

The background features a dark blue field with several large, semi-transparent gears of varying shades of blue. On the left side, there is a vertical strip with a colorful, abstract, and somewhat pixelated texture in shades of orange, yellow, and brown.

30 years of History of Power Quality in Asia (and the world)

Terry Chandler

A Power Quality Practitioner TM

Power Quality Inc USA and

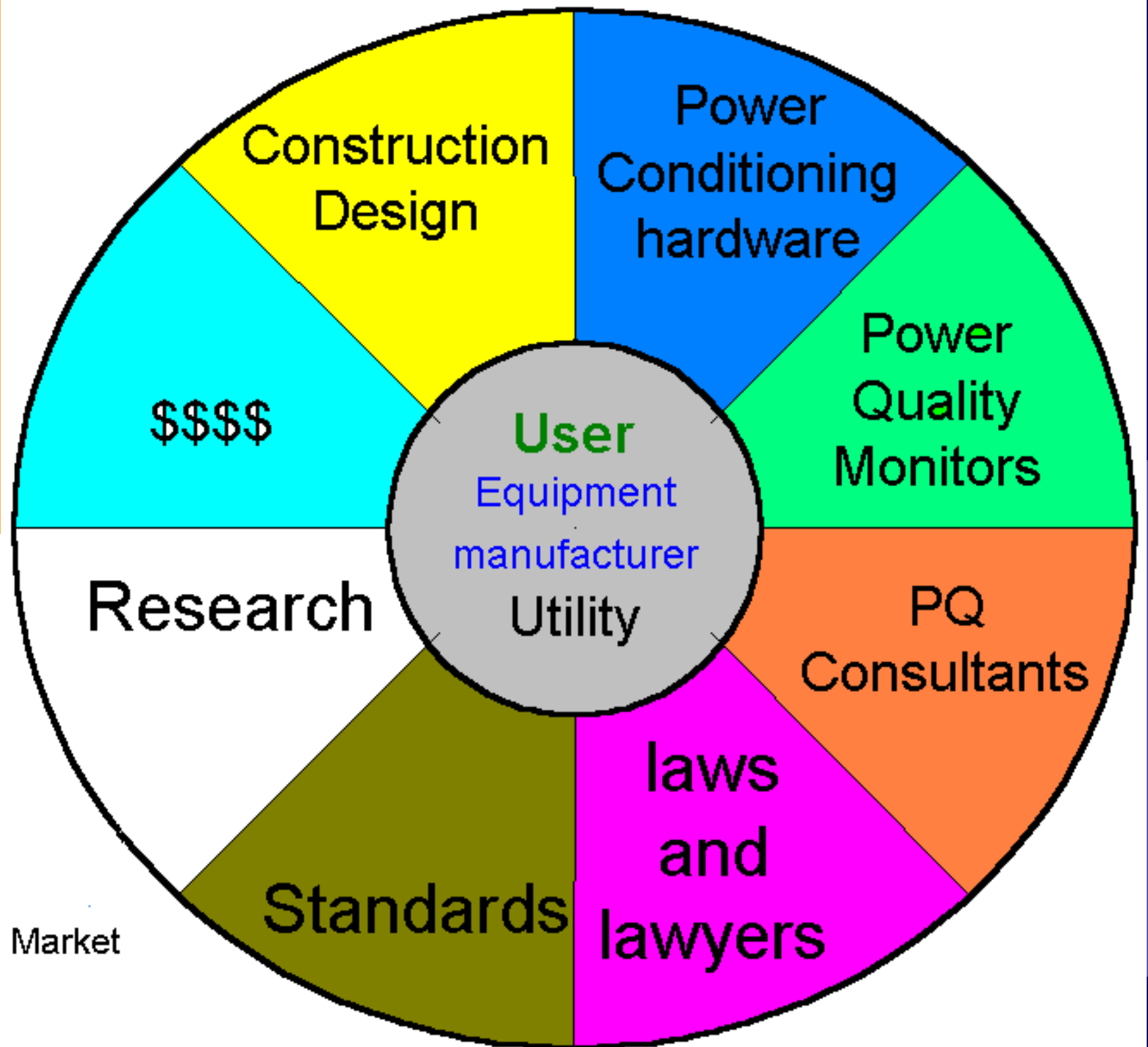
Power Quality Thailand LtD

Pqsynergy TM 2018

What is Power Quality?

- ★ The characteristics of the supply voltage and the electrical system that affect the performance of the load
- ★ The characteristics of the load that affect the electrical system or other loads..

Power Quality definition depends on perspective



Power
Quality

The Power Quality Market
Terry Chandler
April 1997

30 years. What's changed?

- ✦ PQ meters
- ✦ PQMS (PQ monitoring systems)
- ✦ PQ parameters
- ✦ Loads have new technologies
- ✦ Electrical power user awareness
- ✦ Electrical utility awareness
- ✦ Regulator awareness (by country)
- ✦ PQ standards
- ✦ Distributed Generation

History of PQ monitoring

- ★ 1950's to the 60's Analog Meters
- ★ 1970's Circular and numeric Chart recorders
- ★ 1980's Paper roll chart recorders with graphics
- ★ 1994 Digital instruments PQ and energy that build a database.
- ★ 2000 Database analysis tools.
- ★ 2010 more samples per cycle, new standards, lower cost

1960's vintage analog meter

2 parameters

Voltage or Current

Hand written records



Dranetz 616/626 disturbance Analyzer 1960's?



Dranetz 626 and 808 1970's & 80's



[Home](#) > [DRANETZ](#) > 626



Estimated Retail Price - \$8,039.00

representative photo
click to zoom

626

Manufactured by **DRANETZ**

- DRANETZ
- 626
- UNIVERSAL DISTURBANCE ANALYZER
- 7 SLOTS
- AVAILABLE
- REBUILT SURPLUS
- NEW SURPLUS
- REPAIR YOURS

1970's BMI paper roll recorders

- ★ 3 phase
- ★ Voltage RMS
- ★ Voltage Events
- ★ Maximum time 24 hours
- ★ Paper records
- ★ Troubleshooting tools



1990's floppy disks, screens Dranetz 658 printer



PQ systems from Dranetz and BMI before merger



1990's RPM All Digital recorders

- ★ 4 voltage, 5 current
- ★ all 10 PQ parameters
- ★ Every cycle all channels
 - ★ gapless
- ★ maximum time years
- ★ All power parameters
- ★ Network connection and database
- ★ Software becomes more important
- ★ Market disruption with all digital no
UI, no setup, every cycle all the time



The new generation portables 2003 to 2015

- ★ Firmware based
- ★ Compliance to IEC 6100-4-30 Class A
- ★ Measure every cycle, gapless, all parameters
- ★ Data storage for more than 2 years.
- ★ 256 samples per cycle



The next generation portables

- ✦ 512 samples per cycle
- ✦ Remote communications
- ✦ IEC compliance
- ✦ IP65
- ✦ Smaller size
- ✦ More storage
- ✦ Intelligent firmware
 - ✦ Sag direction
 - ✦ Harmonic direction
 - ✦ Harmonic power

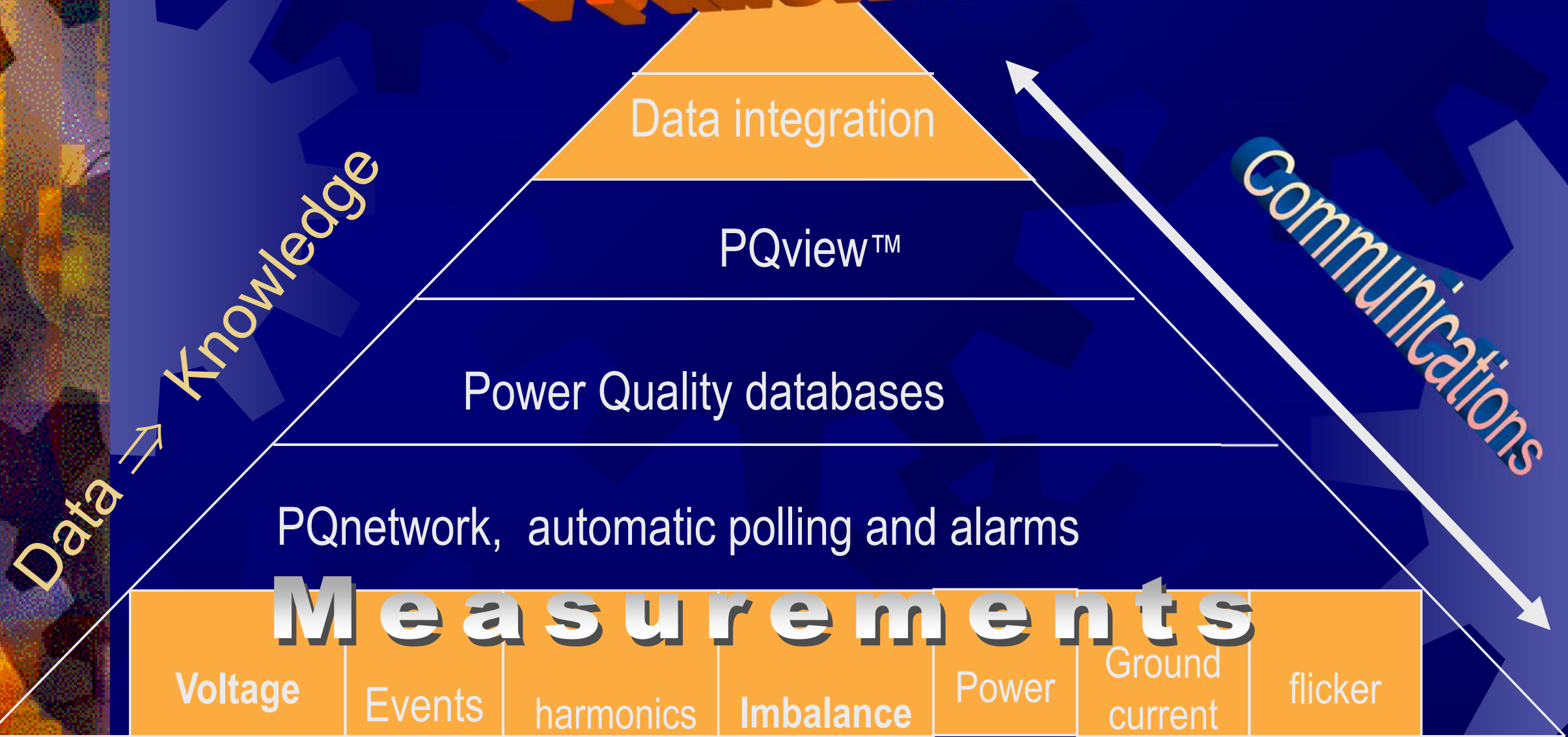


2017 Next generation (Pqview 4) Monitoring System software

- ☀ Monitoring points unlimited
- ☀ Data collection software/system
- ☀ Data characterizing
- ☀ Database management (1000 Terabytes)
- ☀ User Analysis applications
- ☀ Reporting/Viewing of information
- ☀ Move information to knowledge to solutions

PQ monitoring beyond 2020

PQ Knowledge



Data integration

PQview™

Power Quality databases

PQnetwork, automatic polling and alarms

Measurements

Voltage

Events

harmonics

Imbalance

Power

Ground current

flicker

Data

Knowledge

Communications

PQ parameters change

- ✦ More parameters
- ✦ More resolution
- ✦ More accuracy
- ✦ More data

Power Quality Parameters Measurements Utility Side

- ★ RMS voltage, 1970's Periodic samples
- ★ Frequency
- ★ Sags and Surges 1980's Continuous samples
- ★ Voltage transients (fast) 1990's 1 microsec
- ★ 1990 gapless data
- ★ Sinewave –waveshape
- ★ Voltage imbalance
- ★ Flicker
- ★ Harmonics

PQ classifications from user view

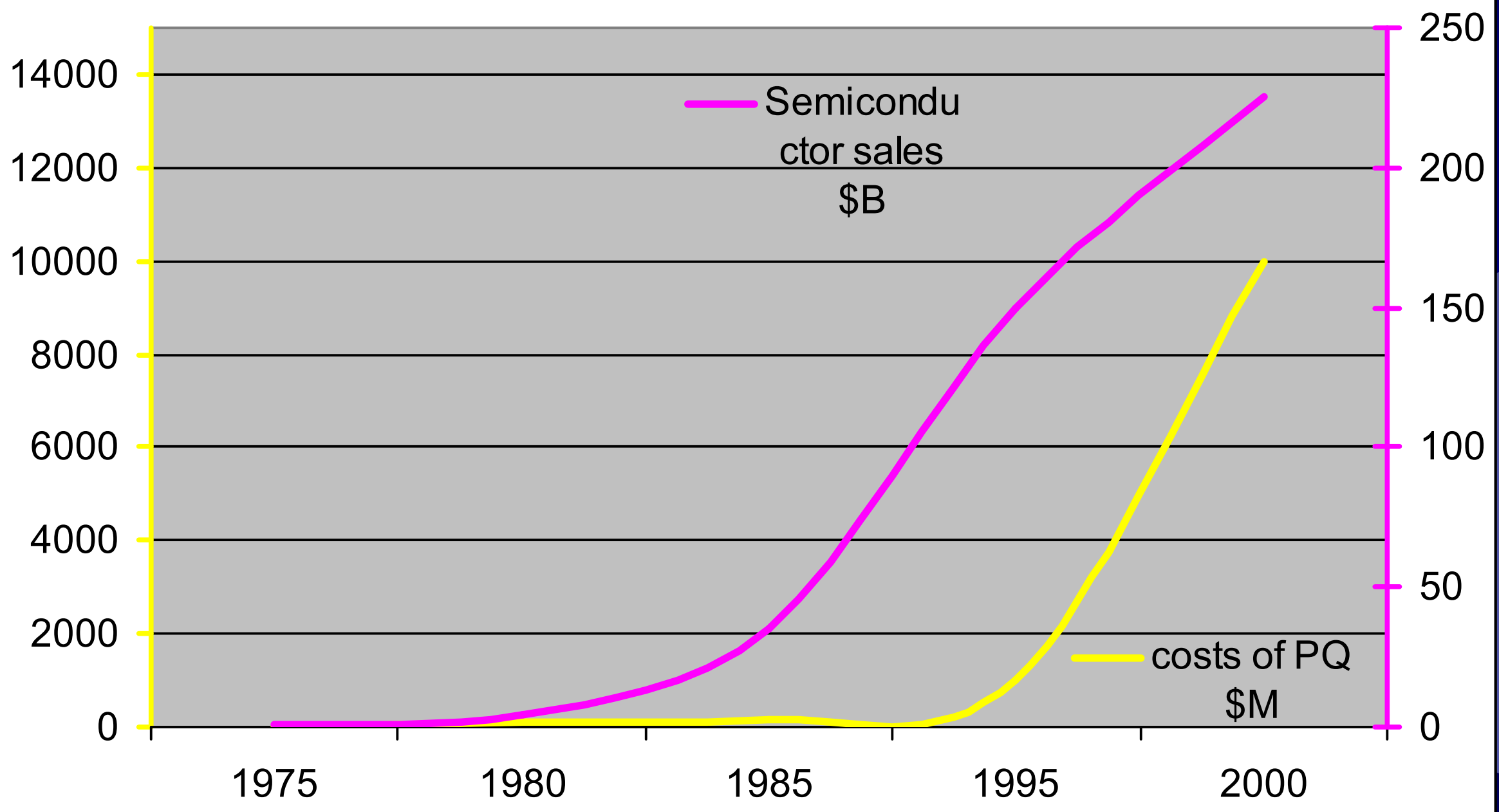
- ★ 1 Electrical system wiring
- ★ 2 Grounding (Earthing)
- ★ 3 Voltage steady state
- ★ 4 Voltage fast transients (fast less than 0.5 cycle)
- ★ 5 Voltage sags and surges (source or load)
- ★ 6 Voltage waveform oscillatory transients
- ★ 7 Harmonics
- ★ 8 Flicker
- ★ 9 Voltage imbalance
- ★ 10 Frequency variations

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Loads are continuously changing

- ✦ Semiconductor technology advances
- ✦ Power Semiconductor capabilities to handle large power
- ✦ Lighting
- ✦ Motors
- ✦ Computers
- ✦ Industrial machines

Semi sales vs PQ costs



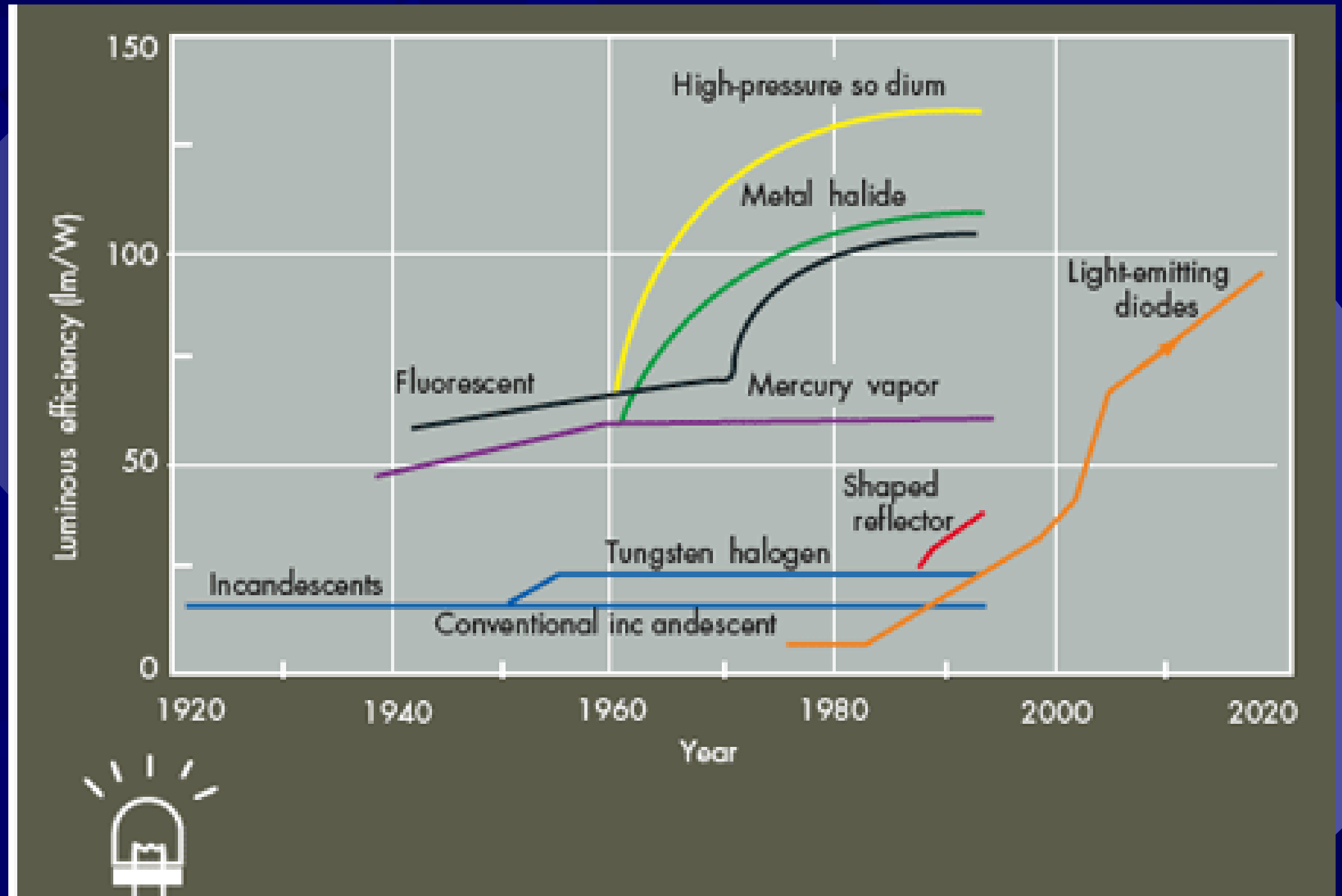
Trends of PQ

- Over \$20 billion of power semiconductor products are installed annually
- 30 percent of all power flows through power semiconductors now
- That will grow to 70 percent by 2010 (EPRI)

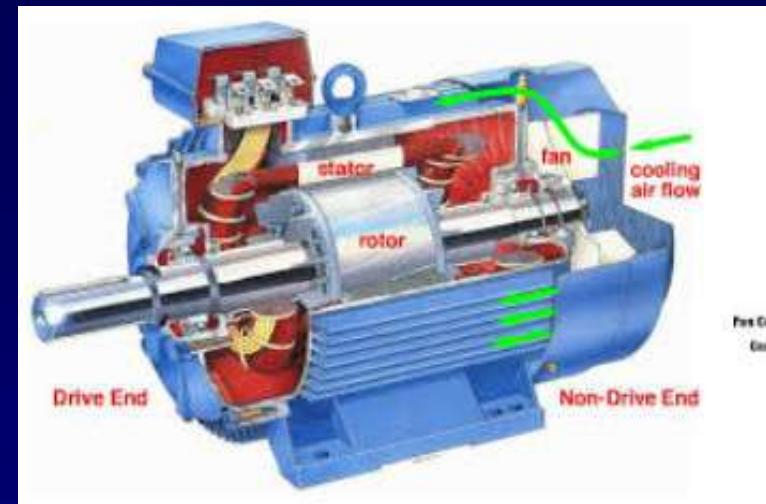
★ What does that mean?

- ★ The annual "cost of poor power quality" is \$12 billion in US? 2001

Lighting technology

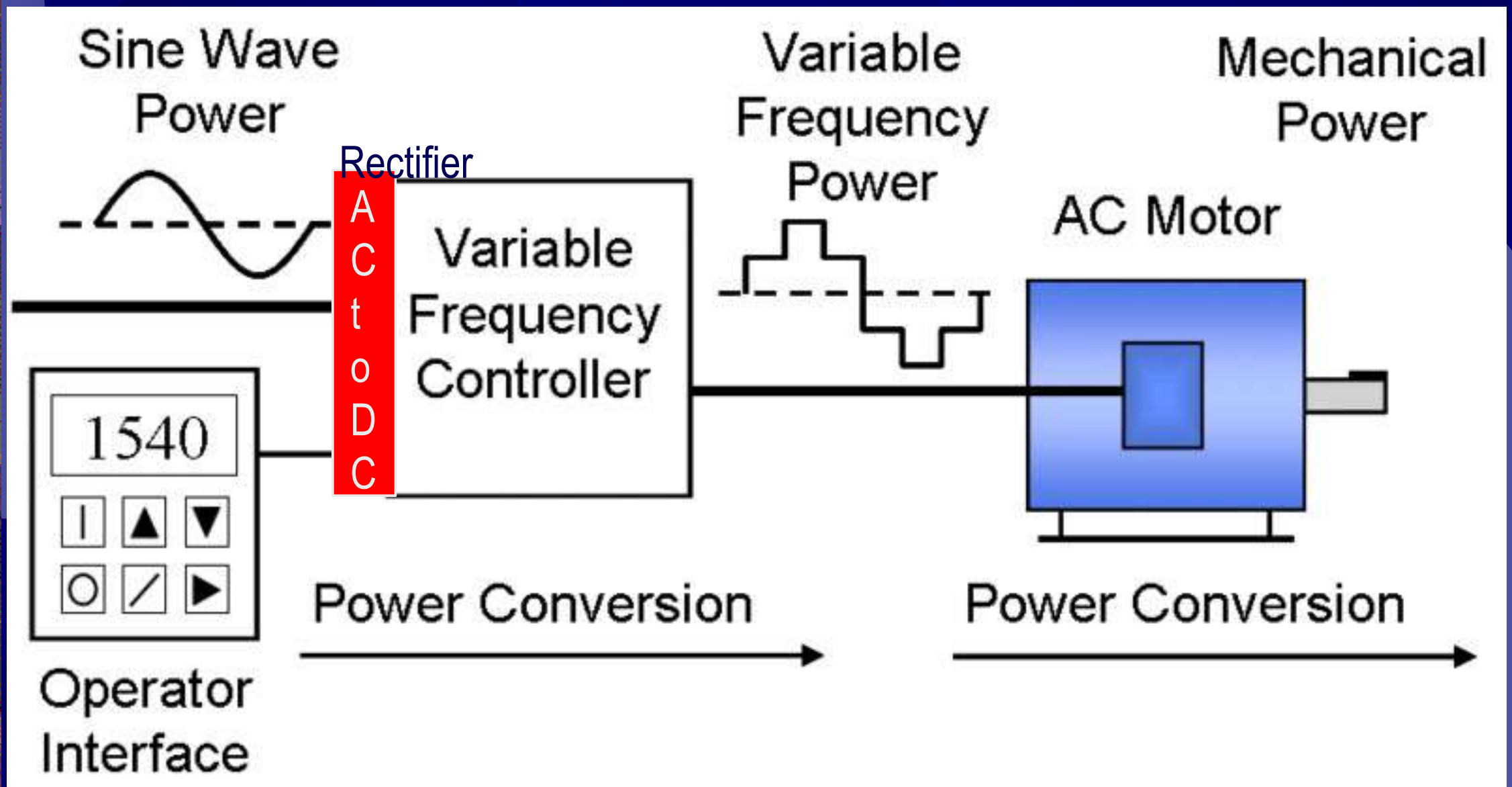


Electric Motors since 1830?



- ★ 70% of electrical load (Industrial) 45% of global load
- ★ High Efficiency motors 5%
- ★ Electronic controls for existing motors
 - ★ Variable Speed Drives (VFD)
 - ★ Variable Frequency Drives (VSD)
 - ★ Softstart

How a VFD or VSD 30% +/- energy savings



Economics of Power Quality

Follow the money!!

- ★ The use of sensitive (electronic) equipment and controls increases the costs of typical power disturbances*
 - ★ 1970's USA EST \$10 million (interruptions)
 - ★ 1980's USA EST \$100 million
 - ★ 1990's USA EST \$ 1 billion (momentary)
 - ★ 2000's World Wide \$10 billion (ALL)
 - ★ 2002 Worldwide \$15 Billion
 - ★ *EPRI estimates

Business problems by Percentage of USA Corporations

- ★ 41% Telecom failure
 - ★ 42.9% Software problems
 - ★ 47.1% Hardware problems
 - ★ **65.9% Power Problems (all types)**
- ★ Source: 1999 Contingency Planning and Management Master Source. Years 1994 to 1999

Power user awareness

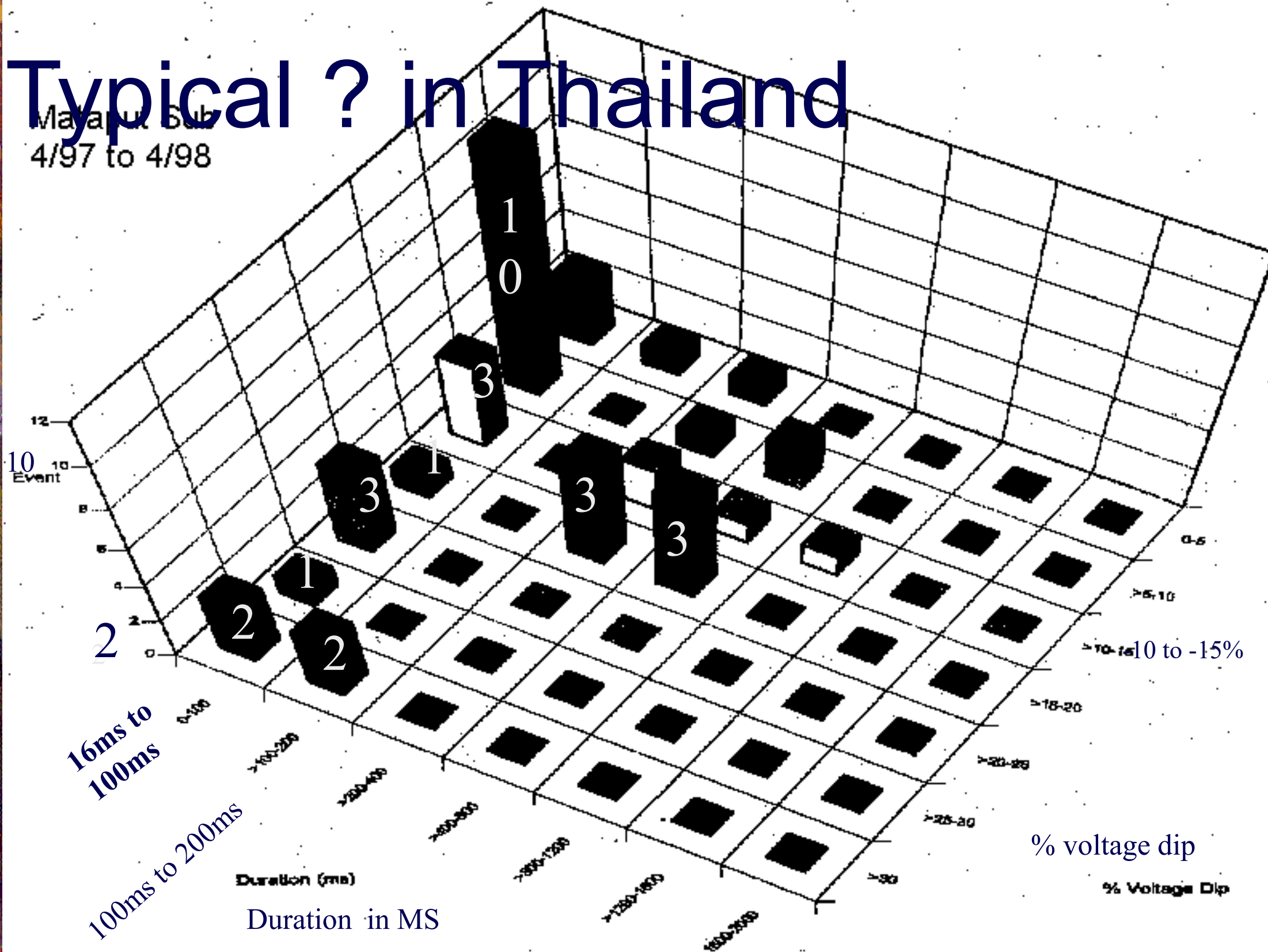
- ✦ From reaction to disruptions in business to a critical requirement for business locations
- ✦ Today major corporations investigate the QOS available at a site before investing in new construction

USA EPRI PQ studies

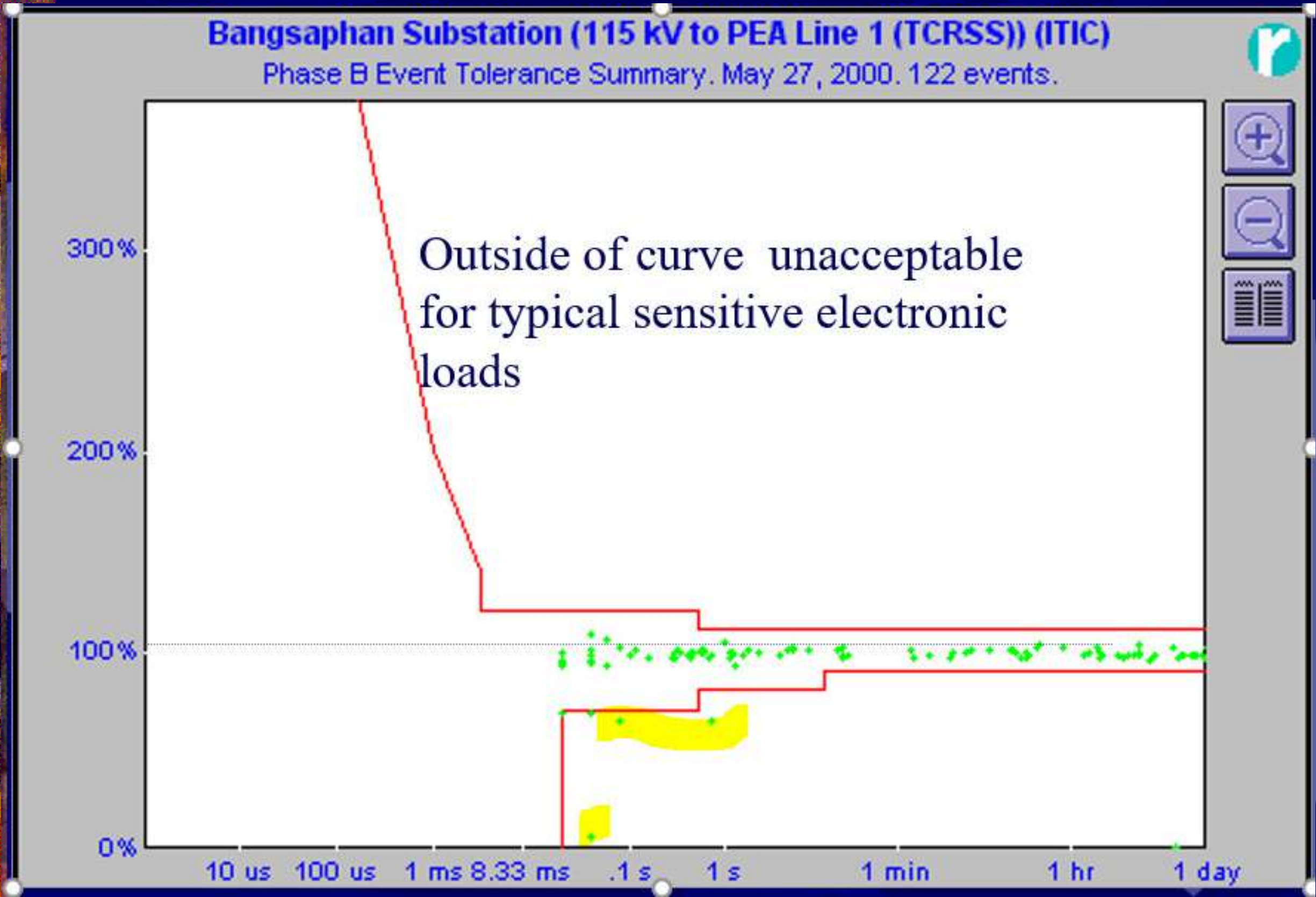
- ★ 1995 Transmission-Distribution Power Quality Report (DPQ I)
 - Voltage sags transients?
- ★ 2004 Transmission-Distribution Power Quality Report (DPQ II),
 - Voltage sags,
- ★ 2014 Transmission-Distribution Power Quality Report (TPQ-DPQ III) analyzes power quality data provided by seven participating utilities.
 - The power quality phenomena examined in TPQ-DPQ III include
 - ★ voltage sags, interruptions, swells, oscillatory transients, harmonics, total harmonic distortion, total demand distortion, voltage unbalance—including negative- and zero-sequence currents—and flicker

Typical ? in Thailand

Mayaput Sub
4/97 to 4/98



ITIC curve introduced in 1995



Sources of power quality problems in order of frequency of occurrence (2009)

- ★ User loads (equipment interactions)
- ★ User electrical system and grounding
- ★ Weather related, lightning, wind, rain
- ★ Utility distribution
- ★ Utility transmission
- ★ Utility generation

Power Reliability vs Quality

- ✱ Power Reliability is the presence of voltage at the meter point.
- ✱ Power Quality is the value of the voltage (and other PQ parameters) as a percent of nominal at the meter.
 - ✱ Mr.. Phil Sarikas , Intel Corporation 4/97

PQ standards

- ★ 1980's few non specific standards
- ★ 2018 very specific standards covering most aspects of PQ

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PQ Standards

- ✦ Too many to mention here

Regulator awareness

- ✱ 1986 total unaware of PQ or QOS
- ✱ Varies by country
 - ✱ To specific regulations for the QOS and the monitoring and documenting QOS
 - ✱ Philippines Regulator requires monthly report of PQ and compared to National grid code and distribution grid code

Distributed generation

- ✱ 33% in Germany
- ✱ Thailand > ?

Future of the Power Quality

- ★ The demands of increasing levels of PQ will continue. Changes in electronic technology continue. No economic pressure to “PQ harden” products unless the customers demand it. (Semiconductor)
- ★ New and improved PQ standards for equipment, distribution, Distributed Generation

Future II

- ★ Equipment manufacturers will offer a robust levels of power quality for a fee?
- ★ ~~Utilities will offer various levels of Power Quality at different price points. Power Quality will be included in tariff structure.~~
- ★ Critical nodes will be monitored or “PQ metered” continuously

Power Quality Thailand LTD

- ✦ Distributor and Value Added Reseller for Dranetz Inc in Asia.
- ✦ 30 + years experience in Power Quality
- ✦ PQ data analysis, site surveys, energy usage surveys and data analysis
- ✦ Power Quality Practitioner TM
 - ✦ Power Quality training for utility engineers
 - ✦ Power Quality training for non-utility engineers
- ✦ Worldwide consulting on PQ problems



Thank You

