

 **UTM** Centre of Electrical Energy Systems (CEES)
UNIVERSITI TEKNOLOGI MALAYSIA

<http://cees.utm.my>


STAKEHOLDER WORKSHOP

PWTC

(19th OCTOBER 2011)

-:PRELIMINARY RESULT:-
POWER QUALITY BASELINE STUDY
FOR
PENINSULAR MALAYSIA


  

 **UTM** Centre of Electrical Energy Systems (CEES)
UNIVERSITI TEKNOLOGI MALAYSIA

<http://cees.utm.my>

Presentation Outline

- Introduction
- Voltage Sag Analysis
- Trends in Power Factor
- Current THD Analysis
- Voltage THD Analysis
- Fault Analysis
- Economic Analysis



POWER QUALITY BASELINE STUDY FOR PENINSULAR MALAYSIA

Introduction

- The preliminary analysis presented based on the logging and monitoring data from the Northern and Eastern Region in Peninsular Malaysia.
- The logging sites are selected based on ratio: 60% industrial sites, 30% commercial sites and 10% residential sites.
- The monitoring sites are chosen based on method of fault position with the objectives are to eliminate blind spot areas (i.e eliminate the possibility of missing PQ events) and to ensure triple redundancy in order to confirm and validate recorded events.
- The preliminary analysis is focused on:
 - Voltage sag and fault analysis
 - Harmonic analysis
 - Power factor analysis
 - Economic analysis

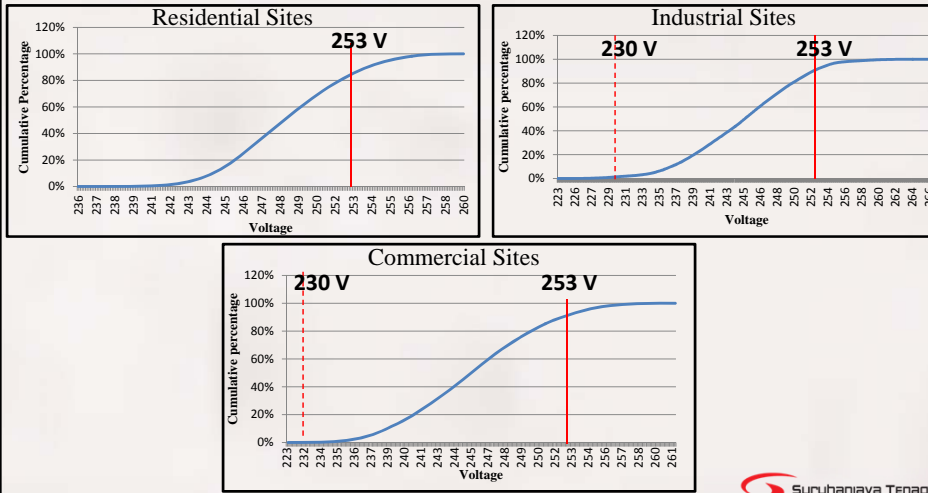
Recording and Analysis Status

- Monitoring data have been collected for nearly ten months.
- Logging have been successfully done for the whole Northern and Eastern Region which is about 250 sites.
- Analysis for the collected data have been carried out and their summary will be presented today.

PQ Event Analysis

Voltage Analysis

- The voltage limit used is +10%, -6% of the nominal voltage (230V).



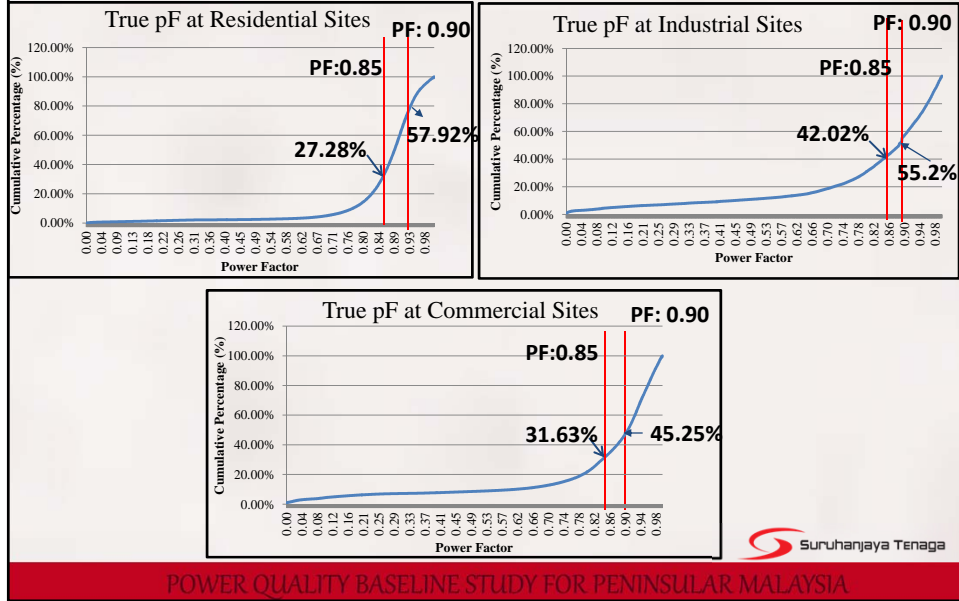
POWER QUALITY BASELINE STUDY FOR PENINSULAR MALAYSIA

Power Factor Charges

- Electricity efficiency is affected by low power factor .
- Utility imposes penalty charges for customers with low power factor .
- Power factor in Malaysia is charged based on kWh and kVAR, which is calculated and not directly measured.
- For 132kV customer, the power factor surcharge will be imposed if their power factor is less than 0.9.
- For below than 132kV customer, the power factor surcharge will be imposed if their power factor is below than 0.85.

POWER QUALITY BASELINE STUDY FOR PENINSULAR MALAYSIA

Trends in Power Factor



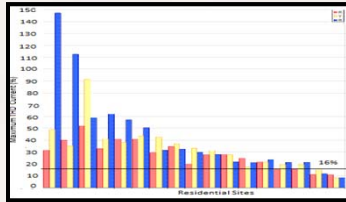
Displacement Power Factor versus True Power Factor

- Power factor is defined as the instantaneous value of real power over apparent power.
- Displacement power factor is the cosine of the angular displacement between the current phase and voltage phase.
- If the load takes only fundamental frequency, the power factor is the displacement power factor.
- If the load produces harmonics, the power factor is affected by the harmonics and displacement power factor.
- True power factor will be discussed later.

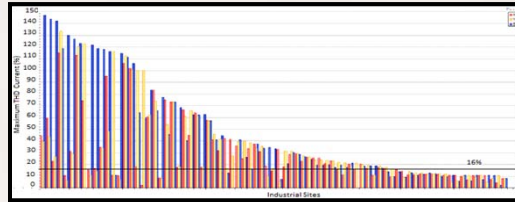
Harmonics Event

Current THD Analysis

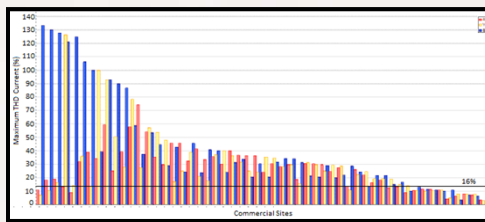
- According to IEC 61000-3-4, the limit for current THD is 16%.



ITHD at Residential Sites



ITHD at Industrial Sites



ITHD at Commercial Sites

Sites	Number of Violating Sites	Total Logging Sites
Residential	16	23
Commercial	45	80
Industrial	61	112

Relationship between Current THD and Power Factor

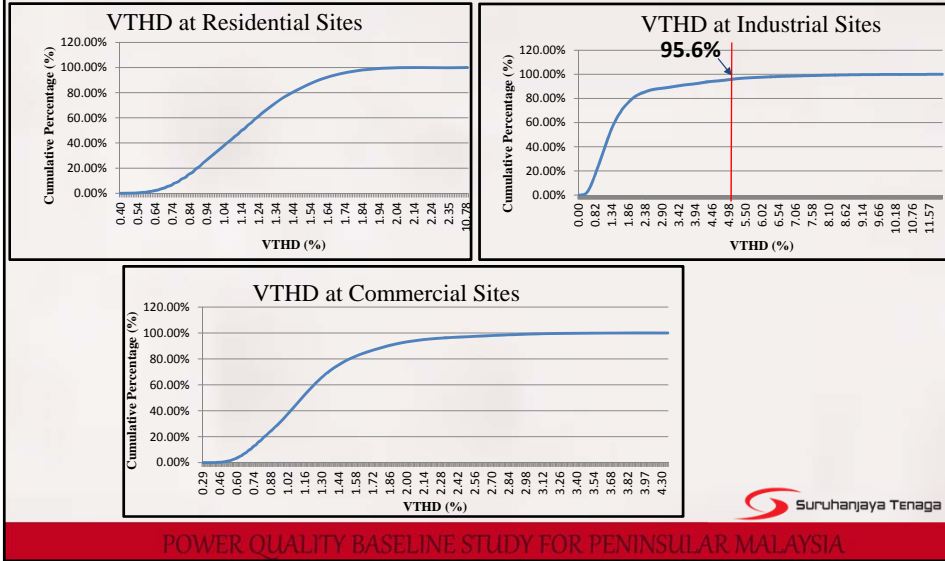
- The harmonic sources that existed on the power system were a cause of concern.
- Power factor with harmonic effect is defined as true power factor and the power factor without harmonic effect known as displacement power factor.

$$\text{Distortion power factor} = \frac{1}{\sqrt{1 + \text{THD}^2}}$$

- From the above equation, let say current THD is 0.6, thus, the distortion power factor is 0.86.
- Our equipment measured the true power factor, where true power factor is Displacement power factor x 0.9 = 0.77.
- The increasing in current THD causes the power factor to drop.

Voltage THD Analysis

- According to IEEE 519 standard, the limit for Voltage THD is 5%.



POWER QUALITY BASELINE STUDY FOR PENINSULAR MALAYSIA

Harmonics Current Limits According to IEC 61000-3-4

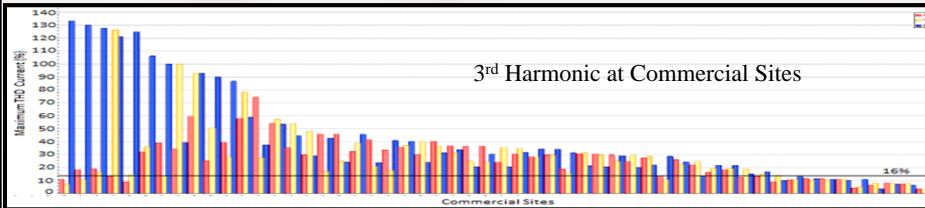
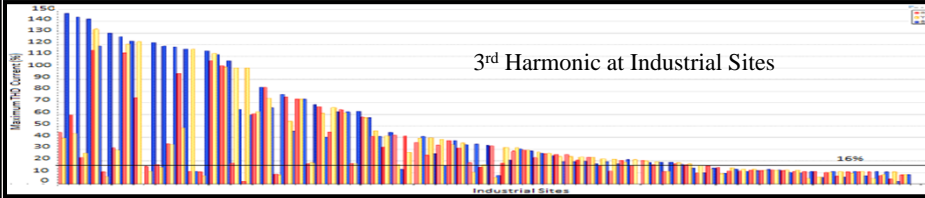
Harmonic order, h	Max. permissible harmonic current* (%)
3	21.6
5	10.7
7	7.2
9	3.8
11	3.1
13	2.0
15	0.7
17	1.2
19	1.1
21	0.6
23	0.9
25	0.8
27	0.6
29	0.7
31	0.7
33	0.6



Harmonic Component Analysis

<http://cees.utm.my>

The limit for 3rd harmonic current is 21.6%.



Sites	Number of Violating Sites	Total Logging Sites
Residential	8	23
Commercial	32	80
Industrial	31	112



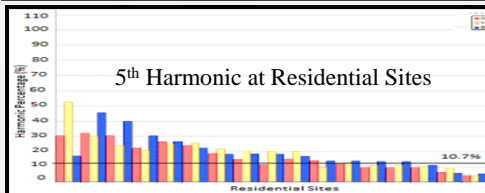
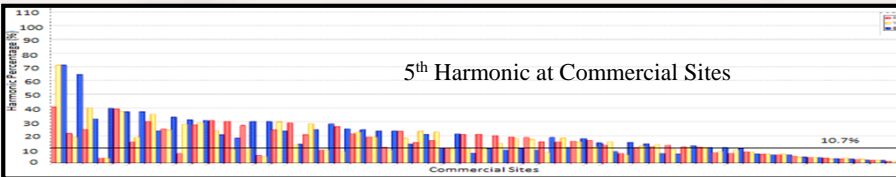
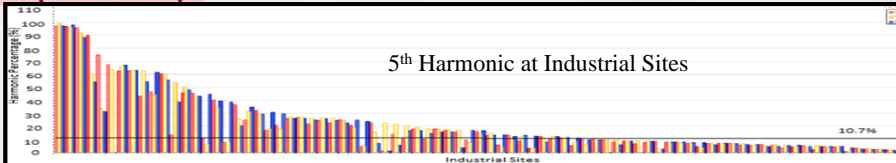
POWER QUALITY BASELINE STUDY FOR PENINSULAR MALAYSIA



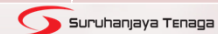
Harmonic Component Analysis

<http://cees.utm.my>

The limit for 5th harmonic current is 10.7%.



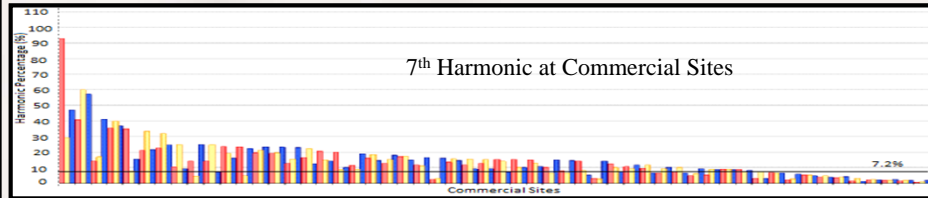
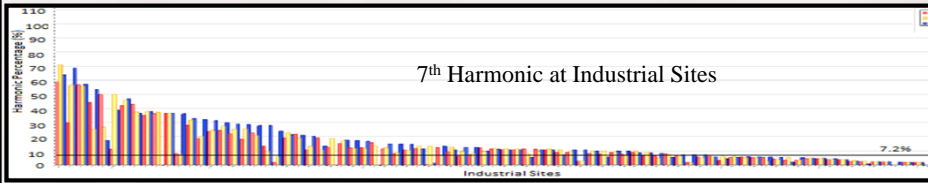
Sites	Number of Violating Sites	Total Logging Sites
Residential	14	23
Commercial	43	80
Industrial	50	112



POWER QUALITY BASELINE STUDY FOR PENINSULAR MALAYSIA

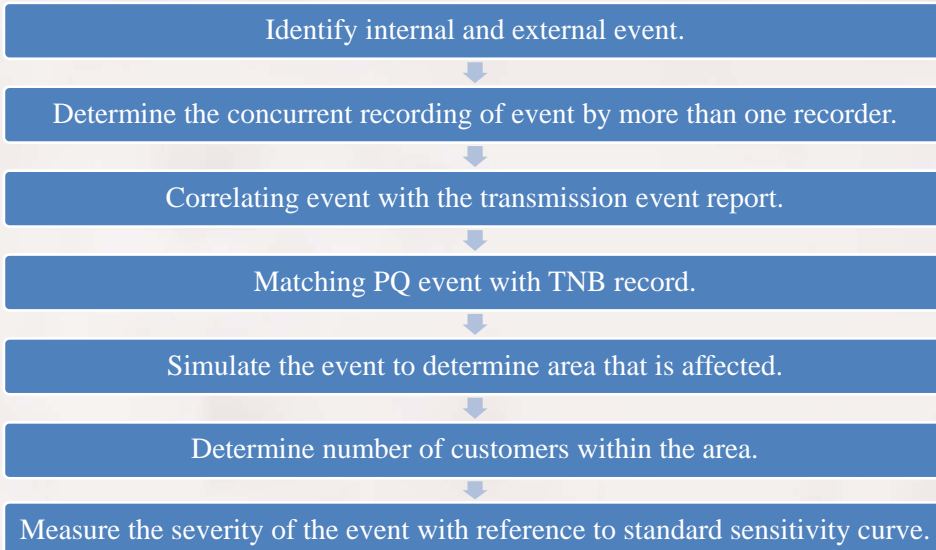
Harmonic Component Analysis

The limit for 7th harmonic current is 7.2%.



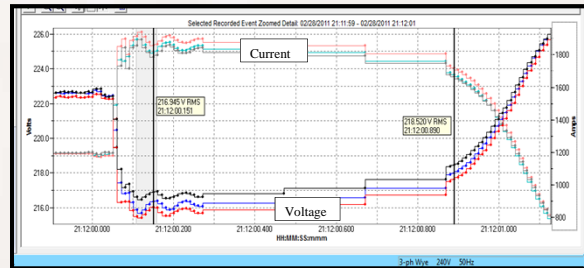
Sites	Number of Violating Sites	Total Logging Sites
Residential	11	23
Commercial	43	80
Industrial	55	112

Voltage Sag Analysis Procedure



Internal Factor of Voltage Sag Event

- Voltage sag can be caused by an internal or external factor. These factors can be determined by analyzing the voltage and current waveform.
- Internal factor that caused voltage sag to occur can be analyzed from the formula of true power $P=VI$, where V and I is voltage and current respectively.
- The current will be increased as it has to supply the large load which will make the voltage tend to increase.



External Factor of Voltage Sag Event

- During a fault, the load is considered constant and the occurrence of voltage sag can be analyzed by using the Ohm's Law, $V=IR$.
- When the voltage from the supply is dropped, the current tends to drop. This is because the energy has not been supplied to the load, but the energy in the supply system has been diverted to the fault that occurred outside of the premise.

