

Impact of Renewable Energy Sources on Power Quality of Grid

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Introduction



- ❖ INDIA has set a goal of 175 GW of power generation by Renewable energy sources upto 2022
- ❖ 100 GW capacity to be installed by Solar PV
- ❖ 60 GW capacity to be installed by Wind energy
- ❖ Electrical power must be of acceptable quality
- ❖ Increasing penetration rate of renewable energy sources raising technical problems like voltage regulation, network protection



<https://mnre.gov.in/file-manager/annual-report/2016-2017/EN/pdf/1.pdf>



- ❖ Central Electricity Authority (CEA) has formulated guidelines to control power quality when connecting renewable generating stations at Point of Common Coupling (PCC)
 - The harmonic current injection from a generating station shall not exceed the limit specified in IEEE 519:2014
 - The generating station shall not inject DC current greater than 0.5% of the full rated output at the interconnection point
 - The generating station shall not introduce flicker beyond the limits specified in IEC 61000-3-7:2008

Background

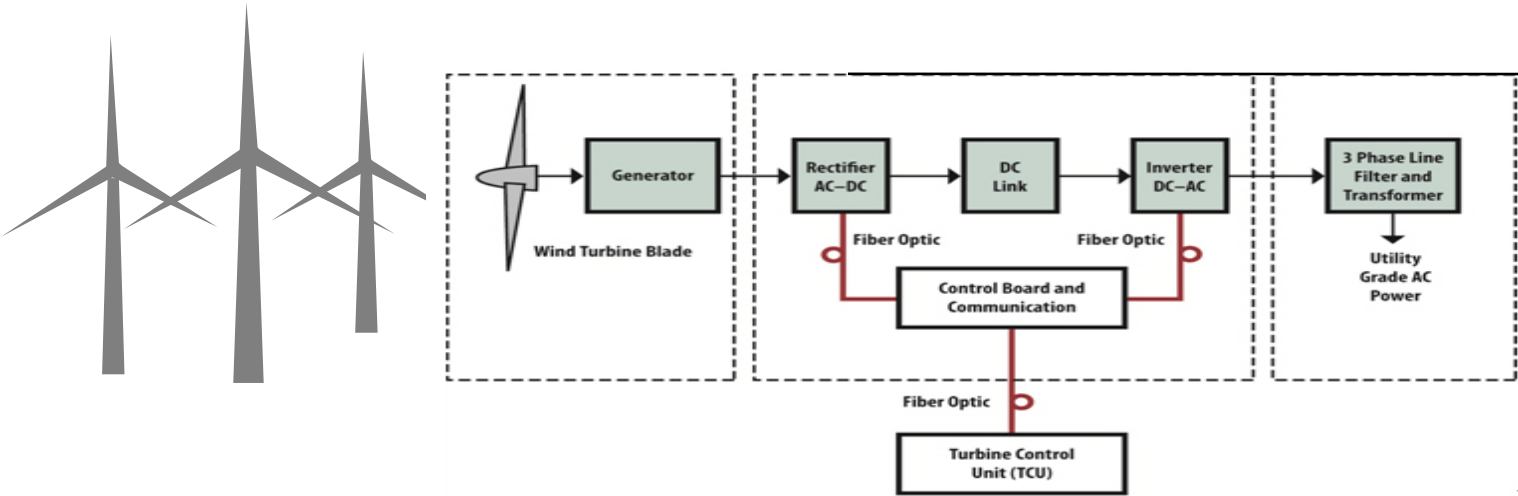


Fig. 1 Simplified Electrical Block Diagram for Wind Power Generation Plant

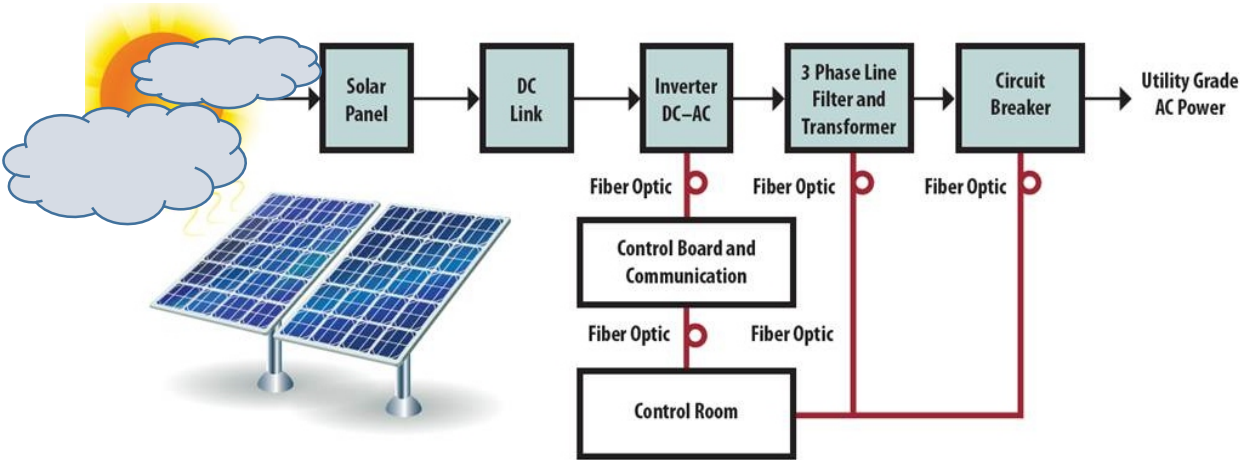
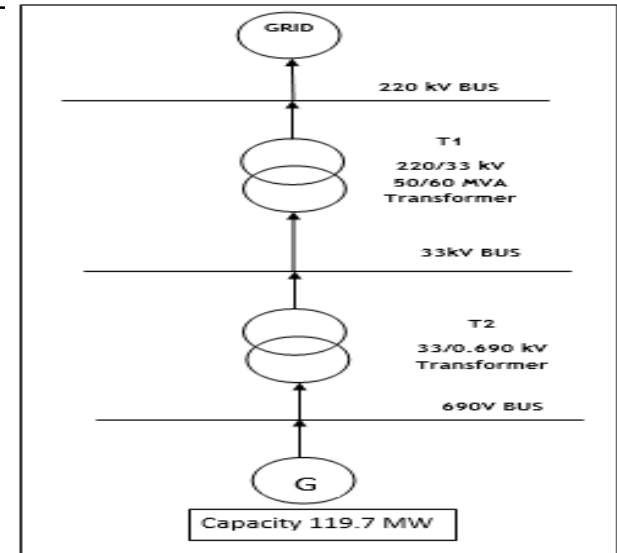


Fig. 2 Simplified Electrical Block Diagram for Solar Power Generation Plant

Power Quality Scenario in Wind Farms



Utility's Requirement



- ❖ In order to supply good quality of power, Utility's made mandatory to conduct PQM as per CEA guidelines
- ❖ Voltage fluctuation evaluation is based on IEC 61000-3-7:2008
- ❖ Instrument should be as per IEC 61000-4-15 :2010
- ❖ Should record short term flicker (Pst) and long term flicker (Plt)

Flicker Severity factor	Planning levels	
	MV	HV
Pst	0.9	0.8
Plt	0.7	0.6

Utility's Requirement



- ❖ Current harmonic measurement should be as per IEC 61000-4-30: 2015
- ❖ Instrument must perform Fast Fourier Transform of current signal for window width of 10 cycles for 50 Hz signal.
- ❖ The measured data is to be compared with IEEE 519: 2014
- ❖ The minimum duration for measurement is 7 days



- ❖ Field measurements were carried out in different state of India.
- ❖ Some of the wind farms are connected to utility through single feeder where as some are with double feeders.
- ❖ Class A Power Meter was used for the measurement.
- ❖ Data recording was done at every PCC for the period of 7 days

Wind Generation Plant details	
Wind Generating Plants	Installed capacity in MW
Wind Plant-1	119.7
Wind Plant-2	226.8
Wind Plant-3	159.5

Flicker :

- ❖ IEC 61000-3-7: 2008 proposes that 95% probability values of P_{st} and P_{lt} should not exceed the limits E_{pst} and E_{plt} .
- ❖ The measured flicker values are categorized based on active power bins.

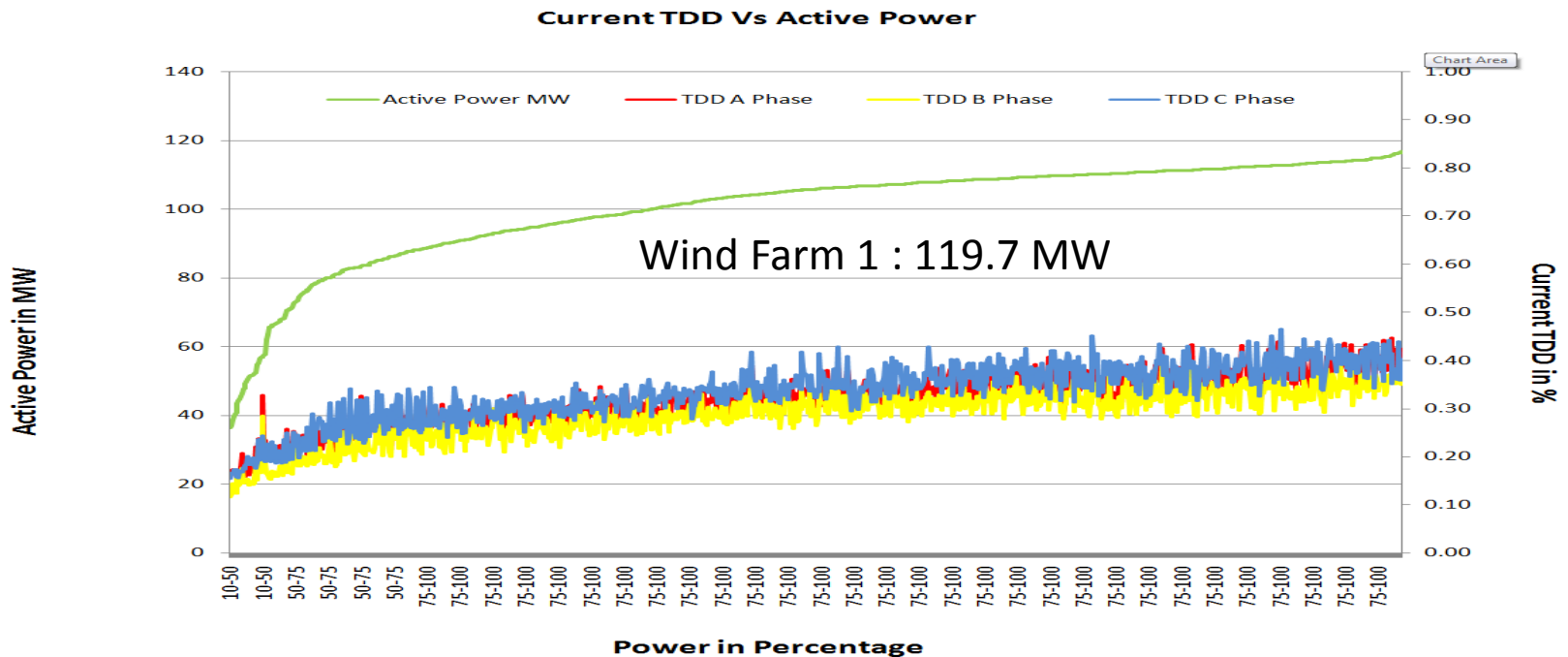
Active Power bins	Maximum value of Short term Flicker P_{st} Monitored		
	Wind plant 1	Wind plant 2	Wind plant 3
10-50 %	0.18	0.55	0.67
50-75 %	1.23	1.23	1.00
75-100 %	6.79	1.48	1.88

PQ Scenario in Wind farms

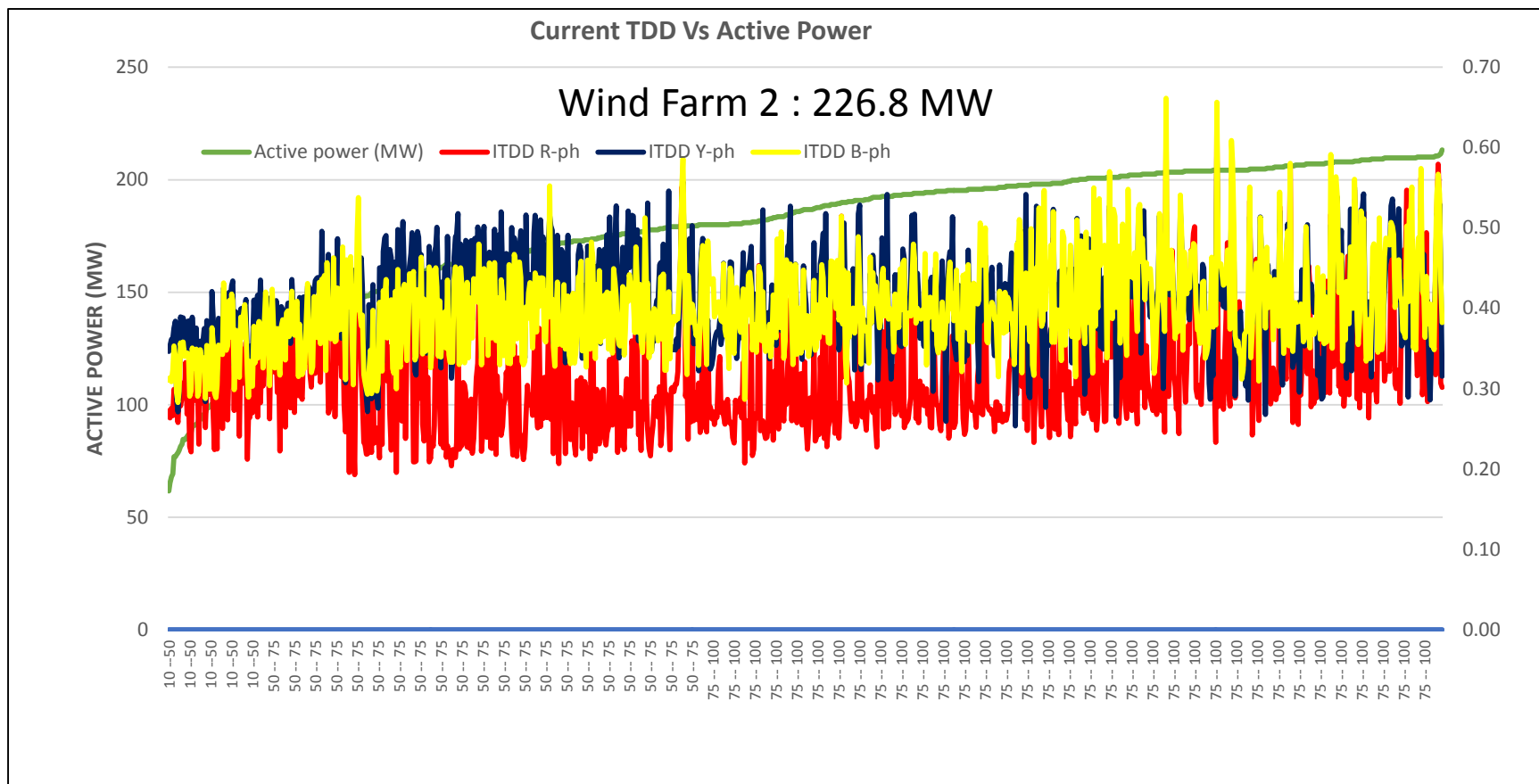


Current Harmonics: _____

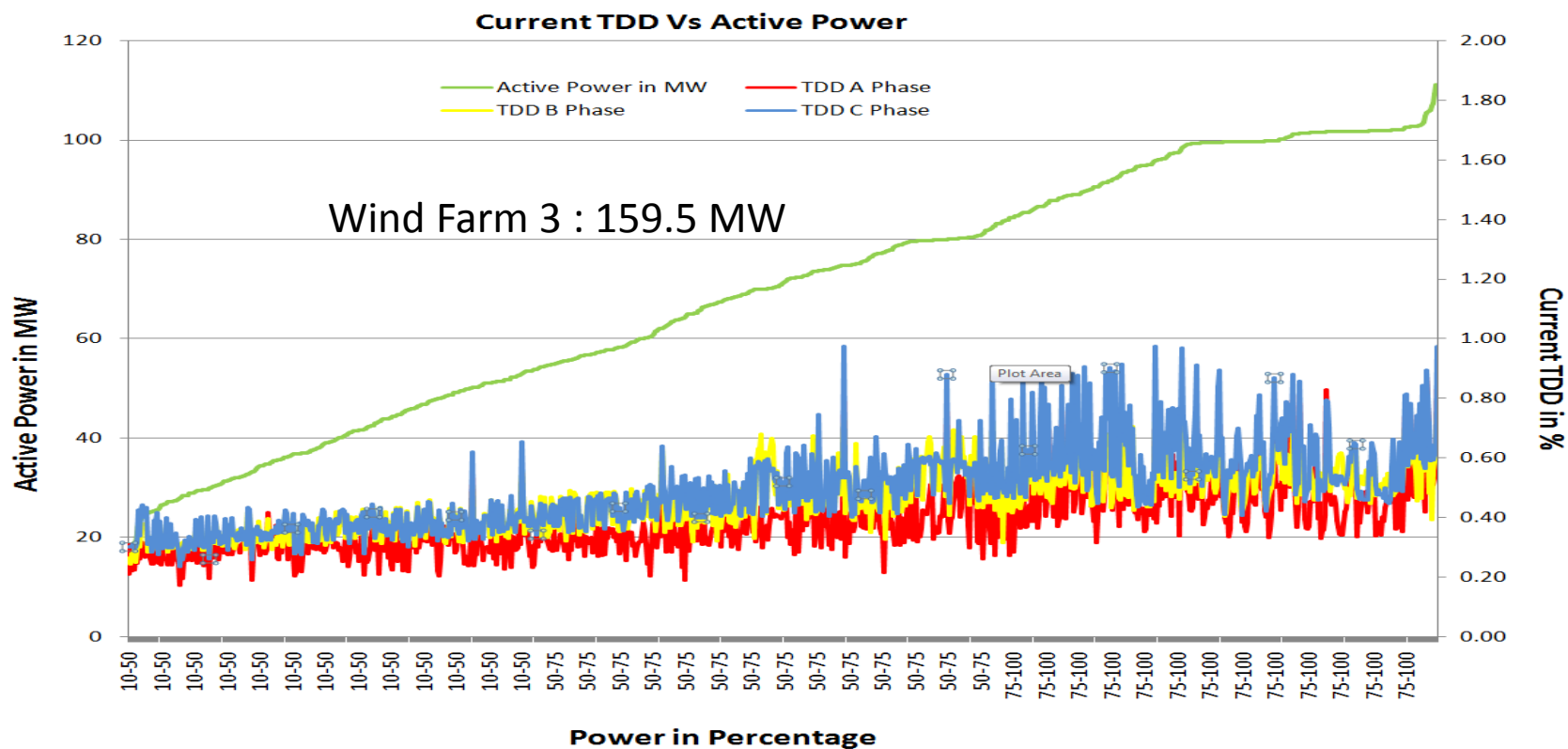
- ❖ IEC 519: 2014 proposes that 95% percentile values of current demand distortion should be within limit.
- ❖ The limit for 66 kV level are 5 % whereas, for 220 kV level are 1.5 %



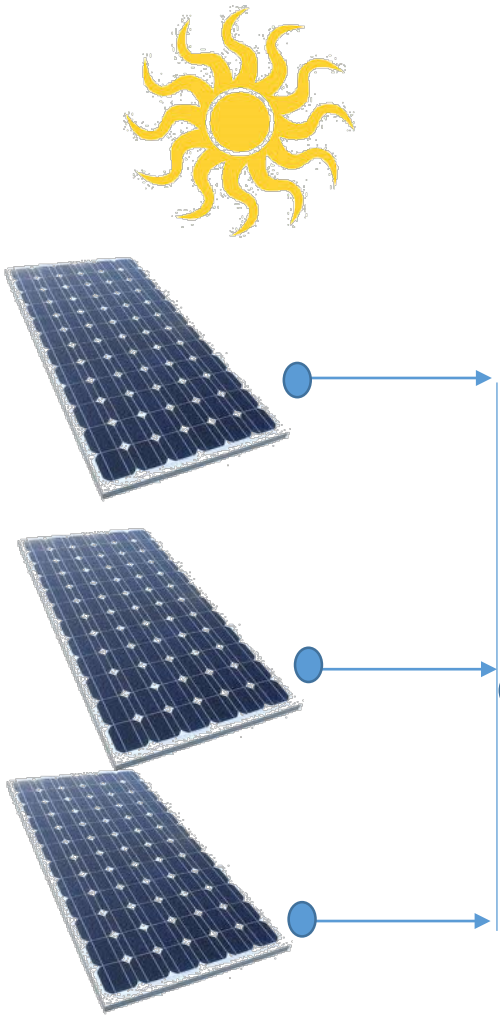
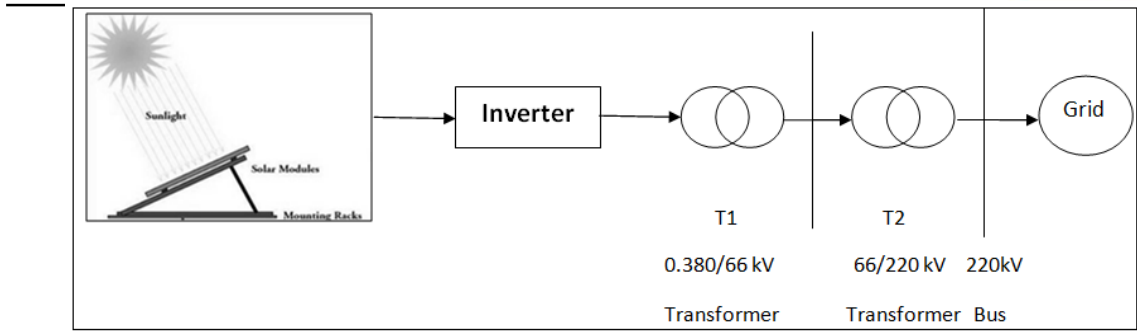
PQ Scenario in Wind farms



PQ Scenario in Wind farms



PQ Scenario in Solar plants



Solar Inverter



Grid

Solar PV Panels

Flicker :

- ❖ IEC 61000-3-7: 2008 proposes that 95% probability values of P_{st} and P_{lt} should not exceed the limits E_{pst} and E_{plt} .
- ❖ The measured flicker values are categorized based on active power bins.

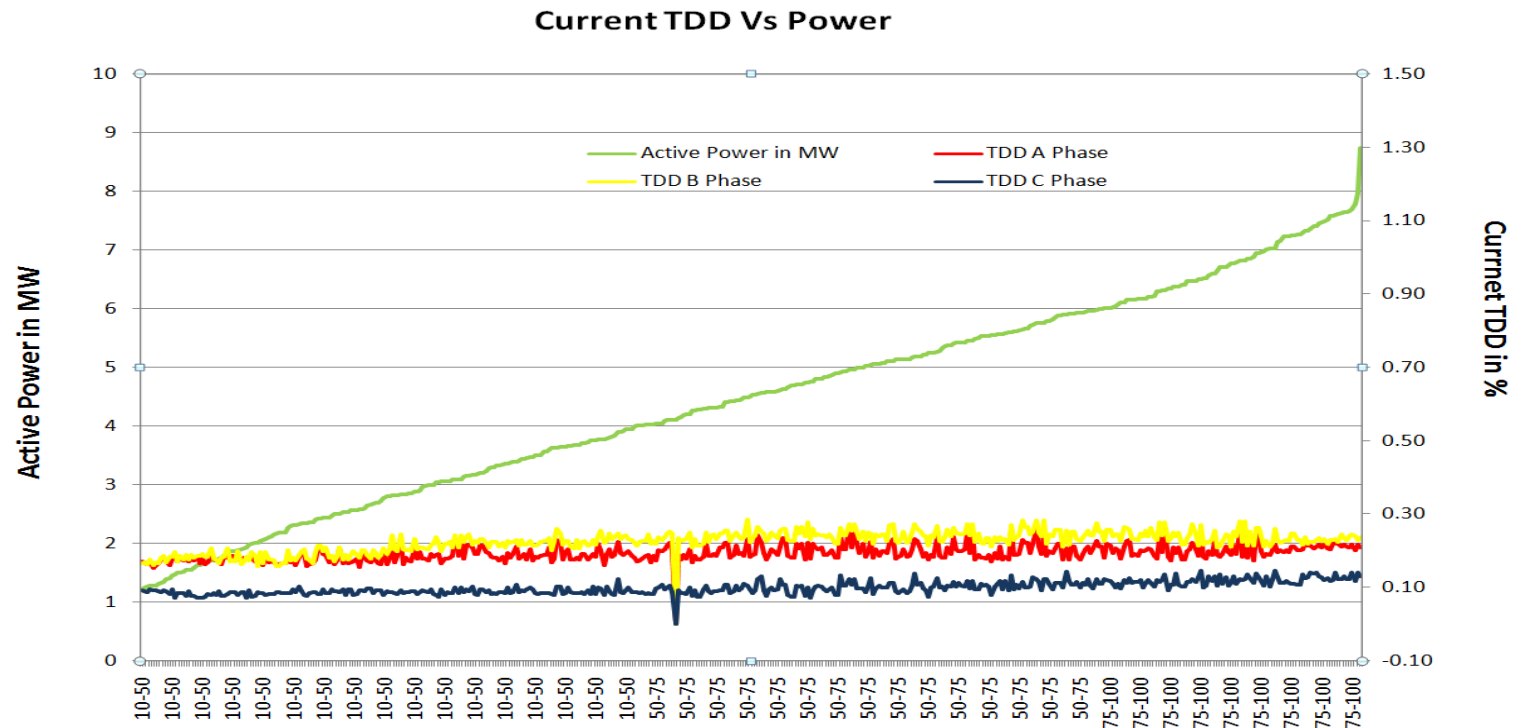
Active Power bins	Maximum value of Short term Flicker P_{st} Monitored
10-50 %	0.50
50-75 %	0.55
75-100 %	0.62

PQ Scenario in solar plants



Current Harmonics:

- ❖ IEC 519: 2014 proposes that 95% percentile values of current demand distortion should be within limit.
- ❖ The limit for 66 kV level are 5 %



Conclusions



- ❖ Power quality scenario for wind farms and solar parks has been discussed.
- ❖ Wind farms:
 - Voltage flicker due to output power variation for continuous operation of wind turbine is analyzed.
 - From three case studies, it is observed that flicker generation varies with active power bins.
 - The current demand distortion also varies with active power bins.
 - The flicker and current demand distortion is observed within limit as per relevant standards.
- ❖ Solar Park:
 - Flicker values remains almost constant irrespective of the active power.
 - The current demand distortion remains in between 0.10 % to 0.30 % with increase in active power from 10 % to 100 %.

It is observed that wind farms and solar plants are meeting the requirements of flicker and harmonics as per CEA guidelines.

Recommendation



- ✓ In present regulations and IEC, the background power quality measurements, without the wind farm connected to grid are not included.
- ✓ There may be instances, where the power quality parameters are beyond the limits in the grid itself.
- ✓ By measuring power quality parameters with wind farm under shut down will help in evaluating as to how much the wind farm is contributing
- ✓ There could be instances where power quality is beyond limits in the grid itself
- ✓ The solar and wind generation is increasing in various parts of the grid, the above practice will help in identifying the source of the power quality parameters that have gone beyond acceptable limit
- ✓ Background power quality parameter test should be witnessed by utility officers.



Thank You