plant is compliant with the requirements of the country's Grid Code. Most Grid Codes of African countries are quite similar and they have common requirements, the specific parameters and limits might be slightly different. These set requirements (grid code) will be discussed in the presentation and the emphasis will be on the Zambian and South African grid codes.

It is the responsibility of the Renewable Power Plant owner to install equipment that ensures that the plant complies with all the requirement of the codes of the TSO/DSO/TSNP/DSNP.
The presentation will focus on the integration of PV Plant into the grid, also considering the actual experience that Enel Green Power has with the Ngonye PV plant in Lusaka, Zambia.

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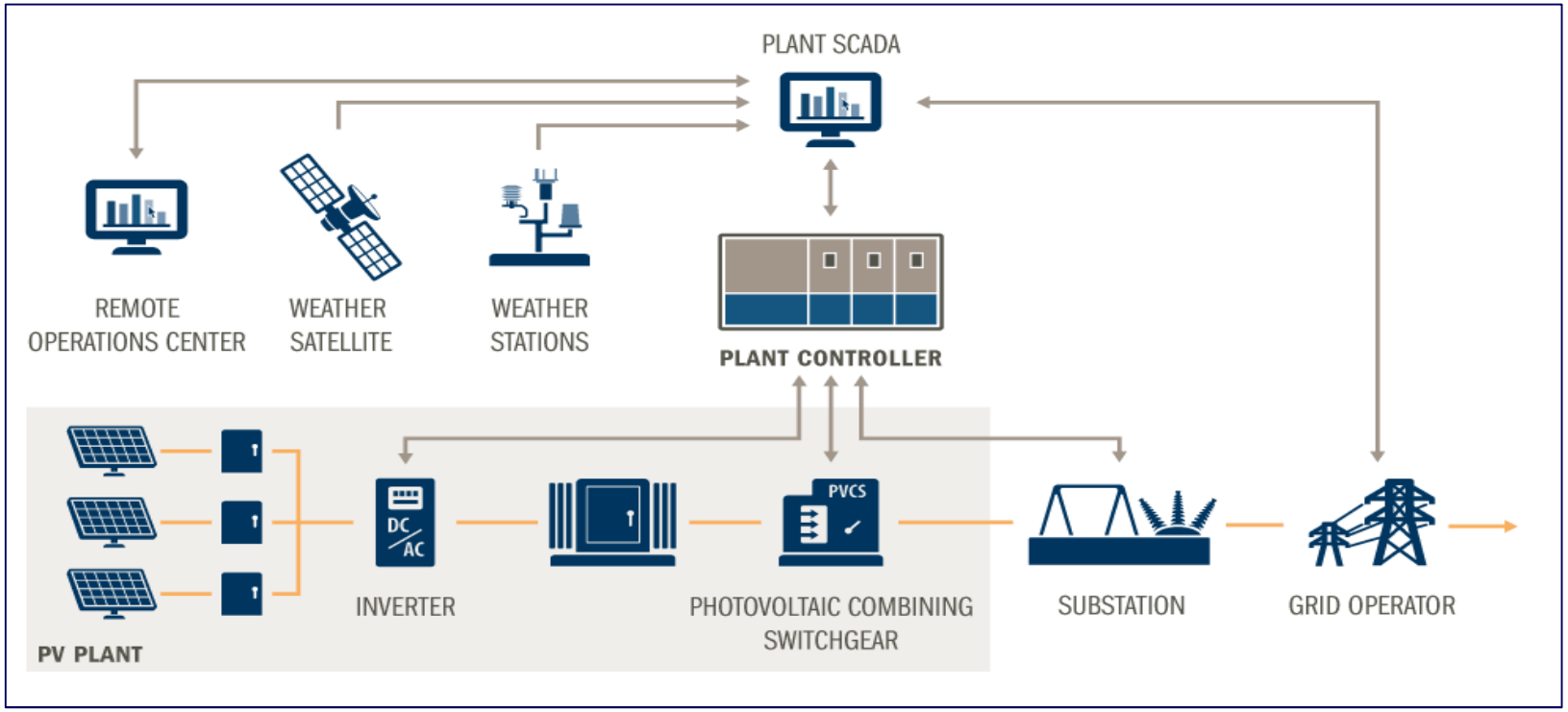
Introduction

Integration of a renewable plant in the grid



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1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP

The following set of requirements can be found in most Grid Codes, including the Zambian Grid Codes:

- ❑ Frequency response
- ❑ Active Power Constraint Functions
- ❑ Low voltage ride through capability
- ❑ High voltage ride through capability
- ❑ Reactive power capability
- ❑ Reactive Power and Voltage Control functions
- ❑ Protection requirements
- ❑ Power Quality

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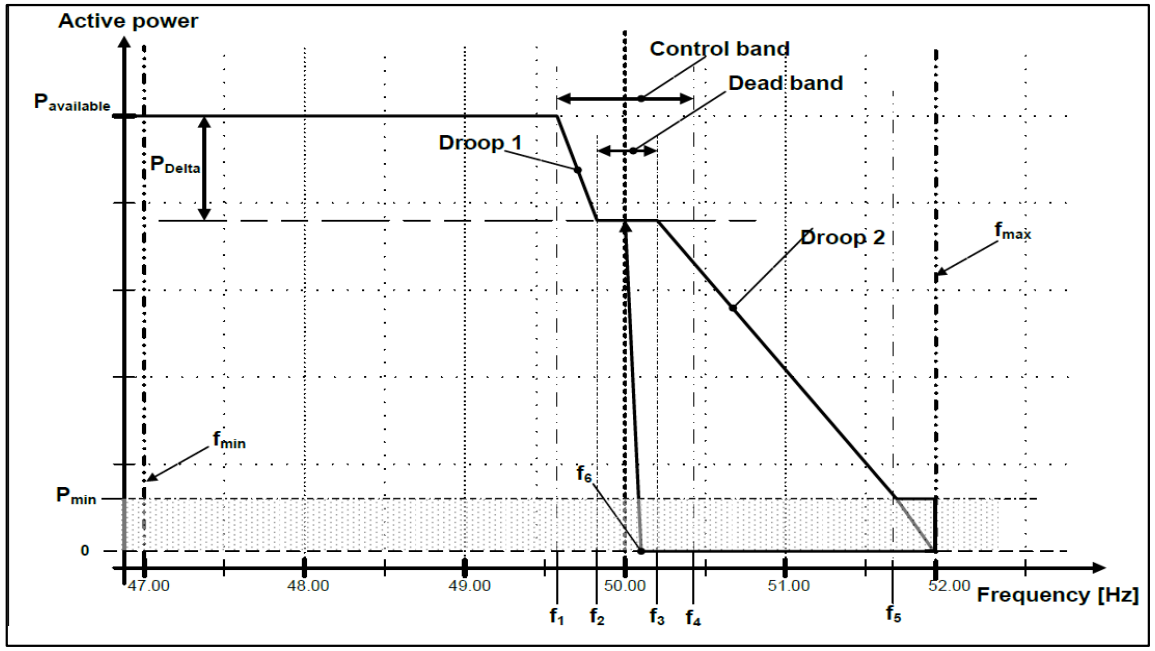
1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP (2)

Frequency response



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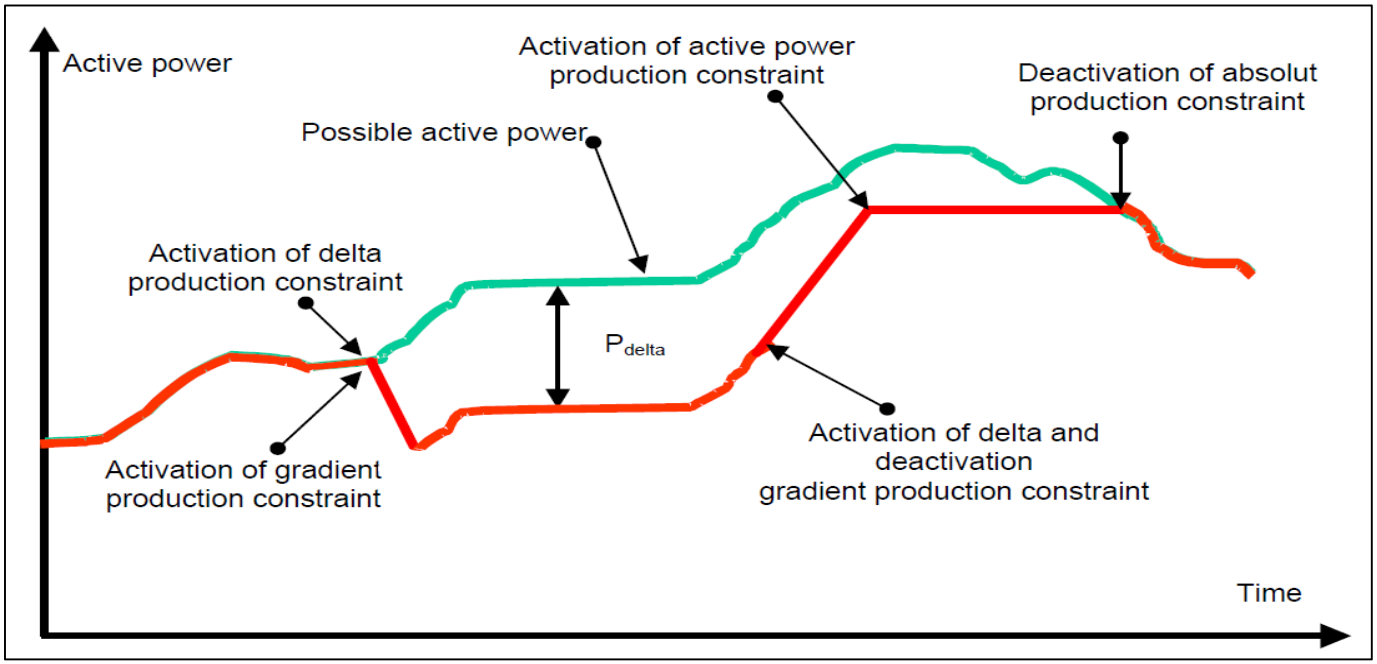
1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP(3)

Active Power Constraint Functions



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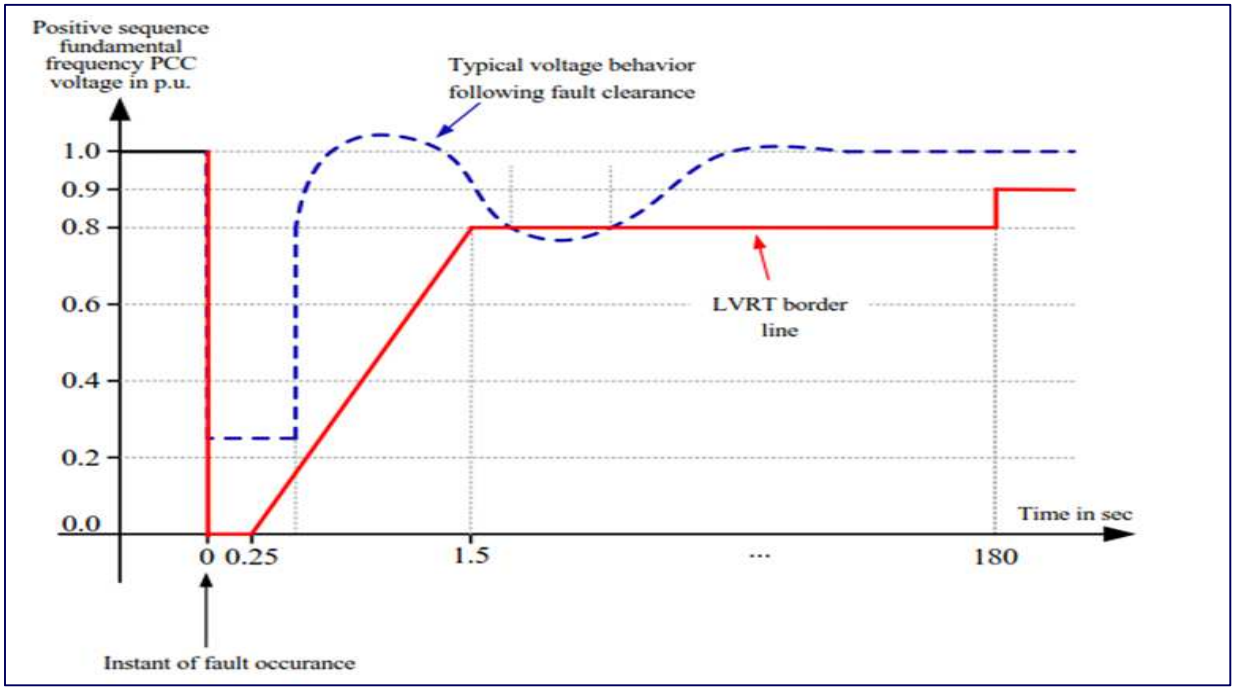
1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP(4)

Low voltage ride through capability



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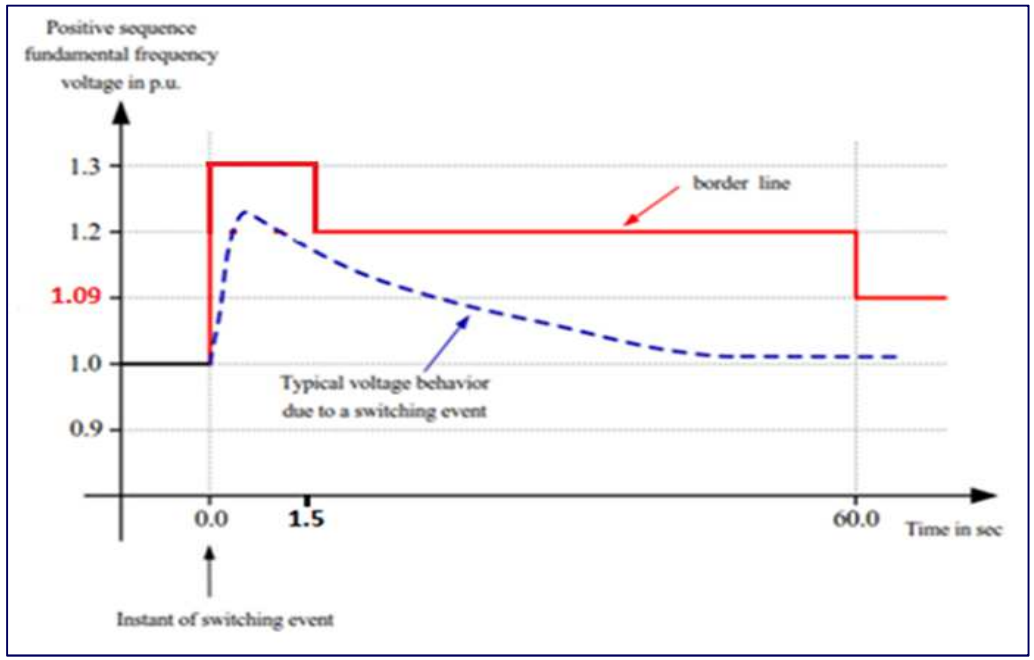
1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP (5)

High voltage ride through capability



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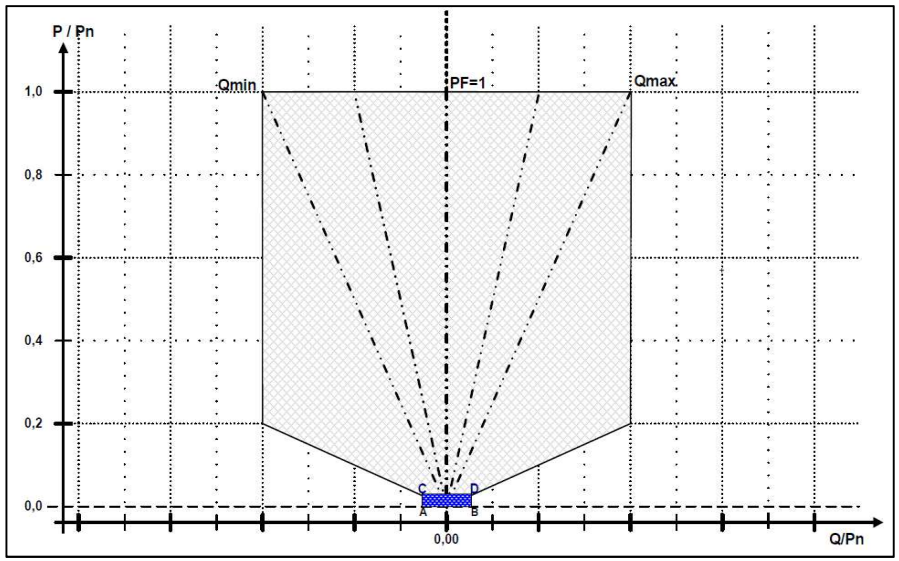
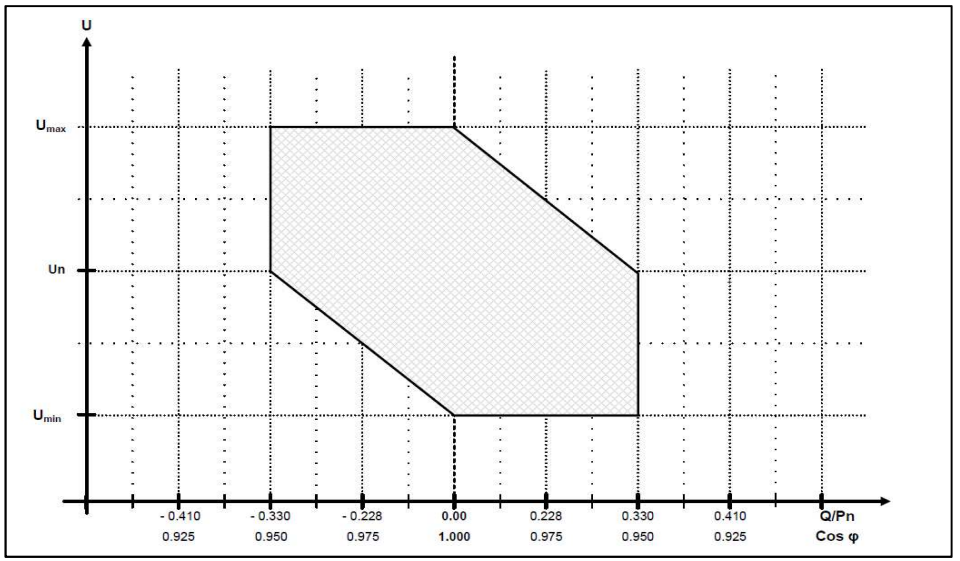
Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP (6)

Reactive power capability





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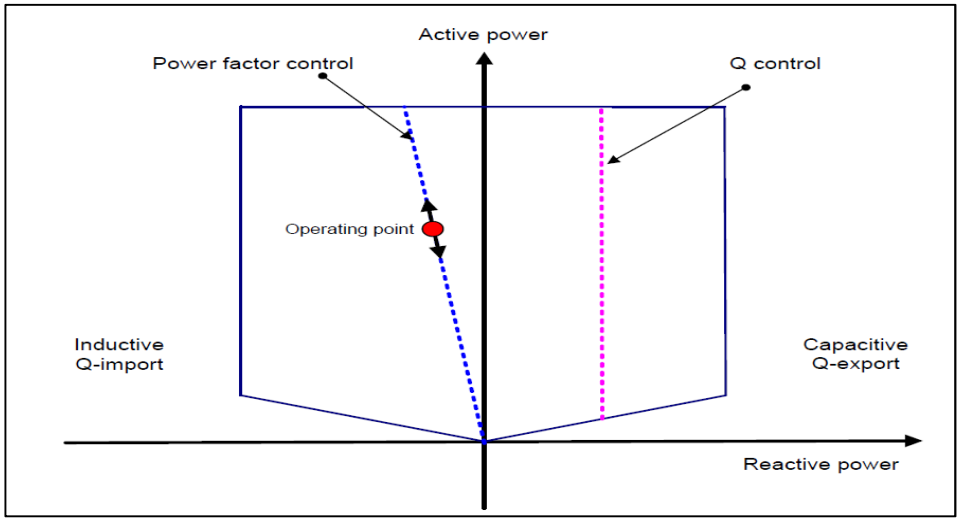
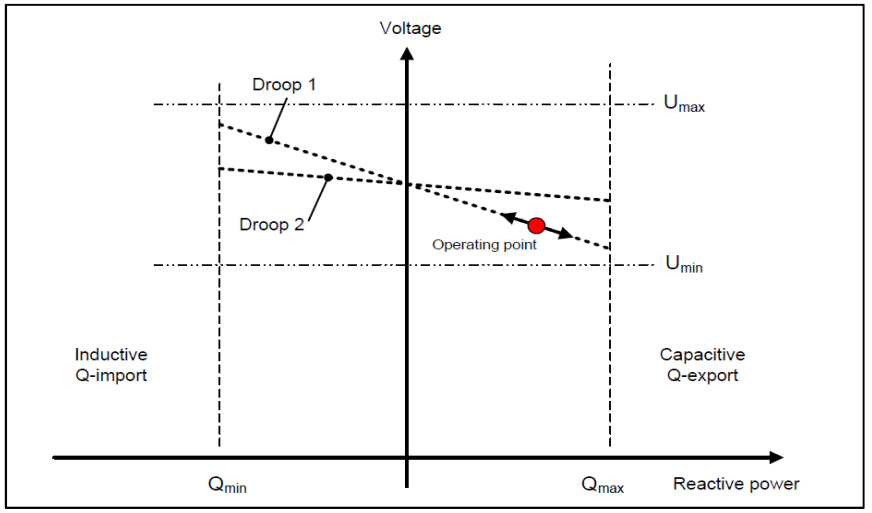
1.Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP (7)

Reactive Power and Voltage Control functions

- Reactive Power control
- Voltage control
- Power factor control





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1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP(9)

Protection requirements

The *RPP owners* must ensure that the *RPP* is dimensioned and equipped with the necessary protection functions so that the *RPP* is protected against damage due to faults and incidents in the *TS* and *DS*. Some of the protection equipment required are:

- Islanding protection
- Synchronous protection
- Earthing mats
- Neutral Earthing Resistors
- Current transformers and voltage transformer
- Lightning protection
- Surge Arrestors

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1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP(8)

Power Quality

This relates to the quality of supply from the Renewable Power Plant and it is the responsibility of the plant owner to ensure that the following parameters remain within limits (as outline by System Operator/Network Owner):

- Voltage and Current harmonic emission
- Flicker
- Voltage Unbalance
- Rapid Voltage Change

If the plant produces emissions that are above the outlined limits, the plant owner will have to install power quality equipment such as *harmonic filters*, to reduce the plants emissions.

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1. Grid Code Compliance Requirements by TSO/DSO/TSNP/DSNP(10)

Summary of the Grid Code Requirements and equipment required

Grid Code Requirements	Equipment required
Frequency response	Power Plant Controller & Inverters
Active Power Constraint Functions	Power Plant Controller & Inverters
Low voltage ride through capability	Power Plant Controller & Inverters
High voltage ride through capability	Power Plant Controller & Inverters
Reactive power capability	Power Plant Controller & Inverters, Capacitor banks and STACOM
Reactive Power and Voltage Control functions	Power Plant Controller & Inverters
Protection requirements	Switch gears, CTs, VTs, Islanding protection, Relays, Surge Arrestors and etc
Power Quality	Inverters & Harmonic Filters

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2. SCADA system that is implemented for the Renewable plants

The System Operator requires SCADA mainly for monitoring and remote control of the renewable plant. In addition, SCADA is also used by the owner to also operate and monitor its own plant. The following signals are sent by the System Operator to the Renewable plant:

- Primary frequency control ON/OFF
- Curtailment mode ON/OFF
- Curtailment setpoint command
- Stop command
- P-delta mode ON/OFF
- P-delta setpoint command
- Power gradient constraint ON/OFF
- Up ramp rate setpoint command
- Down ramp rate setpoint command

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2. SCADA system that is implemented for the Renewable plants(2)

- Reactive power control mode ON/OFF
- Reactive power control mode ON/OFF
- Reactive power control setpoint command
- Power factor mode ON/OFF
- Power factor setpoint command
- Voltage control mode ON/OFF
- Voltage control setpoint

The System Operator will have control of circuit breaker at point-of-connection(POC) to trip the plant if required. An interconnection facility is usually constructed to integrate the Renewable plant in the network and this is where the POC will be located. At the POC the System Operator will have the capability of controlling the plant's response and output, and also to disconnect the plant if required.

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2. SCADA system that is implemented for the Renewable plants(3)

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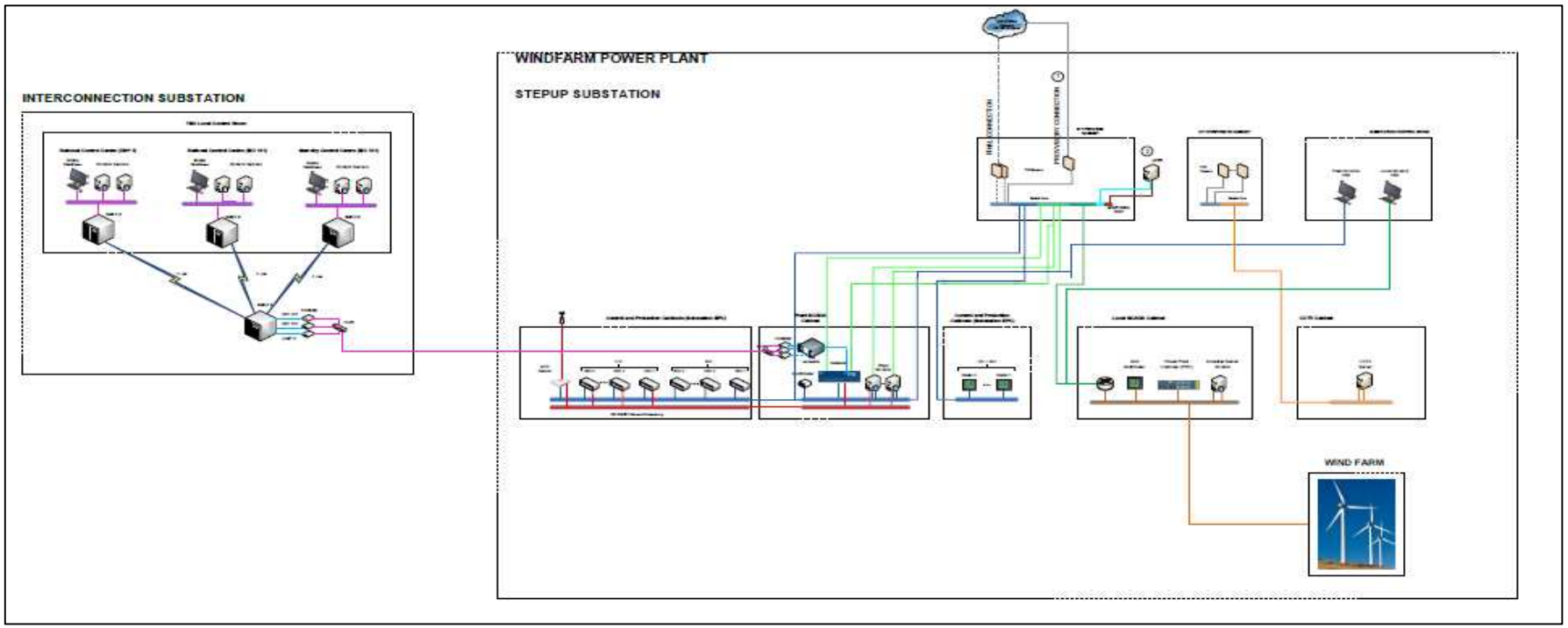
2. SCADA system that is implemented for the Renewable plants(4)

SCADA architecture implemented



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3. Renewable Energy Storage

Renewable Power Plants are intermittent sources of generation and their output is dependent on the natural resources such as the sun irradiation and wind. The sun irradiation is a more predictable resource than the wind resource, but the weather can change at point in time resulting in abrupt decrease and loss of renewable energy generation. This uncertainty that comes with renewable energy generation has resulted in the efforts of developing energy storage solutions that will be utilized to store the generated renewable energy to be used when the natural resources are not available.

Grid Code requirements will have to be developed to take into consideration the integration of the storage facility into the network. This will help in understanding and knowing the equipment that will be required to be installed with storage facility to ensure optimal management of the network.

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4. Renewable energy experience in Zambia- Ngonye PV Solar plant

	Ngonye Solar PV
Technology	Solar Photovoltaic
Capacity	34 MW DC/28.2 MW AC
Location	Zambia, Lusaka
Inverters	FIRMER inverters, 24 inverters
Modules	J SOLAR modules,103500
Interconnection	About 0.2 km 33 kV underground cable from Ngonye PV plant delivery cabin to 33 kV feeder bay in LEMFZ substation
Current activities	• Under construction
Projected COD	Early 2019

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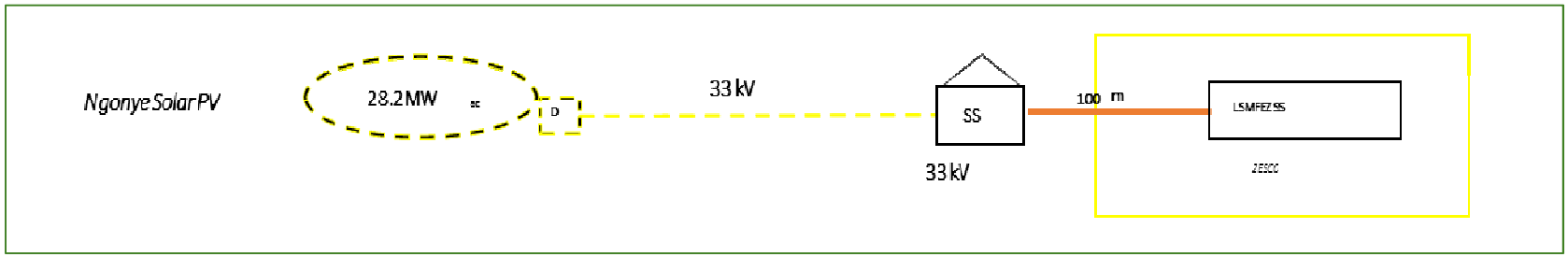
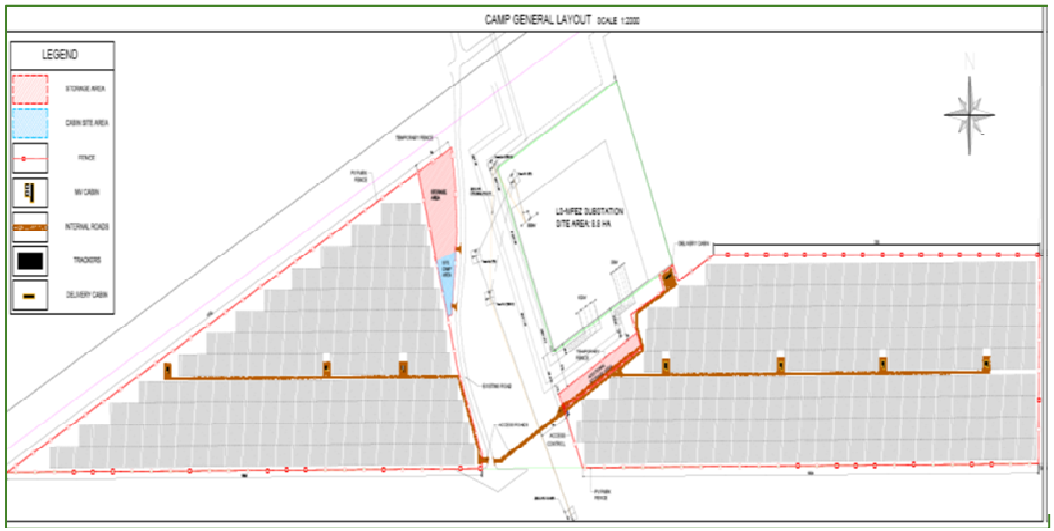
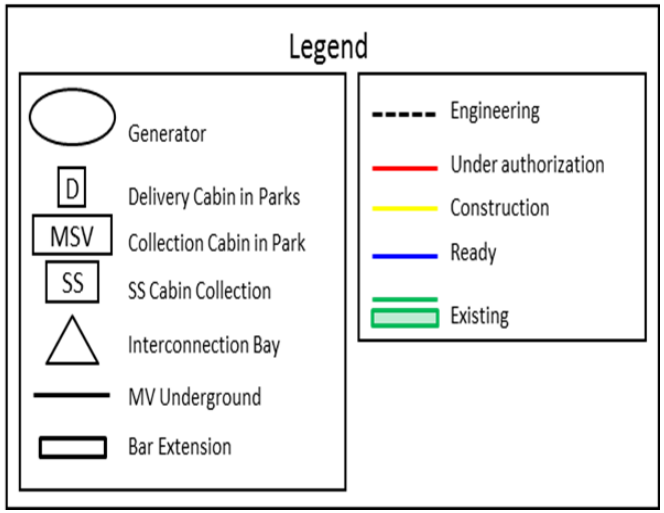
4. Renewable energy experience in Zambia- Ngonye PV Solar plant(2)







Thank you

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