Do we have the tools and expertise to navigate?

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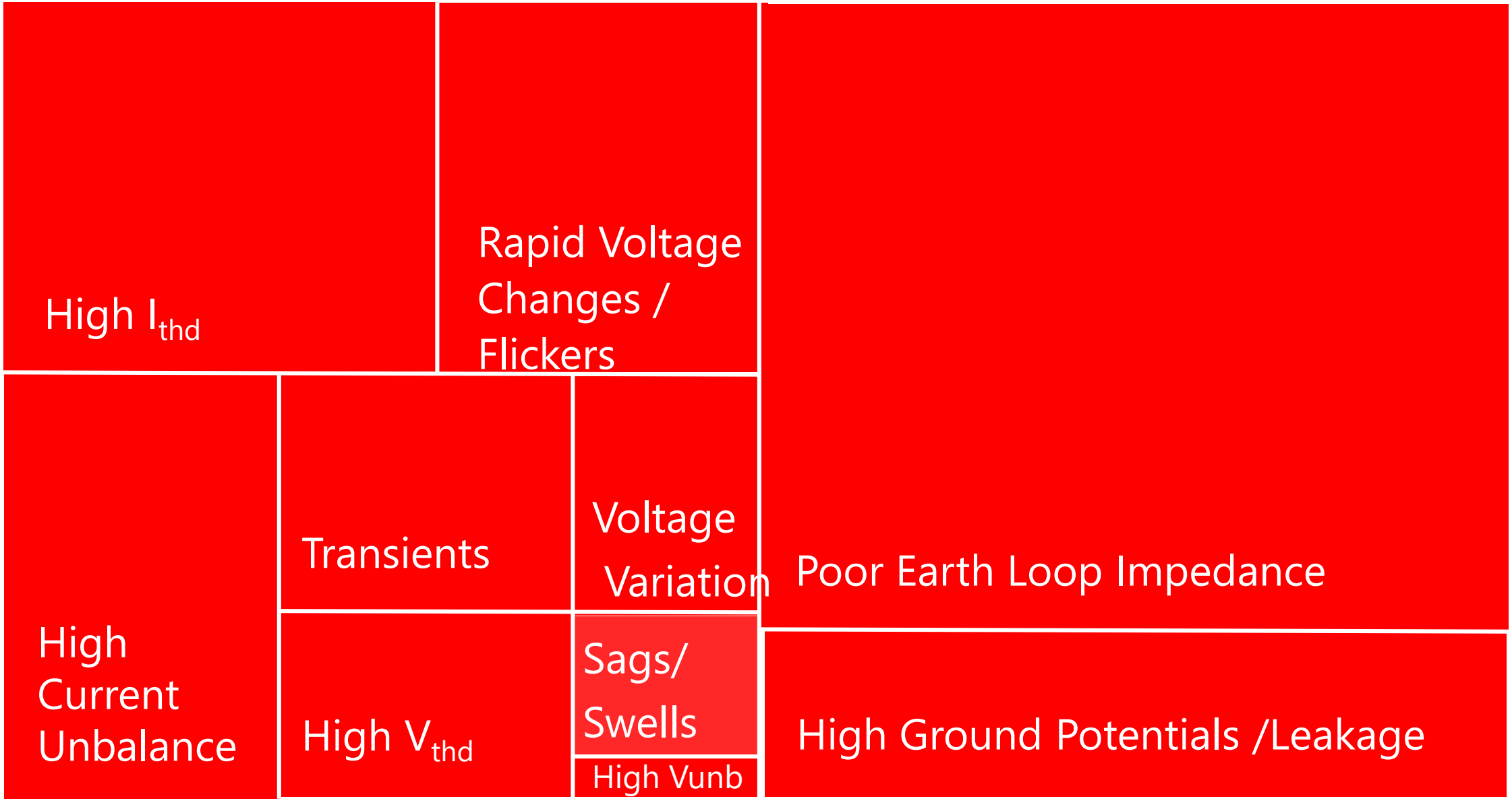
NSN Partner ASIA POWER QUALITY INITIATIVE

Power Quality Workshop
Madurai – 28th September 2019

Power Quality in India - the ground realities



Source: Efficienergi's survey of thousands of locations over > 100 End users upto 2018; Area indicates # of occurrences

Result - PQ responses continue to be reactive.

- Reactive costs you much more than you actually can think

Shutdown of costly studio equipment at a leading Radio Station

Delay of 2-3 months in launch of a flagship, highly advanced AV facility

Revenue loss as a critical equipment at hospital breaks down

Breakdowns due to high concentration of VFDs at a paint manufacturer

Downtime due to PQ disturbances at a Server room catering to a pan India audience

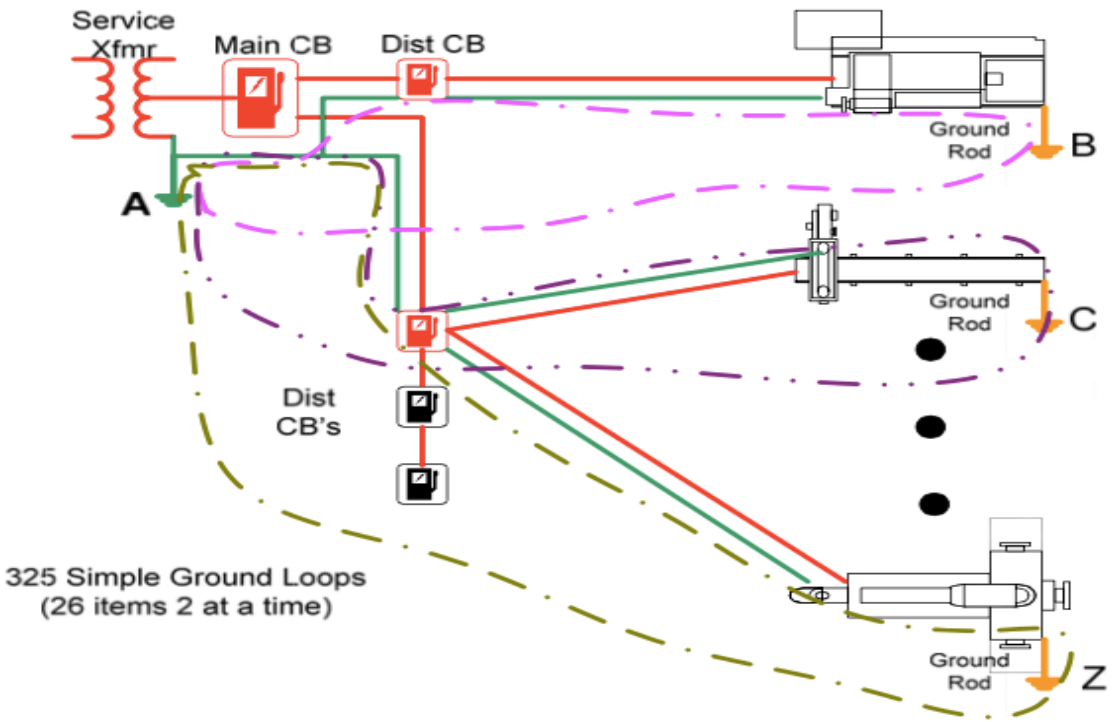
Loss of Reputation due to Elevator malfunctioning at a hospitality chain

PQ = Lot's of Myths.

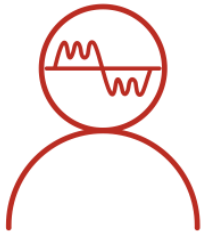
PQ myths that need corrections

- PQ ≠ (just) PF correction
- Harmonics ≠ Always harmful
- UPS/SVR/Harmonic Filter ≠ "The" s
- Oversized System ≠ Better PQ
- PV/Wind Generation ≠ No PQ issue
- Additional earthing stns ≠ protecti

…and many more



The Underlying End User Challenges



FEELING OF RISK

End users always feel at risk with lack of standard reference

DARK ART SYNDROME

Harmonics phobia risk the user's money, time and efforts to solve the problem like a dark art

PSEUDO SOLUTIONS

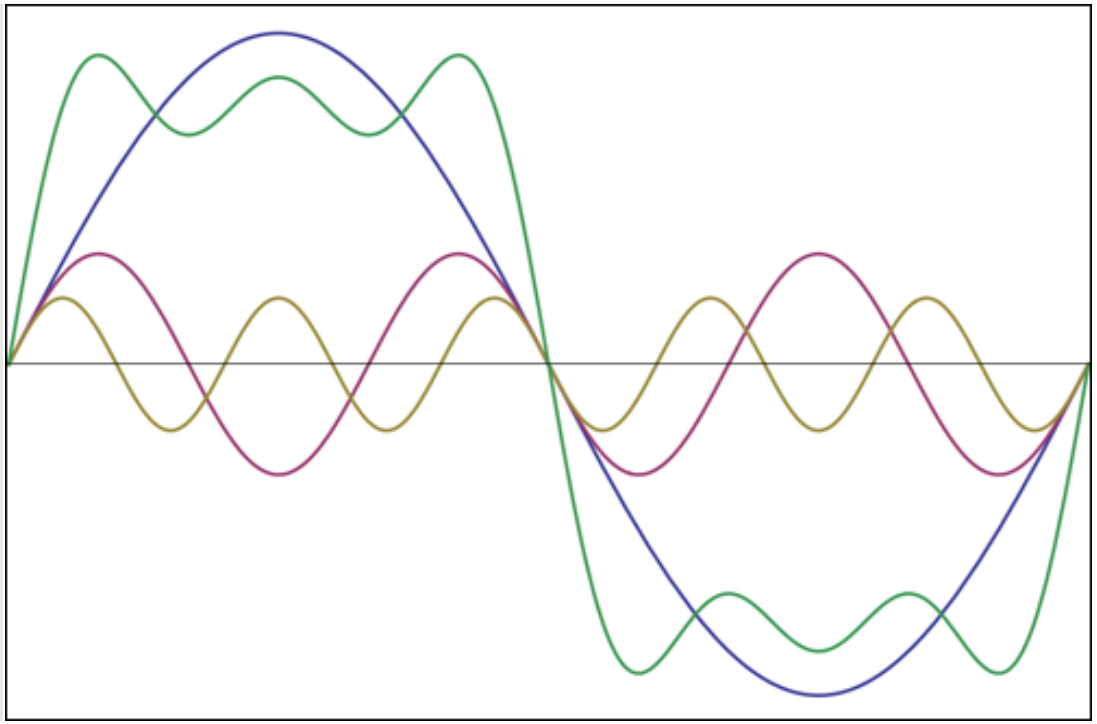
Poor awareness puts end users to risk of investing in pseudo solutions

PREY TO MARKETING

End users often at the risk of falling prey to overzealous marketing

The Driver

- HIGH levels of harmonic pollution present in the Indian power system
- ALARMING lack of awareness and discord in compliance assurance of power quality
- STRIKING absence of a definitive platform to measure, assess, learn, analyse and improve electrical power quality issues at every level



Driver - Implementing Regulatory Compliance

- Need for handholding consumers as well as utility personnel
- Navigate the difficult to understand standards and regulations – IEEE 519 2014 on Harmonics
- Provide a quick dip stick assessment on regulatory compliance
- Make it freely available to enable regulation implementation

Vision

To propagate a common platform to monitor, measure and ensure power quality compliance assurance

Characteristics

‘Standards’ centric design at its core

Transparent testing and evaluation

Action oriented, user need driven

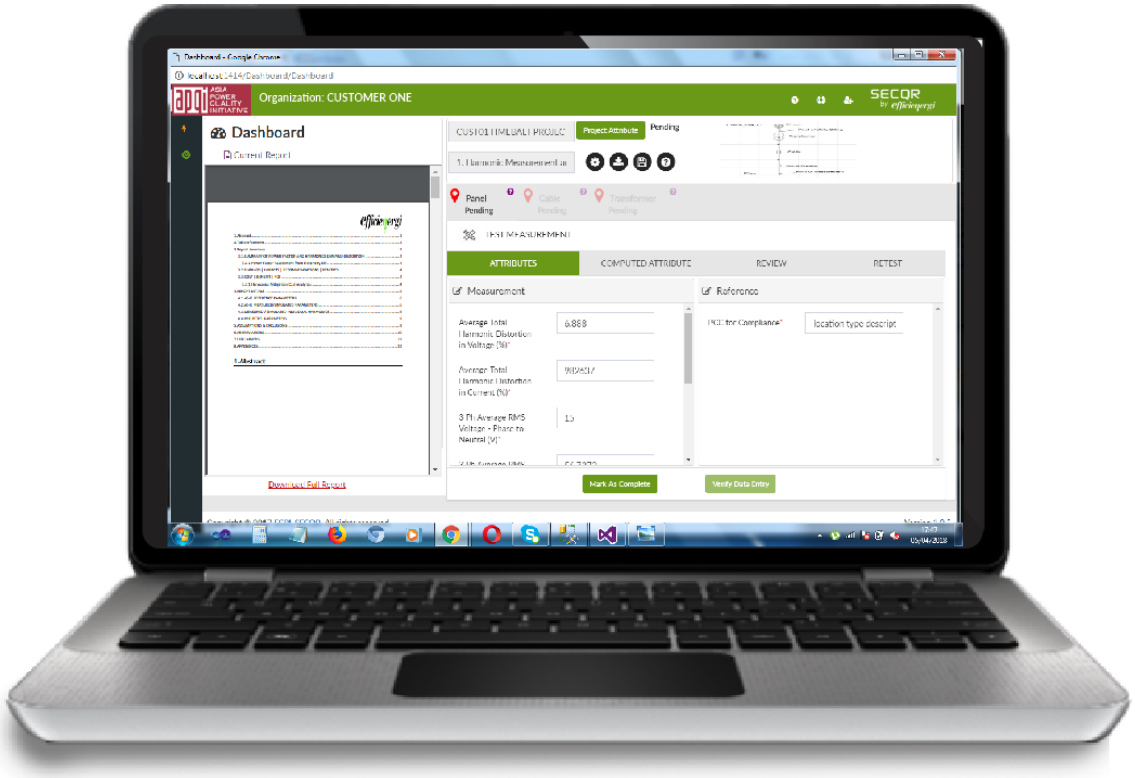
Freemium, flexible and plug-n-play

Equipment and Technology Neutral

First of its kind attempt across various Industries in India

Drivers

- CLOUD based, mobile and web-application
- SIMULATIONS for multiple use cases catering to diverse needs across the country
- BUILT-IN, make/model specific reference libraries of harmonic distortions for simulation with remote upgrades
- STANDARDIZATION of analysis for variety of general and specialist loads



IEEE 519-2014 (Extracted as is)

- 5.1 Recommended harmonic voltage limits At the PCC, system owners or operators should limit line-to-neutral voltage harmonics as follows:
  - Daily 99th percentile very short time (3 s) values should be less than 1.5 times the values given in Table 1.
  - Weekly 95th percentile short time (10 min) values should be less than the values given in Table 1.
- All values should be in percent of the rated power frequency voltage at the PCC. Table 1 applies to voltage harmonics whose frequencies are integer multiples of the power frequency.

Table 1—Voltage distortion limits

Bus voltage V at PCC	Individual harmonic (%)	Total harmonic distortion THD (%)
$V \leq 1.0$ kV	5.0	8.0
1 kV $< V \leq 69$ kV	3.0	5.0
69 kV $< V \leq 161$ kV	1.5	2.5
161 kV $< V$	1.0	1.5[a]

- [a] High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal whose effects will have attenuated at points in the network where future users may be connected.

IEEE 519-2014 (Extracted as is)

- Recommended current distortion limits for systems nominally rated 120 V through 69 kV

- The limits in this sub-clause apply to users connected to systems where the rated voltage at the PCC is 120 V to 69 kV. At the PCC, users should limit their harmonic currents as follows:

  – Daily 99th percentile very short time (3 s) harmonic currents should be less than 2.0 times the values given in Table 2.

  – Weekly 99th percentile short time (10 min) harmonic currents should be less than 1.5 times the values given in Table 2.

  – Weekly 95th percentile short time (10 min) harmonic currents should be less than the values given in Table 2.

- All values should be in percent of the maximum demand current, I_L. This current value is established at the PCC and should be taken as the sum of the currents corresponding to the maximum demand during each of the twelve previous months divided by 12. Table 2 applies to harmonic currents whose frequencies are integer multiples of the power frequency.

IEEE 519-2014 (Extracted as is)

- Table 2 —Current distortion limits for systems rated 120 V through 69 kV
- Maximum Harmonic Current Distortion in percent of I_L.
- Individual harmonic number (odd harmonics) [a,b]

I_{sc}/I_L	$3 \le h < 11$	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h < 50$	TDD
<20[C]	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

- Even harmonics are limited to 25% of the odd harmonic limits above.
- Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.
- All power generation equipment is limited to these values of current distortion, regardless of actual Isc/IL.

where

- I_{sc} = maximum short-circuit current at PCC
- I_L = maximum demand load current (fundamental frequency component) at the PCC under normal load operating conditions

A Sample Case Study :
Results using PF and HF assessment tool

- *A Textile industry* has a 2500KVA transformer and the Maximum Demand is about 1279KVA with V_{THD} = 8% and I_{THD}= 42% and following takeaways can be obtained from typical harmonic analysis calculations

1. Total kW Loss: 17.23 kW, Total kVA Loss: 50.71kVA, Transformer additional kW Loss: 6.164 kW.
2. It is recommended to install additional 175 KVAR with 7% Series Detuned Reactor
3. Required Harmonics Filter (HF) = 550 Amps
4. Achievable kVA Demand Reduction by improving PF and Harmonics: 125.38 kVA &
5. Estimated Recoverable Total kWh Loss with Harmonic Filter and Caps ON to be: *75924 kWh/Year*
6. Transformer Derating = 0.92 that means 2500KVA transformer can be loaded only up to 2297.5KVA due to the harmonics present.
7. Thus the estimated annual savings works out to *INR 9,12,906* along with the ROI of *2.7 yrs*.

Summary : Key things to remember (Harmonics Assessment)

- Is a filter needed at all?
- IEEE 519-2014 plays a crucial role
- Correct interpretation of the "recommended practice"
- Few key aspects
  - PCC
  - Isc (SCC not generally known – key point of contention)
  - Demand Load Current
  - Tdd – Filter size based on Tdd compliance
  - Measurement Intervals & Multipliers

Summary : Key things to remember (Overall Power Quality)

- Periodic and continuous monitoring is the key
- Access to economic IoT based Power Quality Assessments
- Automated compliance reports to various international standards such as IEEE 519-2014, EN 50160, IEEE 1159, SEMI 47, IS 17036
- Automated insights and actionable recommendations for PQ improvement geared towards ROI
- Linking PQ Improvement to quantifiable and qualitative benefits helping to prevent malfunctions, downtime and improve energy productivity

We look forward to your support to build this more better and spread it much farther …

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