Stakeholder Workshop
PWTC
(19th October 2011)

Structured Database System for Monitoring and Analysis of Power Quality Baseline Study

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Presentation Outline

- Requirement of Structured Systems
- Concept and Approach
- Methodology
- Project flow
- Analysis
- Simulation

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Requirement of Structured System

- Power Quality Analysis is a combination of many analysis includes simulations which requires a lot of data comes from many sources
- More data added from Recorder and Logger
- Data gathering and preparation take long time and exhausting prior to analysis
- Analysis always end up become difficult and not conclusive due to data fragmentation
- Always end up solving the Jigsaw Puzzle
- Comprehensive analysis become impossible

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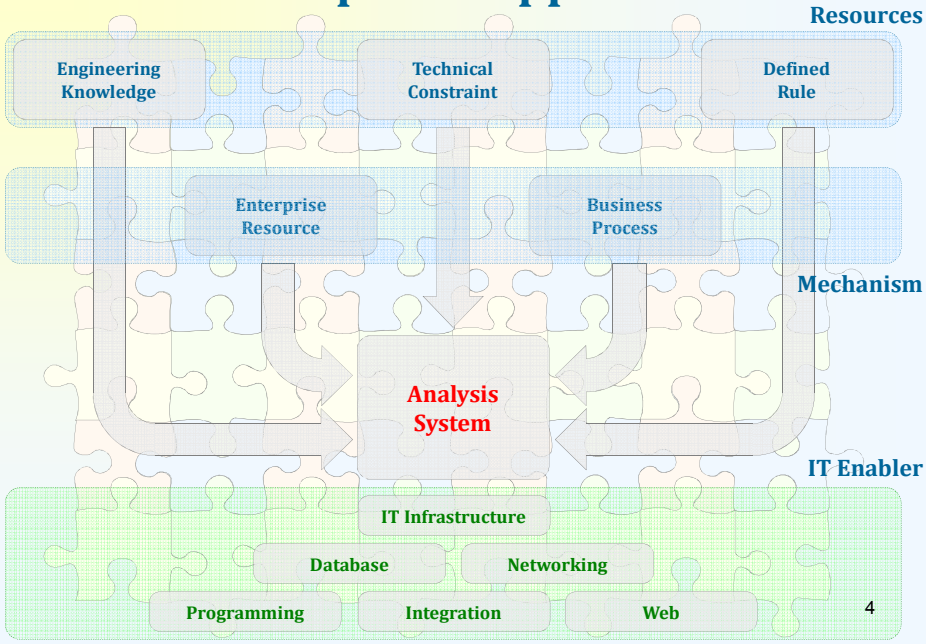
Concept and Approach



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Clear Contribution of IT

- It is Information Highway, which require proper
  - Entry
  - Exit
  - Direction
  - Interchange
  - Enterprise Definition
  - Enterprise way of doing thing
- It is Information Storage
  - Input at the moment the Information available with certain process
  - Output at the moment the Information is required at certain format
- Routed Objective
  - Mathematically or Logically Derived
- Clear Contribution
  - Effective Comprehensive Analysis
  - Instant generation of summary
  - Traceable detail
  - Benefit across the Enterprise

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Approach Methodology

- Clear Demarcation of Role
- Clear Definition
- Clear Objective
- Clear Boundary
- Clear Data Source

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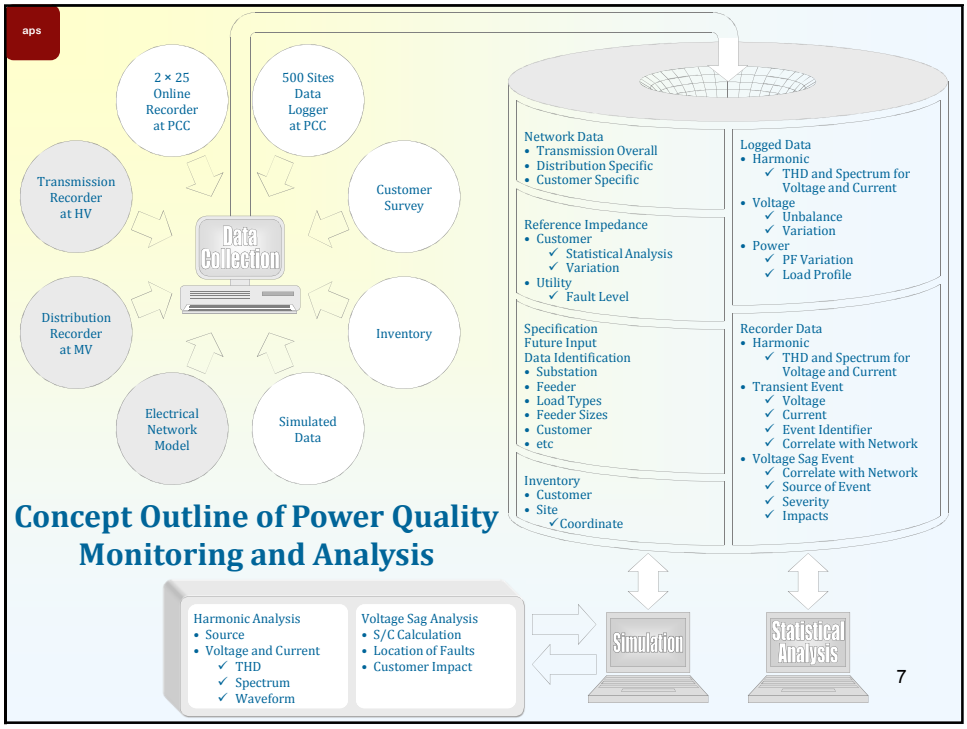
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2 × 25 Online Recorder at PCC
500 Sites Data Logger at PCC
Transmission Recorder at HV
Customer Survey
Data Collection
Distribution Recorder at MV
Inventory
Electrical Network Model
Simulated Data
Network Data
• Transmission Overall
• Distribution Specific
• Customer Specific
Reference Impedance
• Customer
✓ Statistical Analysis
✓ Variation
• Utility
✓ Fault Level
Specification
Future Input
Data Identification
• Substation
• Feeder
• Load Types
• Feeder Sizes
• Customer
• etc
Inventory
• Customer
• Site
✓Coordinate
Logged Data
• Harmonic
✓ THD and Spectrum for Voltage and Current
• Voltage
✓ Unbalance
✓ Variation
• Power
✓ PF Variation
✓ Load Profile
Recorder Data
• Harmonic
✓ THD and Spectrum for Voltage and Current
• Transient Event
✓ Voltage
✓ Current
✓ Event Identifier
✓ Correlate with Network
• Voltage Sag Event
✓ Correlate with Network
✓ Source of Event
✓ Severity
✓ Impacts
Concept Outline of Power Quality Monitoring and Analysis
Harmonic Analysis
• Source
• Voltage and Current
✓ THD
✓ Spectrum
✓ Waveform
Voltage Sag Analysis
• S/C Calculation
• Location of Faults
• Customer Impact
Simulation
Statistical Analysis
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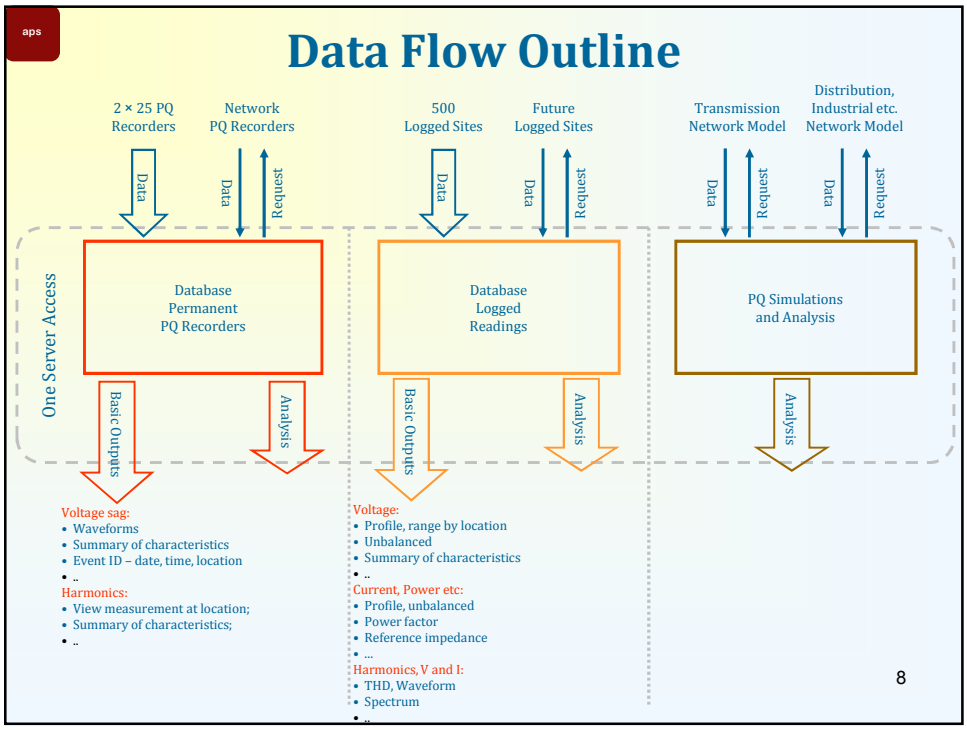
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Data Flow Outline
2 × 25 PQ Recorders
Network PQ Recorders
500 Logged Sites
Future Logged Sites
Transmission Network Model
Distribution, Industrial etc. Network Model
Data
Request
One Server Access
Database Permanent PQ Recorders
Database Logged Readings
PQ Simulations and Analysis
Basic Outputs
Analysis
Voltage sag:
• Waveforms
• Summary of characteristics
• Event ID – date, time, location
• ..
Harmonics:
• View measurement at location;
• Summary of characteristics;
• ..
Voltage:
• Profile, range by location
• Unbalanced
• Summary of characteristics
• ..
Current, Power etc:
• Profile, unbalanced
• Power factor
• Reference impedance
• ...
Harmonics, V and I:
• THD, Waveform
• Spectrum
• ..
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Analysis Outputs from Permanent Monitors

Voltage Sag Event

- Source of Event
  - Associate with Customer Plant Installation (*Customer Survey*)
  - Associate with Customer Plant Operation (*Customer Survey*)
  - Associate with Network Recorded Data (*on Request*)
    - Analyze Propagation
    - Area of Vulnerability
  - Associate with Network Tripping or Switching (*on Request*)
  - Associate with Lightning (*Meteorological Department*)
  - Compare shape with Simulated Event
- Severity
  - Compare Existing Standard
- Impacts
  - Associate with Customer Loss of Production due to maloperation
- Incipient
  - Check Occurrence of Incipient

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Analysis Outputs from Permanent Monitors

Harmonic

- Direction
  - Trace Direction of Harmonic Current
- Trend
  - Analyze Trend of THD against Time
- Source of Event
  - Associate with Customer Plant Installation (*Customer Survey*)
  - Associate with Customer Plant Operation Schedule (*Customer Survey*)
  - Associate with Network Capacitor Switching (*on Request*)
  - Compare Spectrum with Typical Generated Equipment
- Severity
  - Compare Existing Standard
- Impacts
  - Associate with Customer Loss of Production due to maloperation

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Analysis Outputs from Data Loggers

- Direction
  - Trace Direction of Harmonic Current
- Trend
  - Analyze Trend of THD against Time and Site Location
- Source of Event
  - Associate with Customer Plant Installation (*Customer Survey*)
  - Associate with Customer Plant Operation Schedule (*Customer Survey*)
  - Associate with Network Capacitor Switching (*on Request*)
  - Area of Vulnerability
    - Associate with Trend base on Time and Area
  - Compare Spectrum with Typical Generated Equipment
- Severity
  - Compare Existing Standard
- Impacts
  - Associate with Customer Loss of Production due to mal-operation

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Analysis Outputs from Simulation

- Voltage Sag
  - Short Circuit Analysis
    - Single Line to Ground
    - Line to Line
    - Line to Line to Ground
    - Three Phase
    - Three Phase to Ground
    - Single Line to Ground with Resistance
    - Propagation
    - Area of Vulnerability
- Harmonic
  - Harmonic Injection
    - Waveform
    - Total Harmonic Distortion
    - Impedance Scan
    - Spectrum
    - Area of Vulnerability

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Power Factor Implication

Reference Impedance

- Customer Side Reference Impedance
  - Customer Load Resistive Component
- Utility Side Reference Impedance
  - Sum of the Short Circuit Network Impedance and the Last Transformer Impedance before the Connection Point

Power Factor

- Displacement - *disp*
- True - *true*
- Distortion - *dist*
- $PF_{true} = PF_{disp} \times PF_{dist}$

$$PF_{dist} = \frac{1}{\sqrt{1 + (THD_I / 100)^2}}$$

Sign for Direction of Power Factor and Harmonic Spectrum (±)

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Main Interface for Analysis by Site

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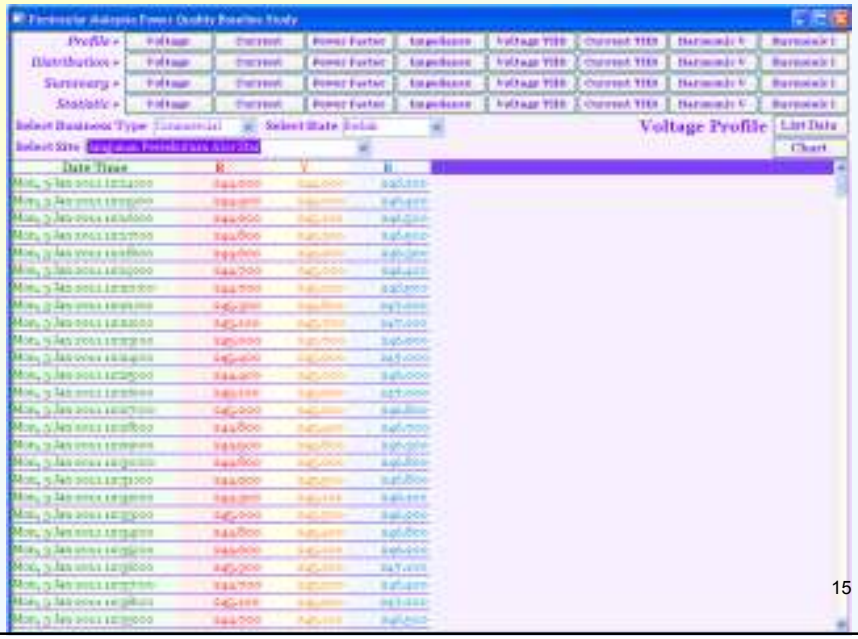
Voltage Listing for Individual Site



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Profile Chart for Individual Site

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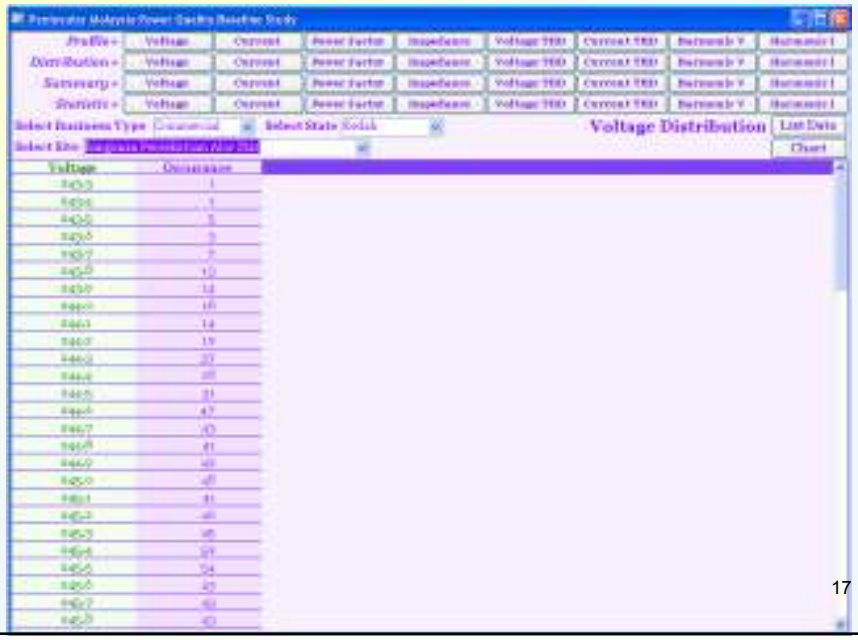
Distribution Listing for Individual Site



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Distribution Chart for Individual Site

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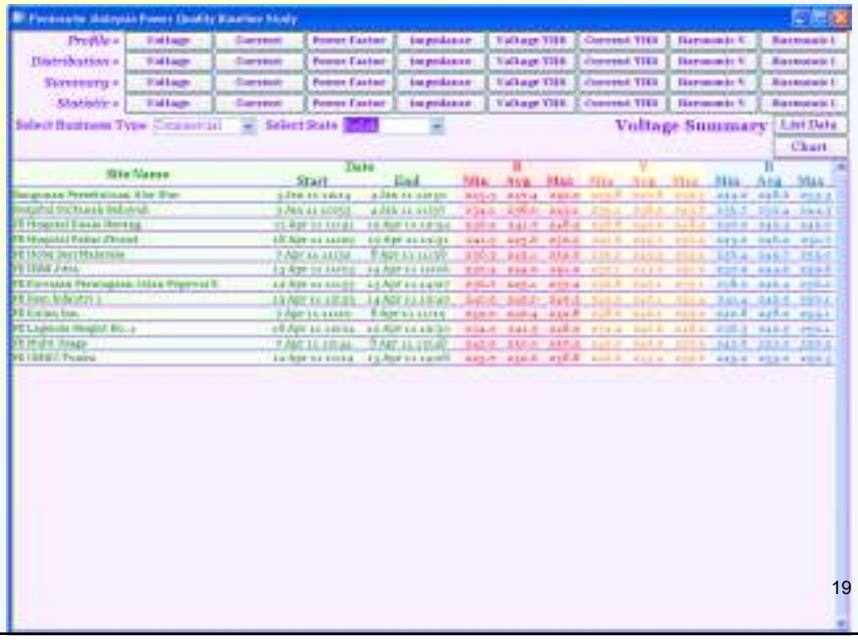
Summary Listing by Site



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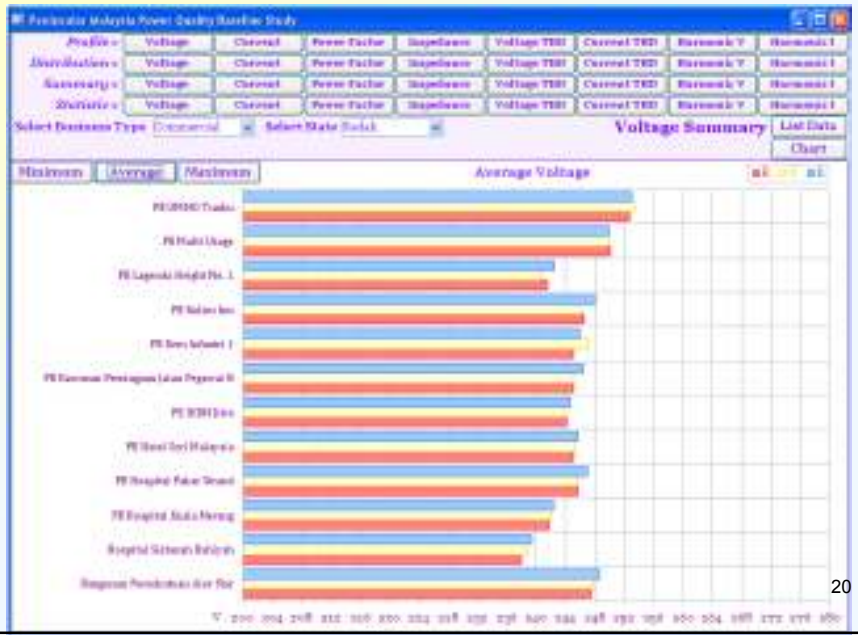
Summary Chart by Site



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Statistic Data Listing

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Statistic Data Chart

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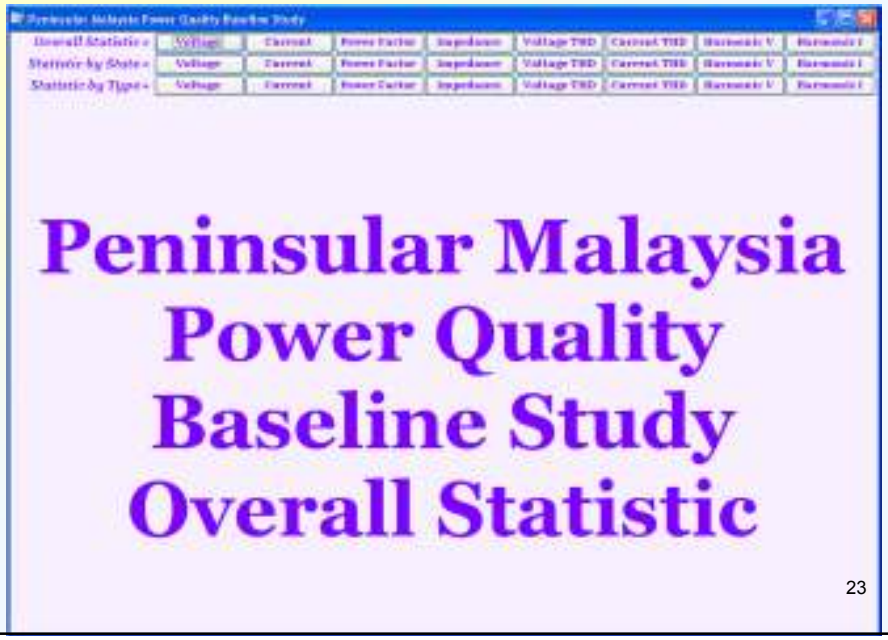
Main Interface for Overall Statistic



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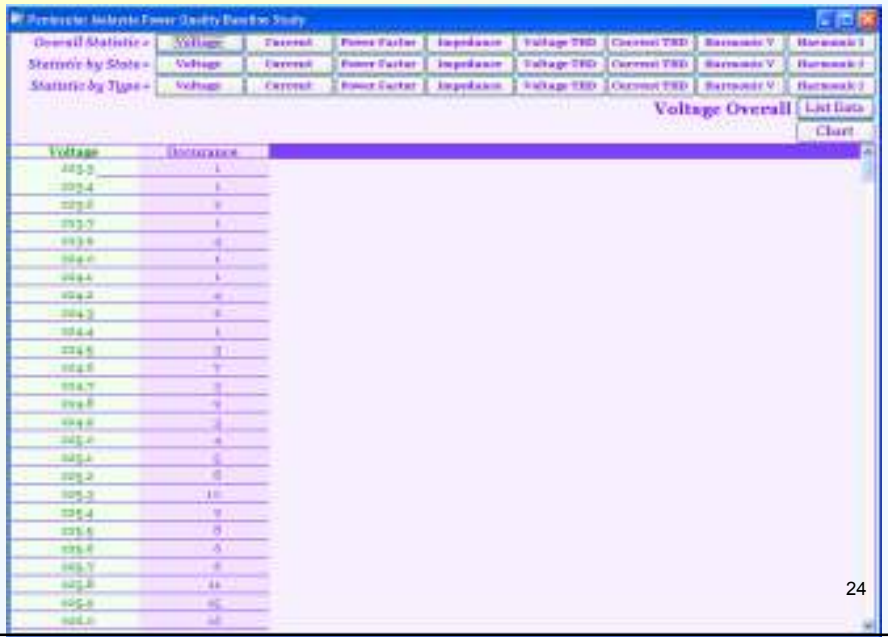
Overall Statistic Data Listing



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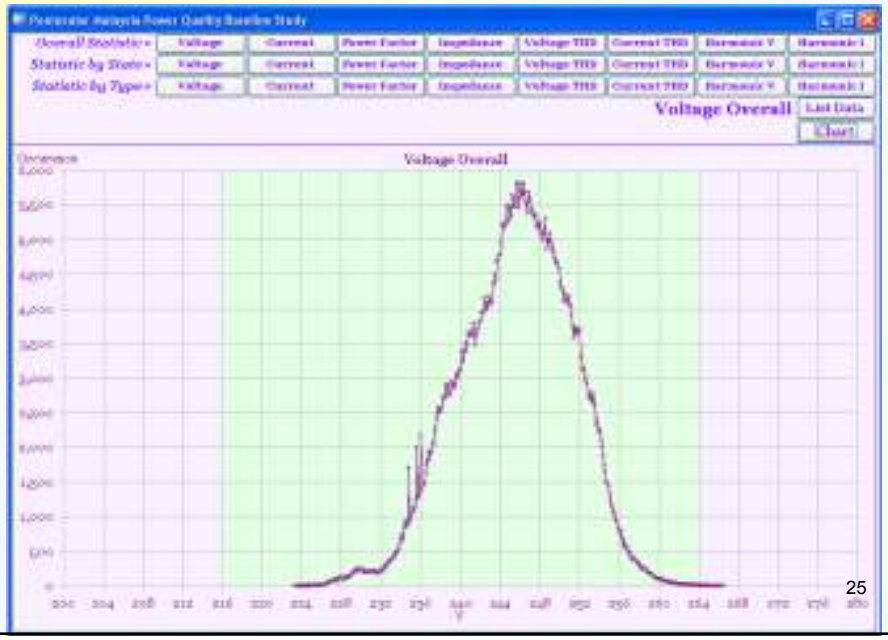
Overall Statistic Chart



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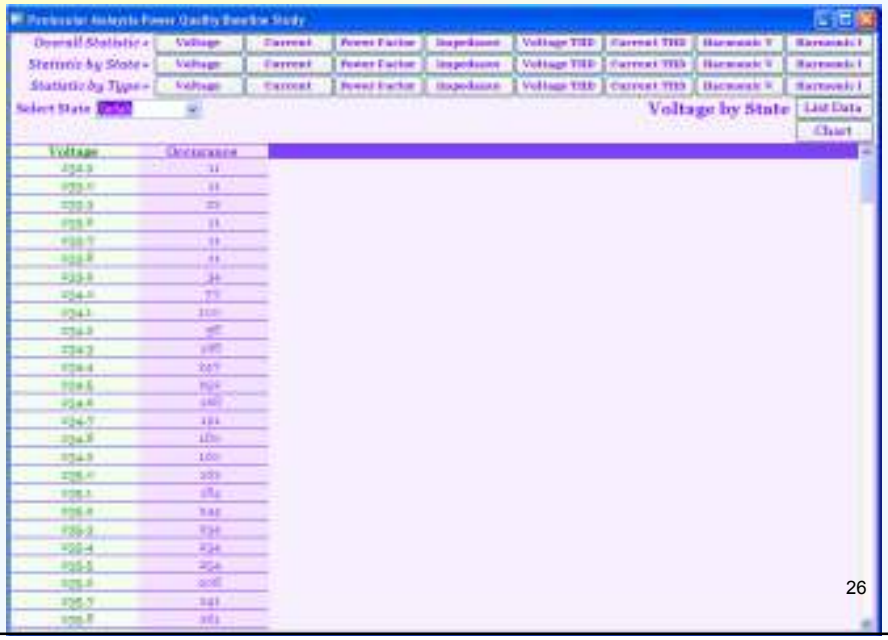
Statistic Data Listing by State



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Statistic Chart by State

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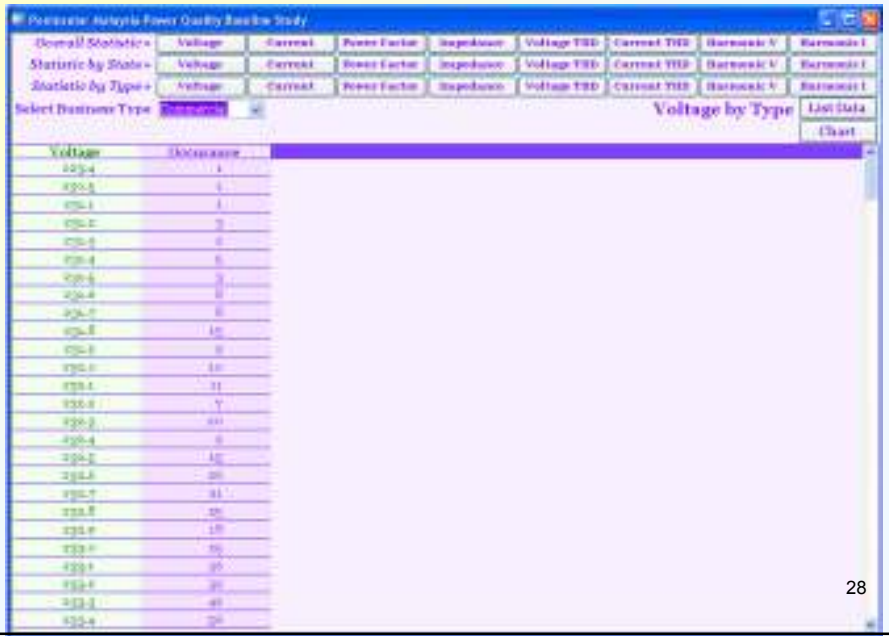
Statistic Data Listing by Business Type



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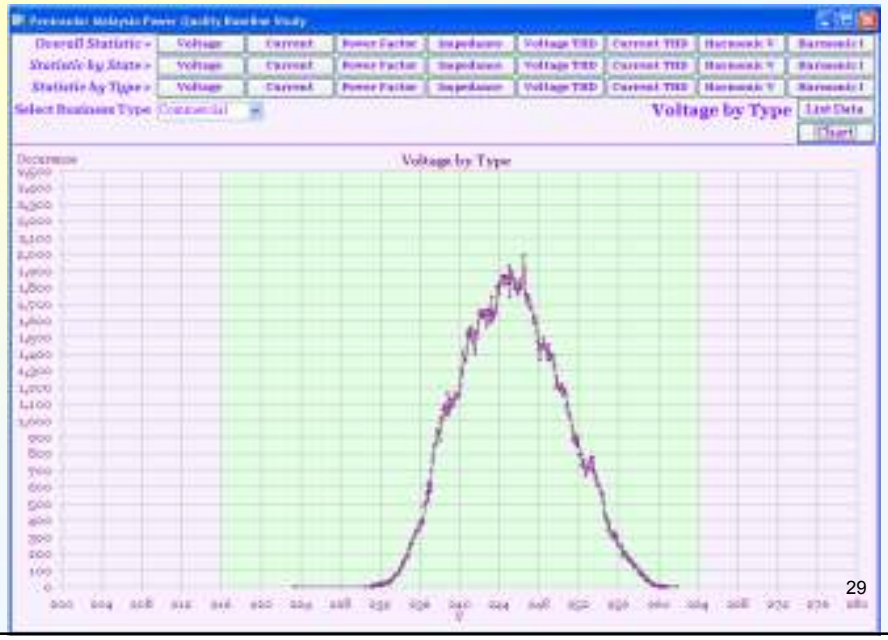
Statistic Chart by Business Type



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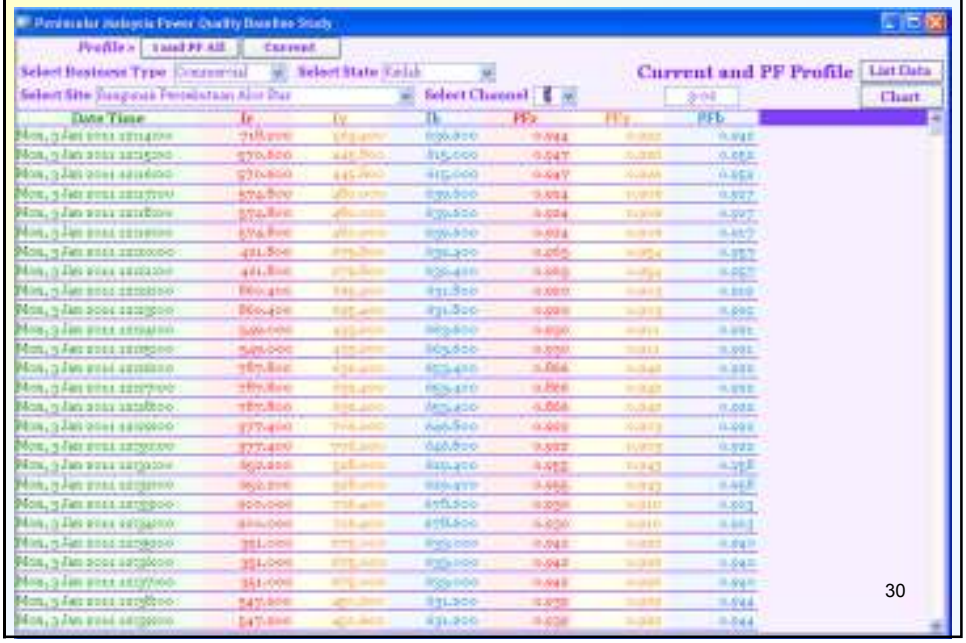
Current and PF Data by Feeder



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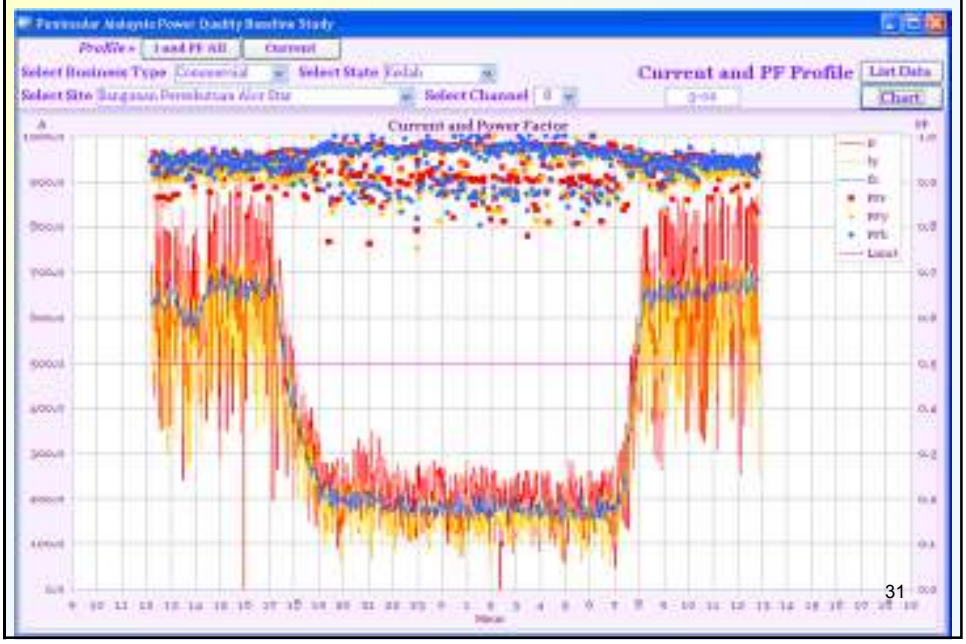
Current and PF Chart by Feeder



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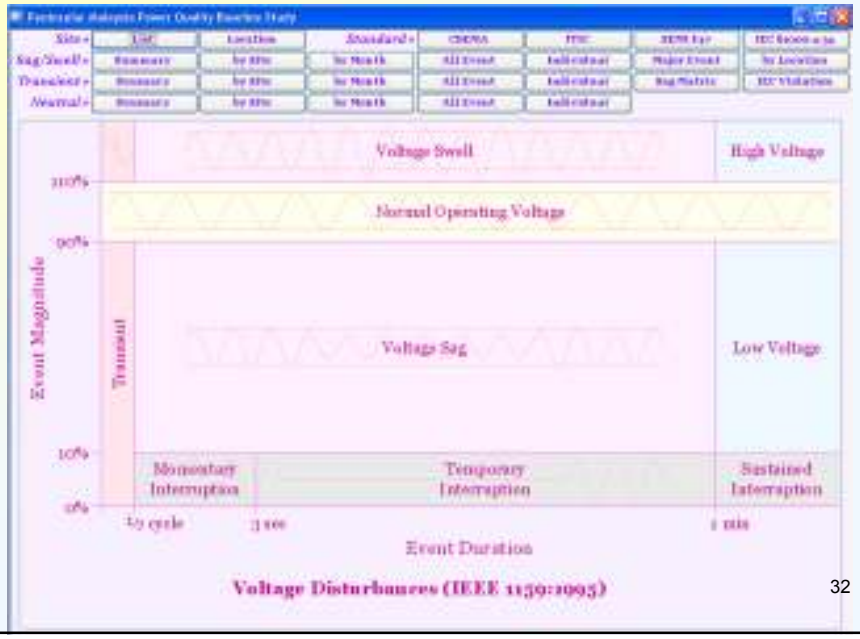
Main Interface for Event Data



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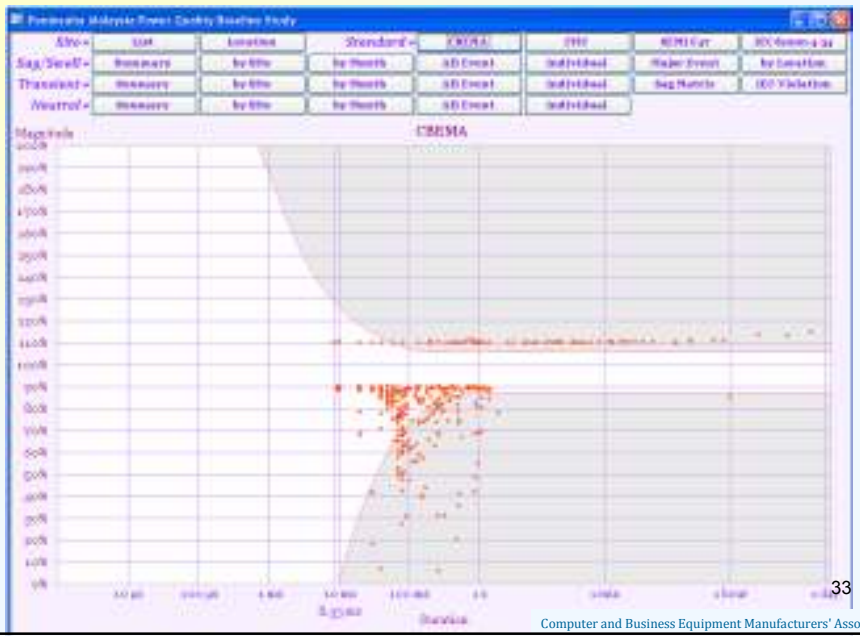
Event versus CBEMA



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Computer and Business Equipment Manufacturers' Association

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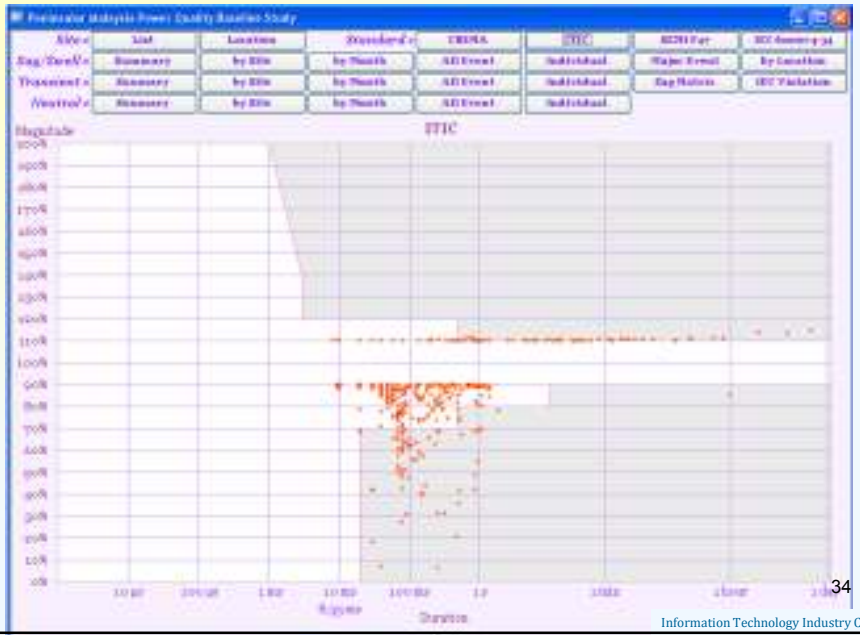
Event versus ITIC



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Information Technology Industry Council

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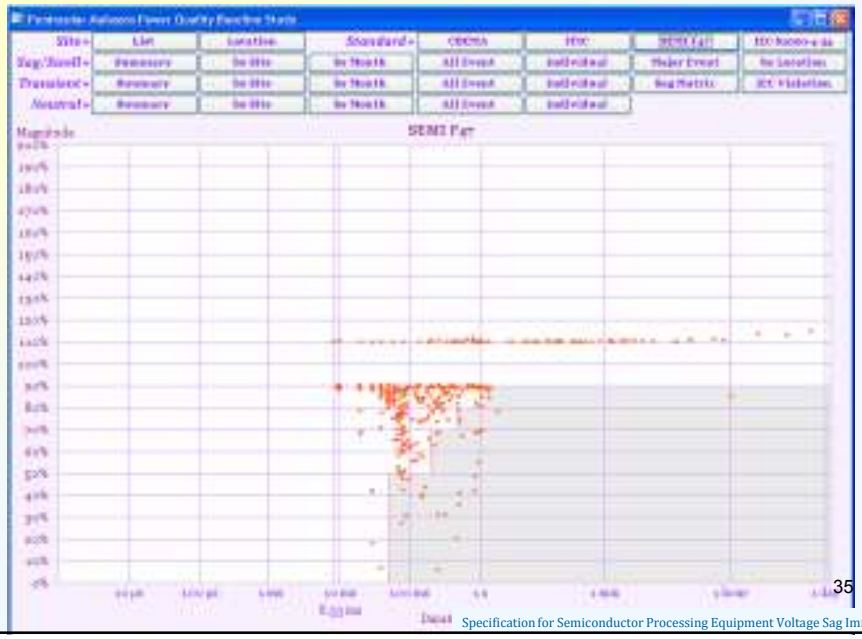
Event versus SEMI F47



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Specification for Semiconductor Processing Equipment Voltage Sag Immunity

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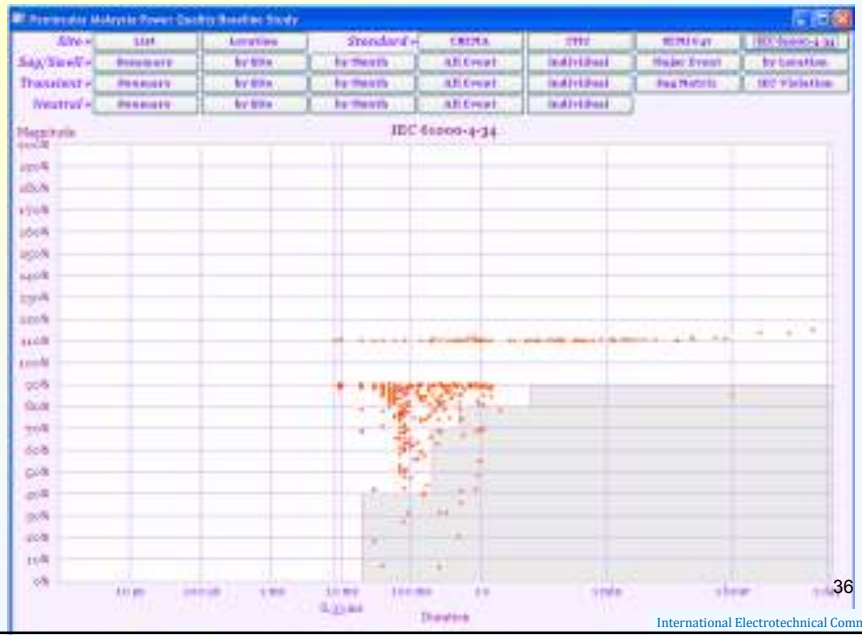
Event versus IEC 61000-4-34



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International Electrotechnical Commission

Event Summary at Monitored Sites

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THANK YOU

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