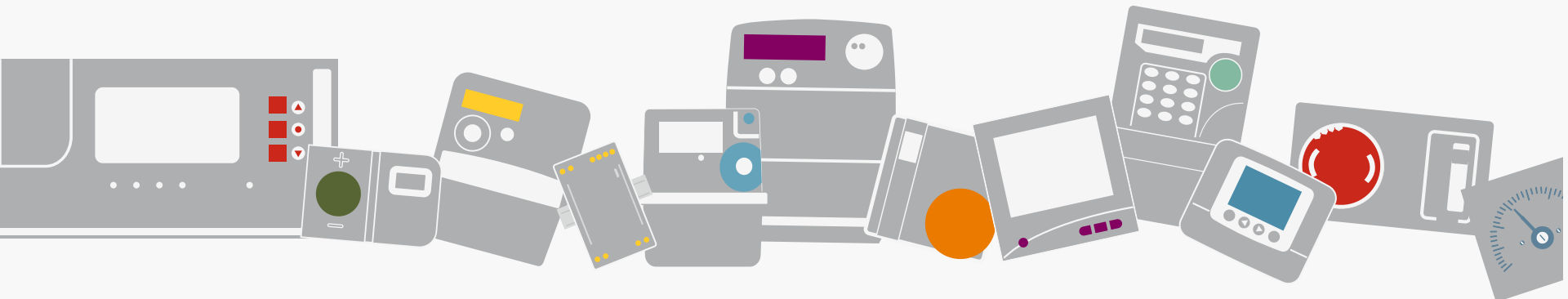


# Power quality- Developed countries improved, it's time for India



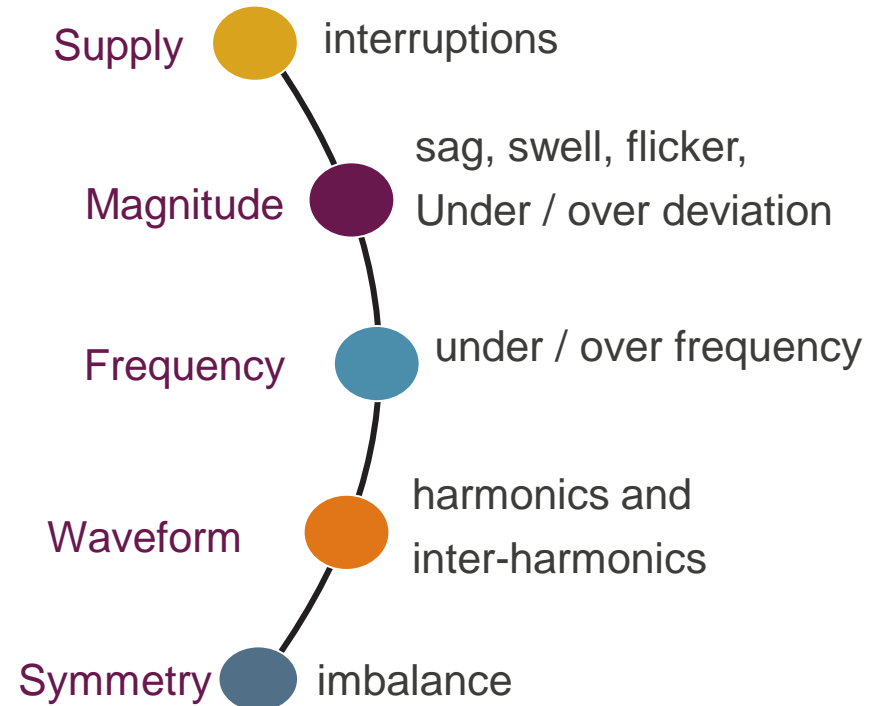


# What is Power quality?

**Electricity is a commodity,  
Should be fit for consumer use,  
implying:**

- Continuity of **supply**
- Stability of rated **magnitude**
- Stability of rated **frequency**
- Purity of sinusoidal **waveform**
- Symmetry across **phases**

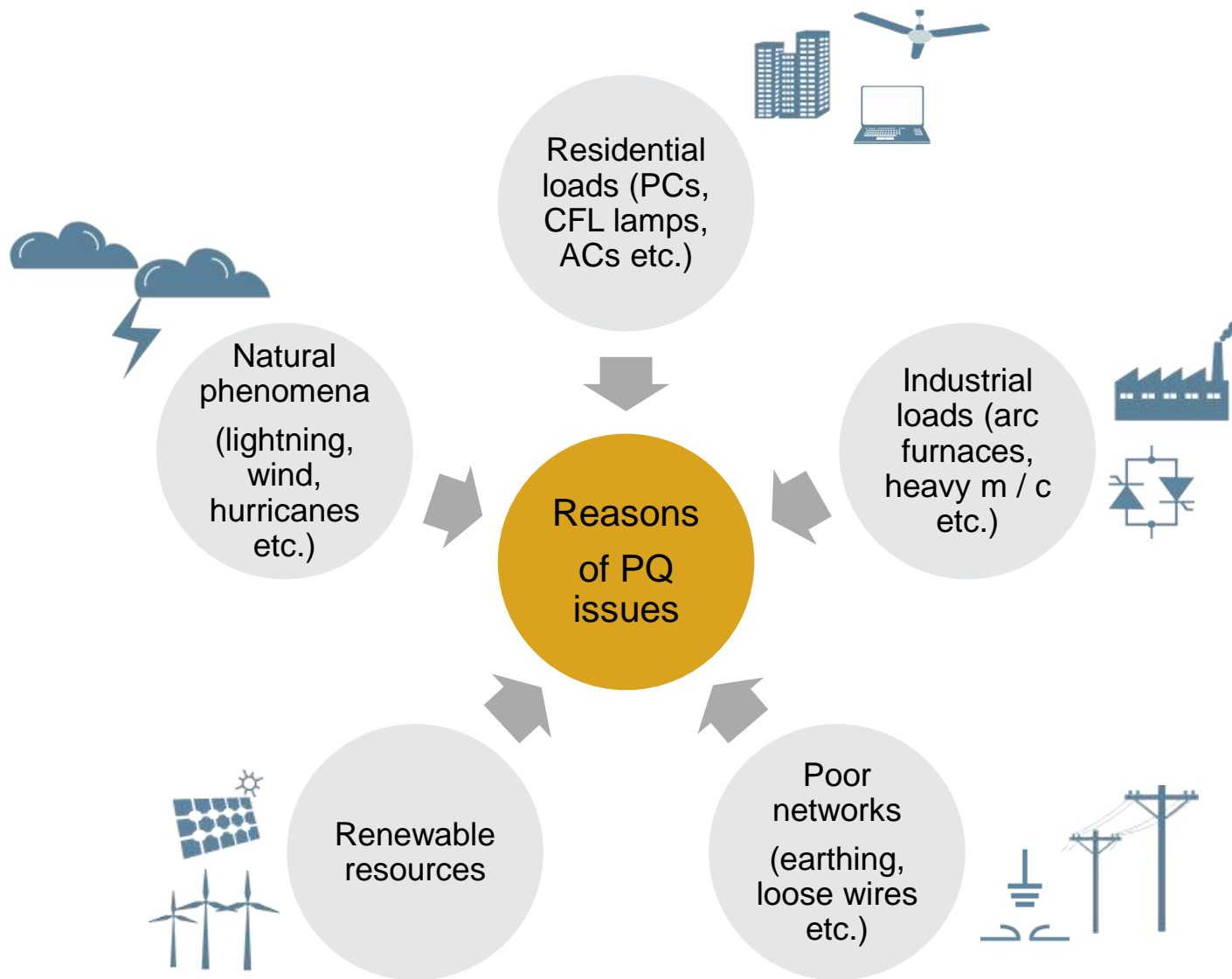
## Power quality manifestations



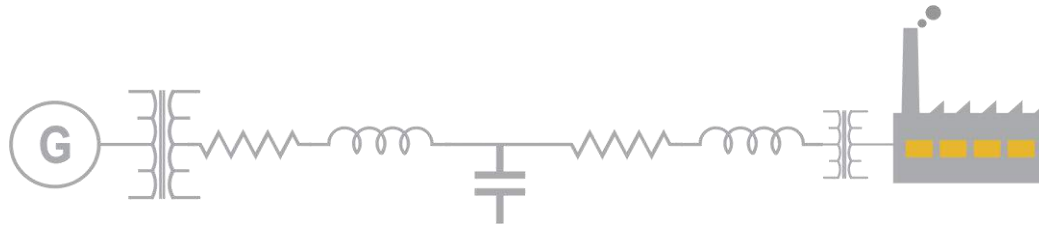
**POWER QUALITY = RELIABILITY**



# What causes PQ issues?



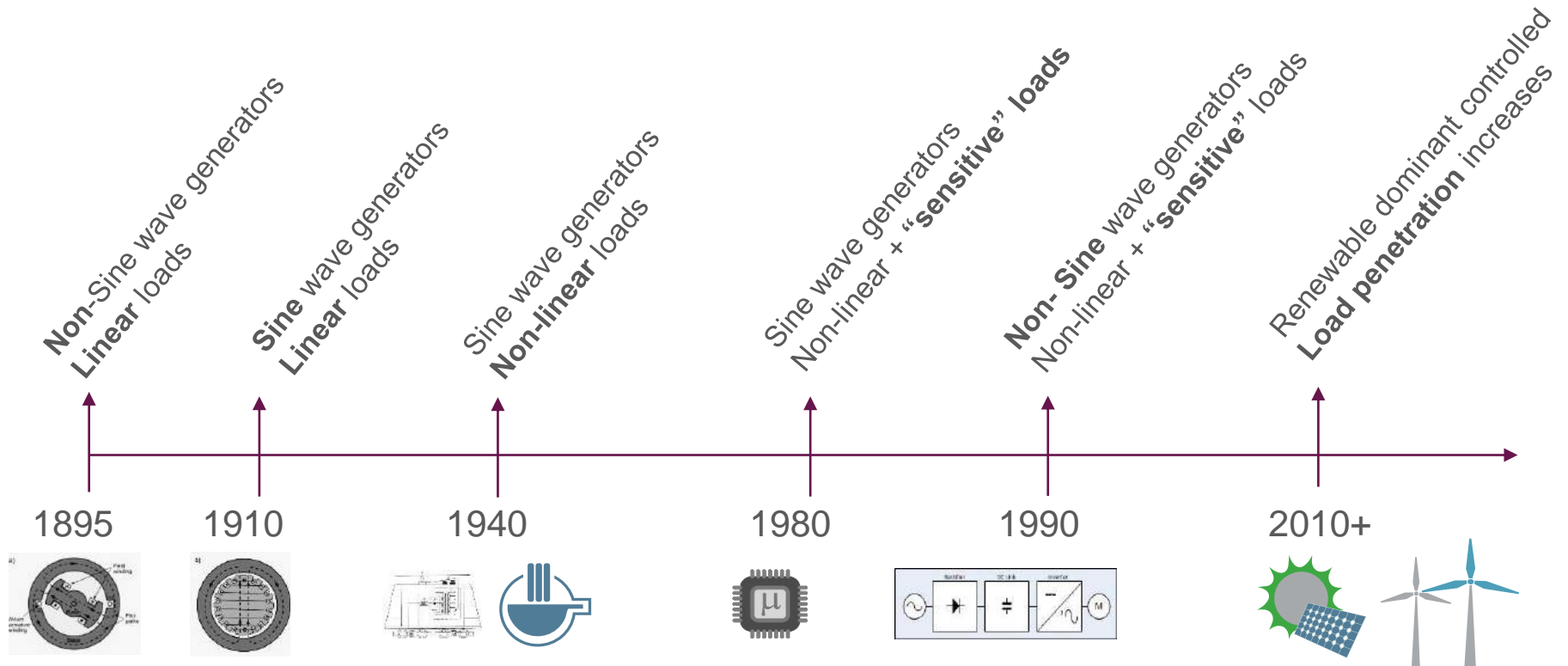
# How electricity generation has changed over time?



Uni-directional & centralised

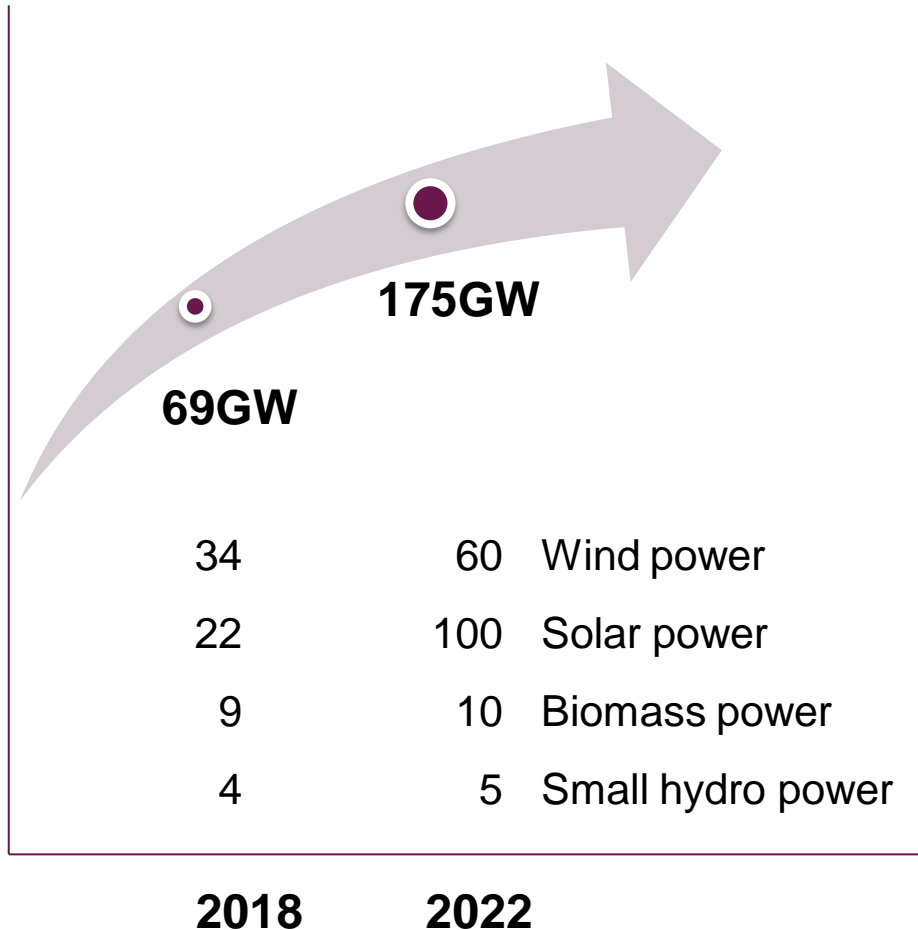


Bi-directional & distributed

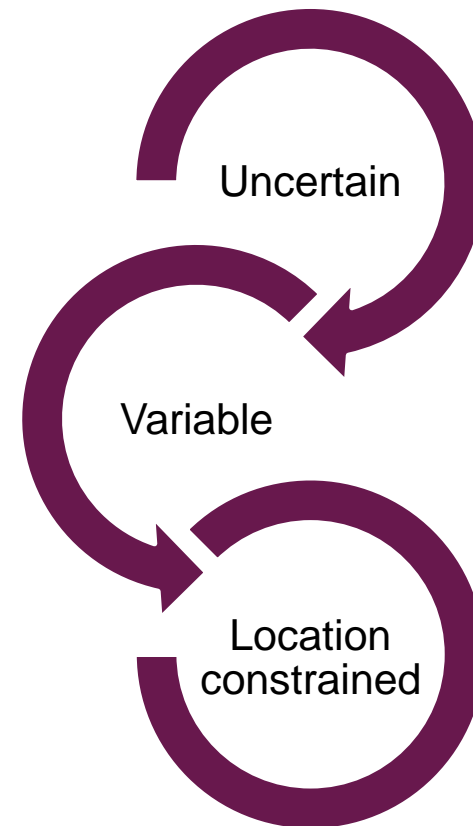




# India - Renewable energy generation, plan and challenges



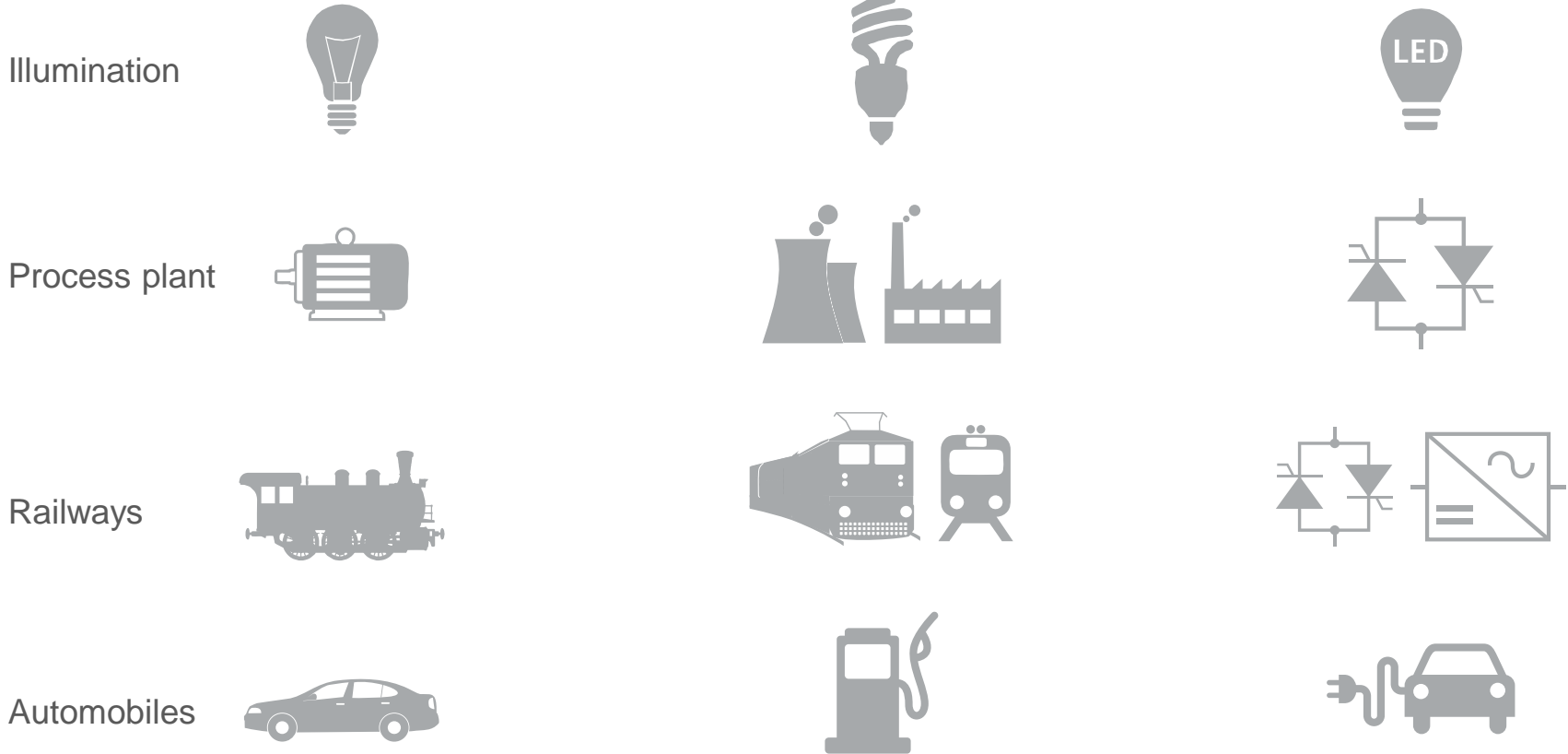
## Challenges:



# How loads have changed over time?



Linear / less sensitive  Non-linear / more sensitive



Better control using power electronics (non-linear)



Efficiency

# Harmonics generation by LED, TFT and UPS

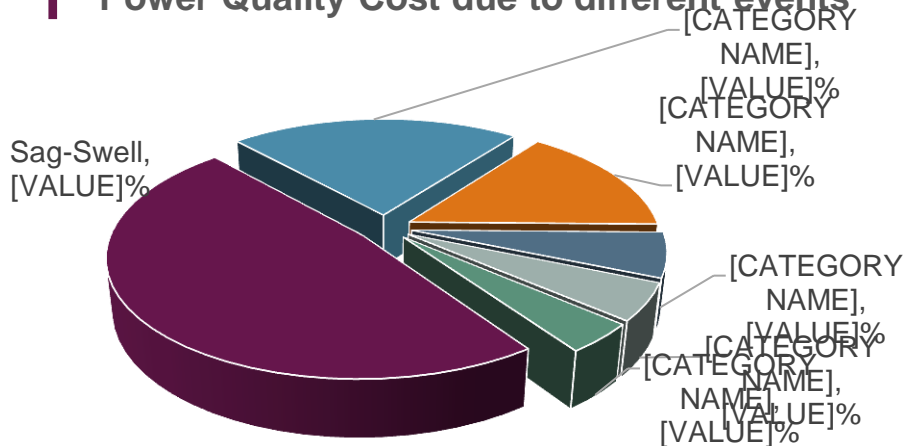


THD	150 -170%	70-90%	30-70%
Harmonic order	3,5,7,9,11,13	3,5,7,9,11,13	5,7,11,13
Power factor	0.5 - 0.6 lagging	0.7 - 0.8 leading	0.8 - 0.9 leading

# PQ events - probability and their impact



## 1 Power Quality Cost due to different events



## 2

## Cost impact



### Direct Cost

- loss of material
- occasional damage to equipment or machine
- non-productive staff hours
- hours required to restart the process

### Indirect Cost

- failed delivery
- loss of reputation

## 3

PQ event	Mitigation
Sag, Swell and short interruptions	Protection operation, UPS and constant voltage transformer
Long interruption	Power back-up
Flicker	CVTs and UPS
Harmonics	Harmonic filters (passive and active filters)
Transient	LAs and MOVs
Imbalance	Audits for load distribution and proper transposing





# Cost of poor power quality

Estimated annual costs due to dips for end-users is between **120 and 440 million kr (Norwegian Krone)**

Survey: NVE and stakeholders, Norway (2002)

Estimated annual costs for industrial customers due to dips and interruptions is about **€157 million**

Survey: Elforsk, Sweden (2003)

Estimated annual costs due to dips and interruptions (< 1 sec) for the whole production system is between **465 and 780 million €**

Survey: AEEG and Politecnico di Milano, Italy (2006)

Costs of PQ wastage EU-25 exceeds **€150 billion (₹ 12 lac crores)** annually

Survey: Pan-European survey by Leonardo power quality initiative (2005-2007)

Source: CEER 4<sup>th</sup> benchmarking report

# Cost of poor power quality- Indian perspective



The direct costs of downtime in India are nearly ₹ 20,000 crores per annum\*\*. 57% of the losses are due to voltage sags & short interruptions

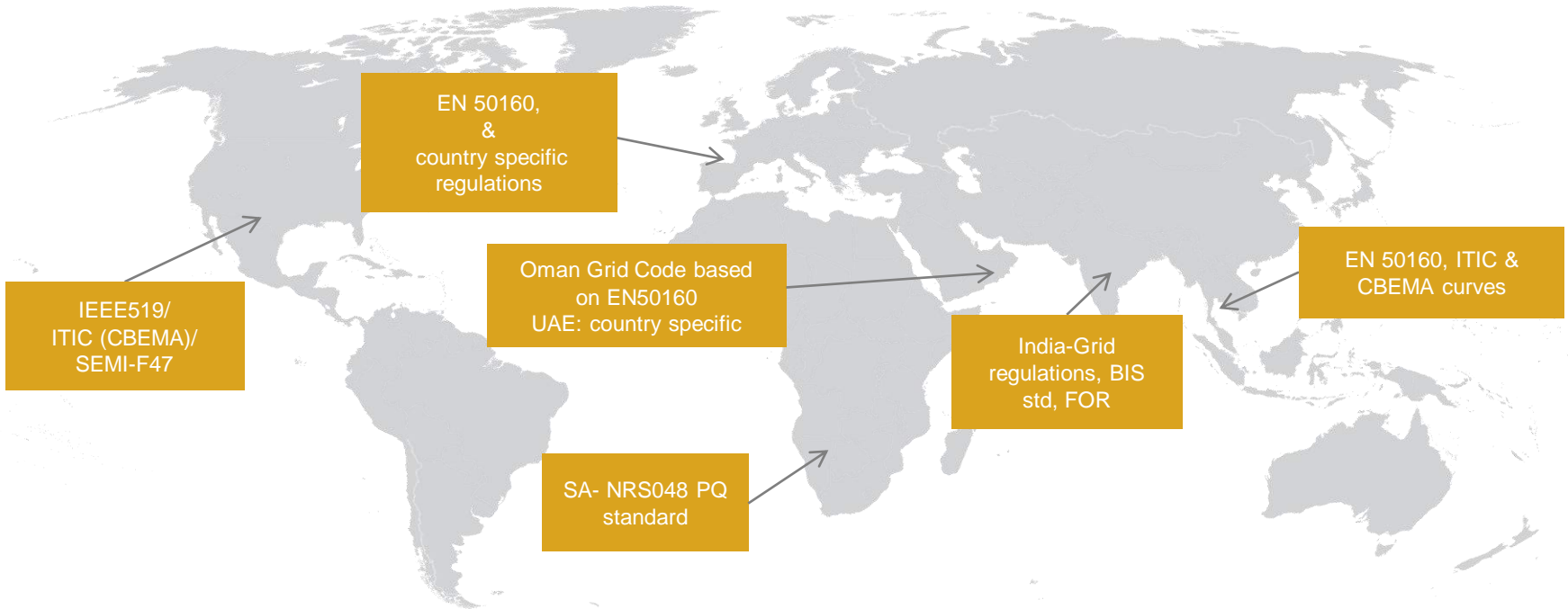
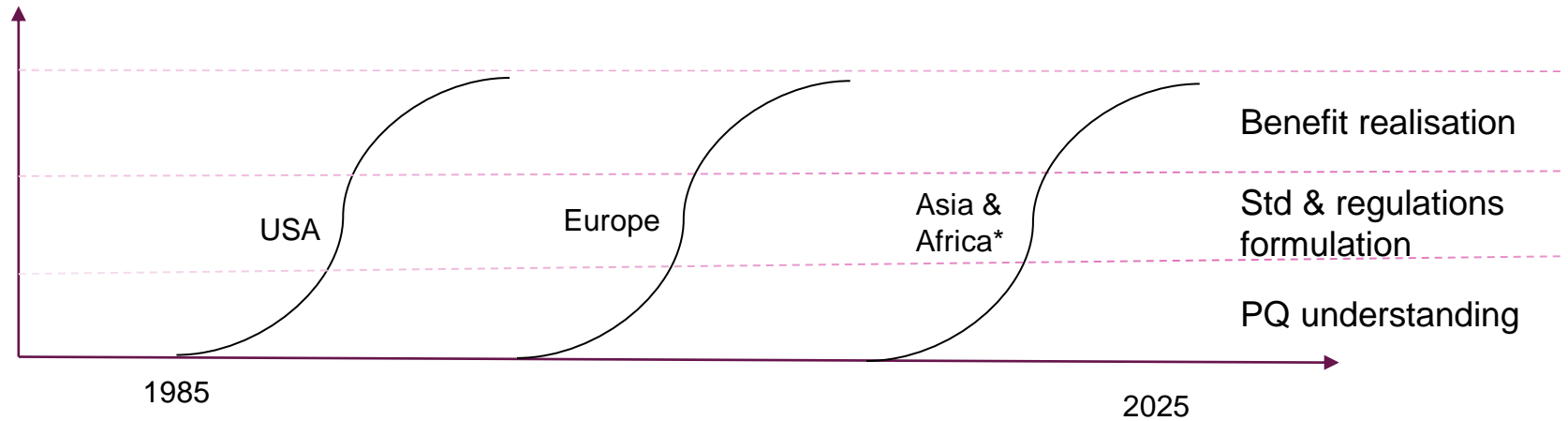
Source: APQI Report

About 30% of the firms suffer more than 20 percent of cost escalations due to the use of power backups to support their production activity

Source: “Lack of Affordable & Quality Power: Shackling India’s Growth Story (2012)”, FICCI[12]

\*\* The cost of prevention for these may be less than 10 per cent of the cost of the problems they cause.

# PQ monitoring across the globe





# Power quality standards and regulations

## PQ Standard

IEC 61000-4-30  
Measurement  
methods for PQ

IEC 62586-1  
Product and  
performance for  
PQI

IEC 62586-2  
Functional test  
and limit for PQI

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## PQ regulation

EN50160  
Distribution  
system supply  
voltage quality

BIS 17036  
Distribution  
system supply  
voltage quality.

Country specific  
regulations  
e.g. NRS, NVE,  
EIFS etc.

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## PQ guideline

IEEE 519  
Harmonic  
emission limit  
guideline

CIGRE 596  
PQ monitoring  
guideline

# Indian electricity policy and power quality



- Electricity is an essential requirement for all facets of our life.
- Equally important is availability of reliable and **good-quality power** at competitive rates to the Indian industry in order to make it **globally competitive**.
- **Services sector** has made significant contribution to the growth of our economy. Availability of good-quality **supply** of electricity is very crucial for sustained growth of this segment.

## National electricity policy aims to achieve:

Supply of reliable and **good-quality power**, of specified standards, in an efficient manner, and at reasonable rates.





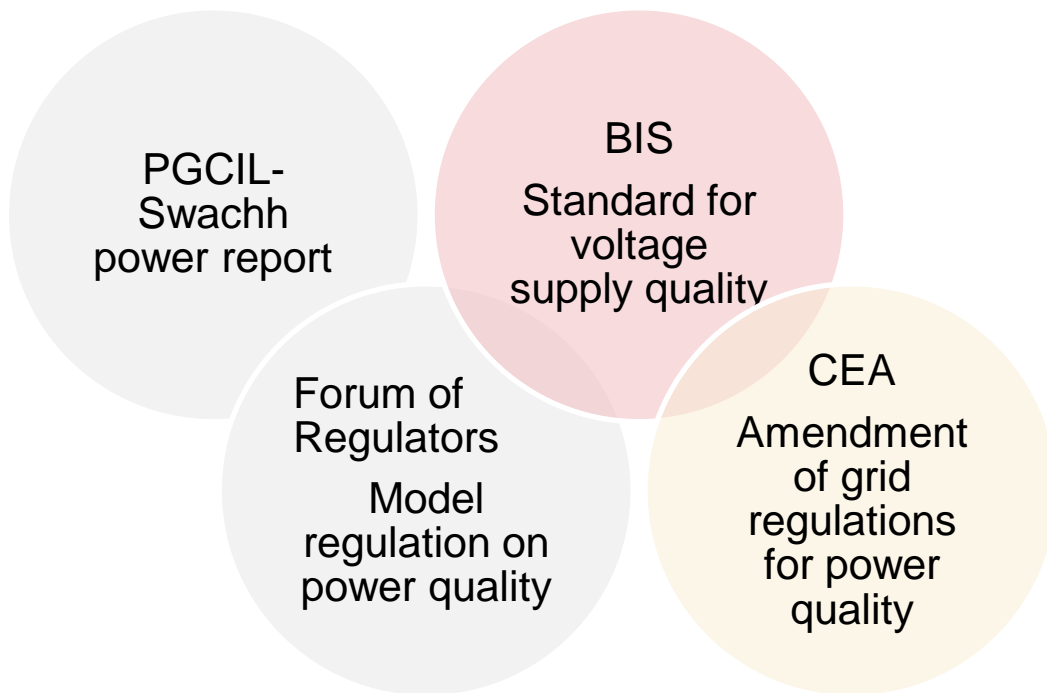
# PQ advances in India

## Present gaps

- Lack of awareness
- Inconsistency in state level electricity norms
- No framework to monitor implementation



## On going actions



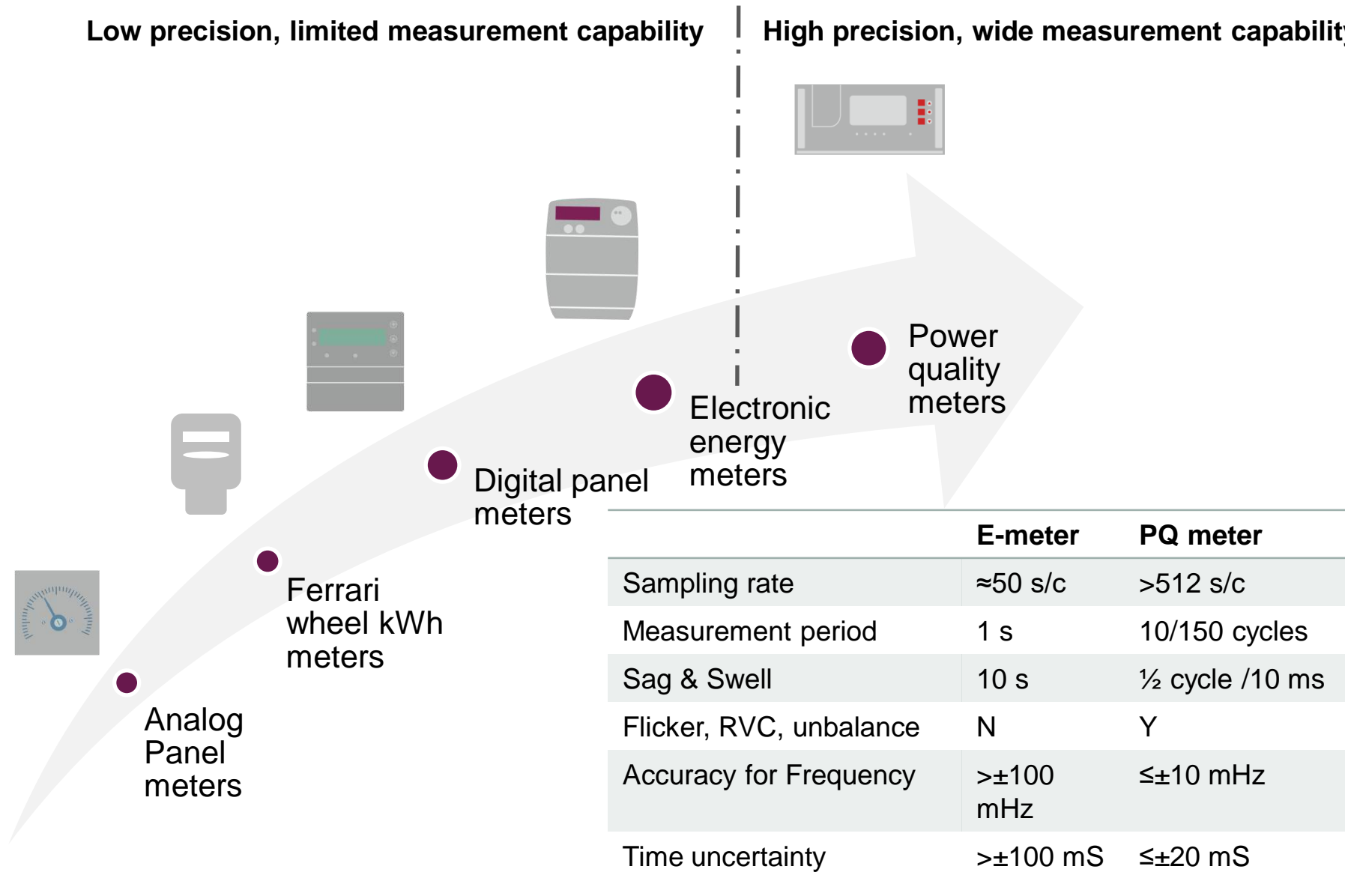
- Continuous power quality monitoring using Class A PQ meters by distribution licensee & bulk consumers
- Harmonic measurements at PCC as per IEEE 519

# Evolution of measurement technologies



Low precision, limited measurement capability

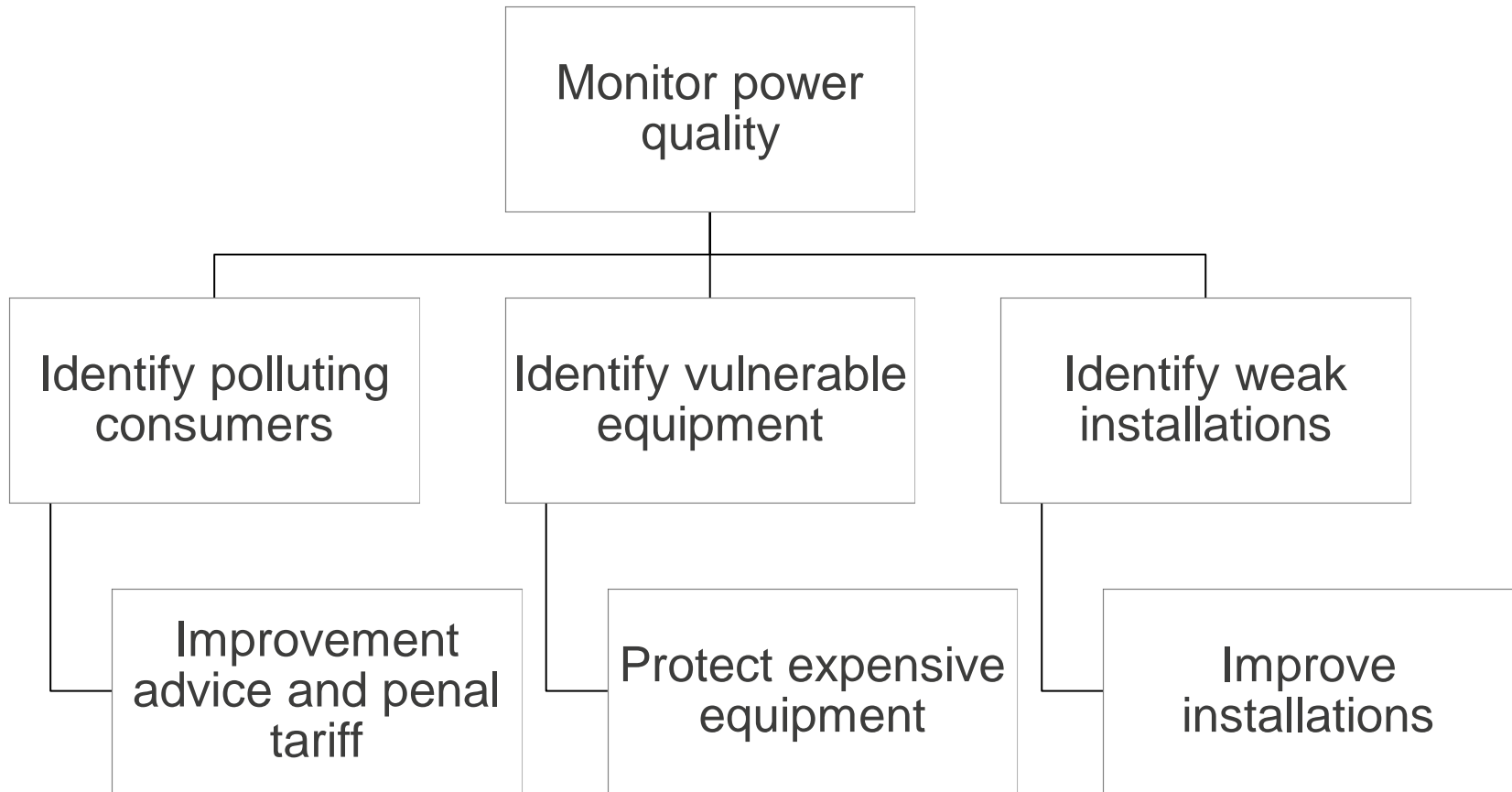
High precision, wide measurement capability





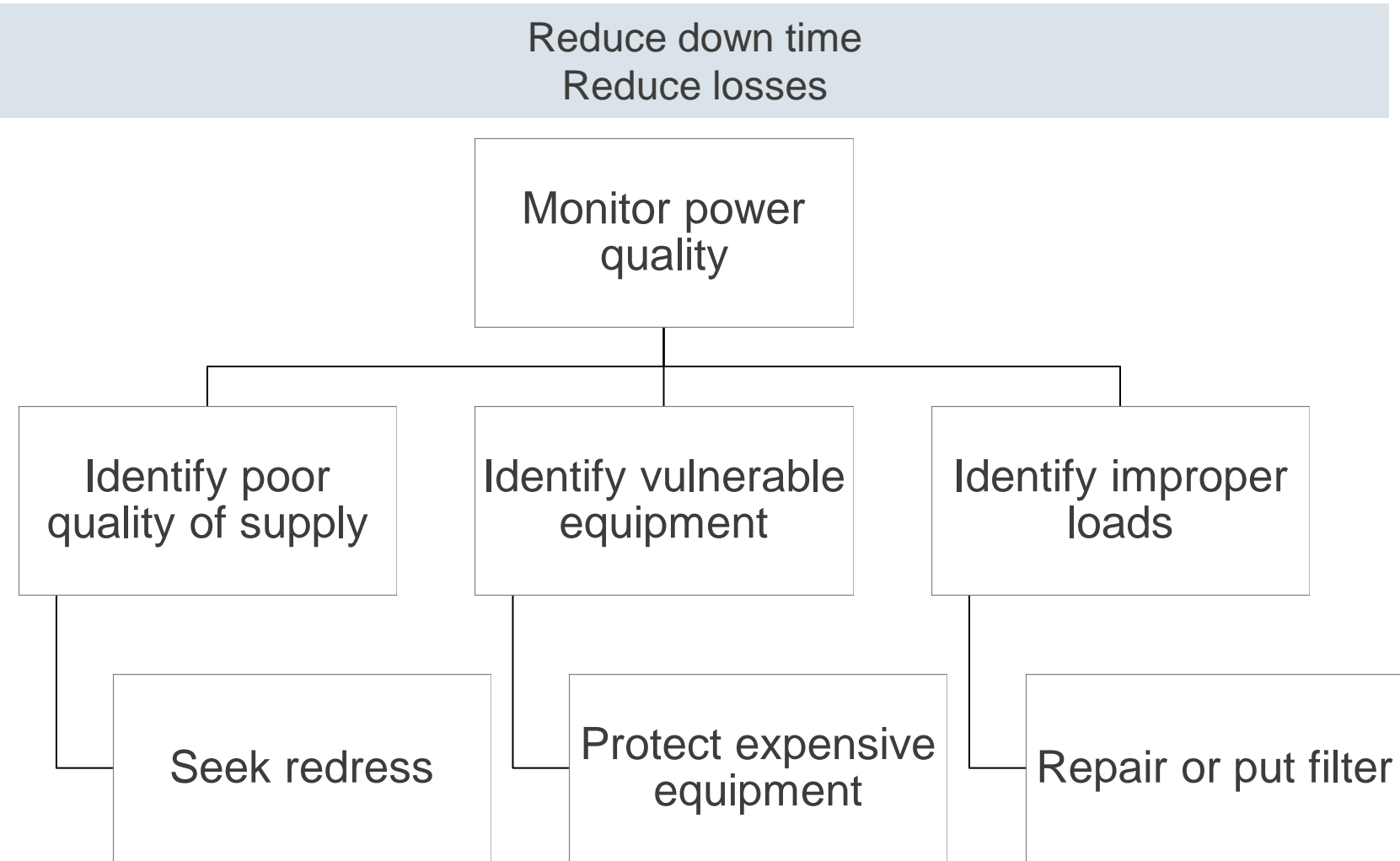
# A PQ deployment strategy (for utility)

Improve revenues  
Meet compliance obligations

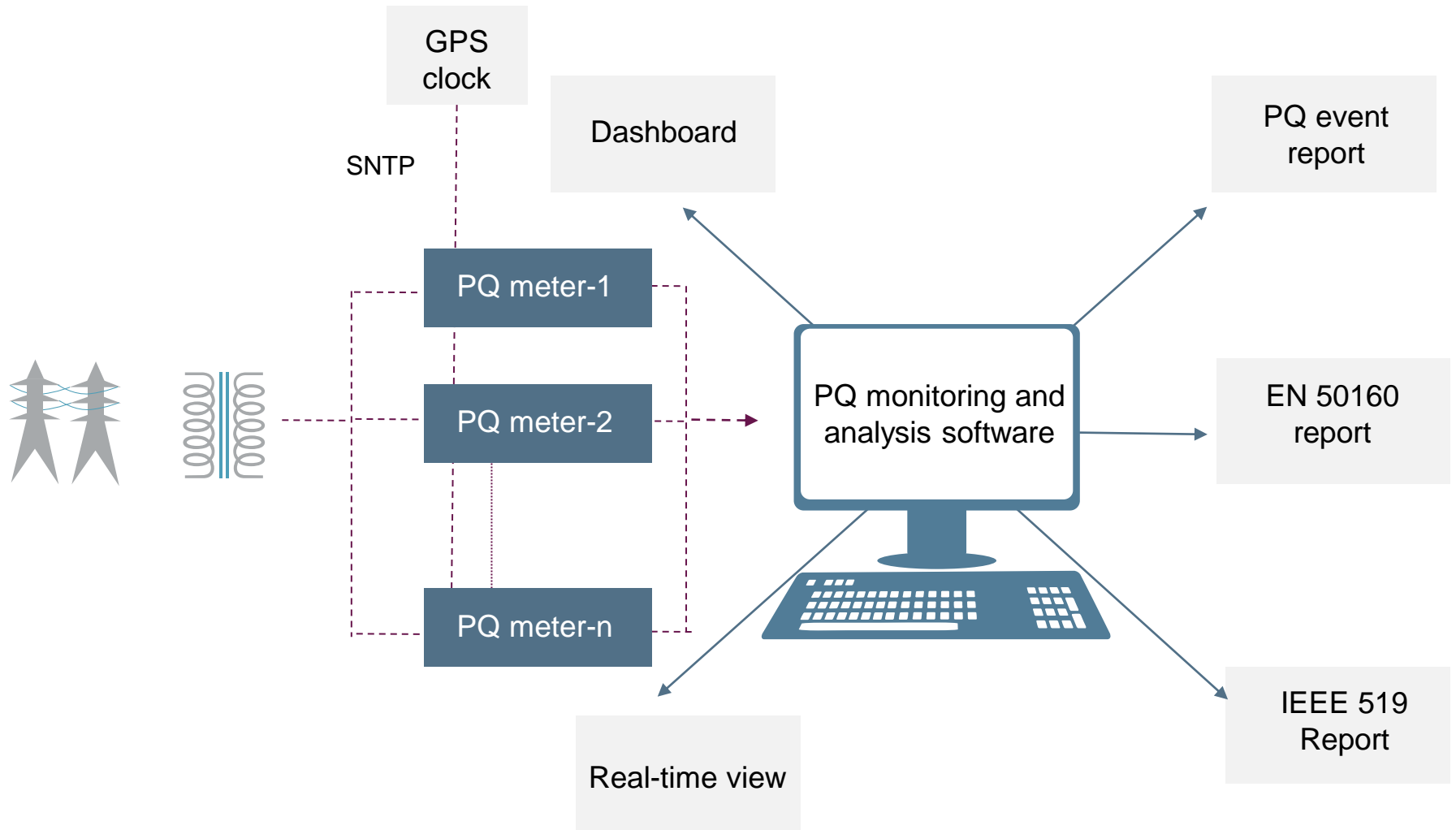




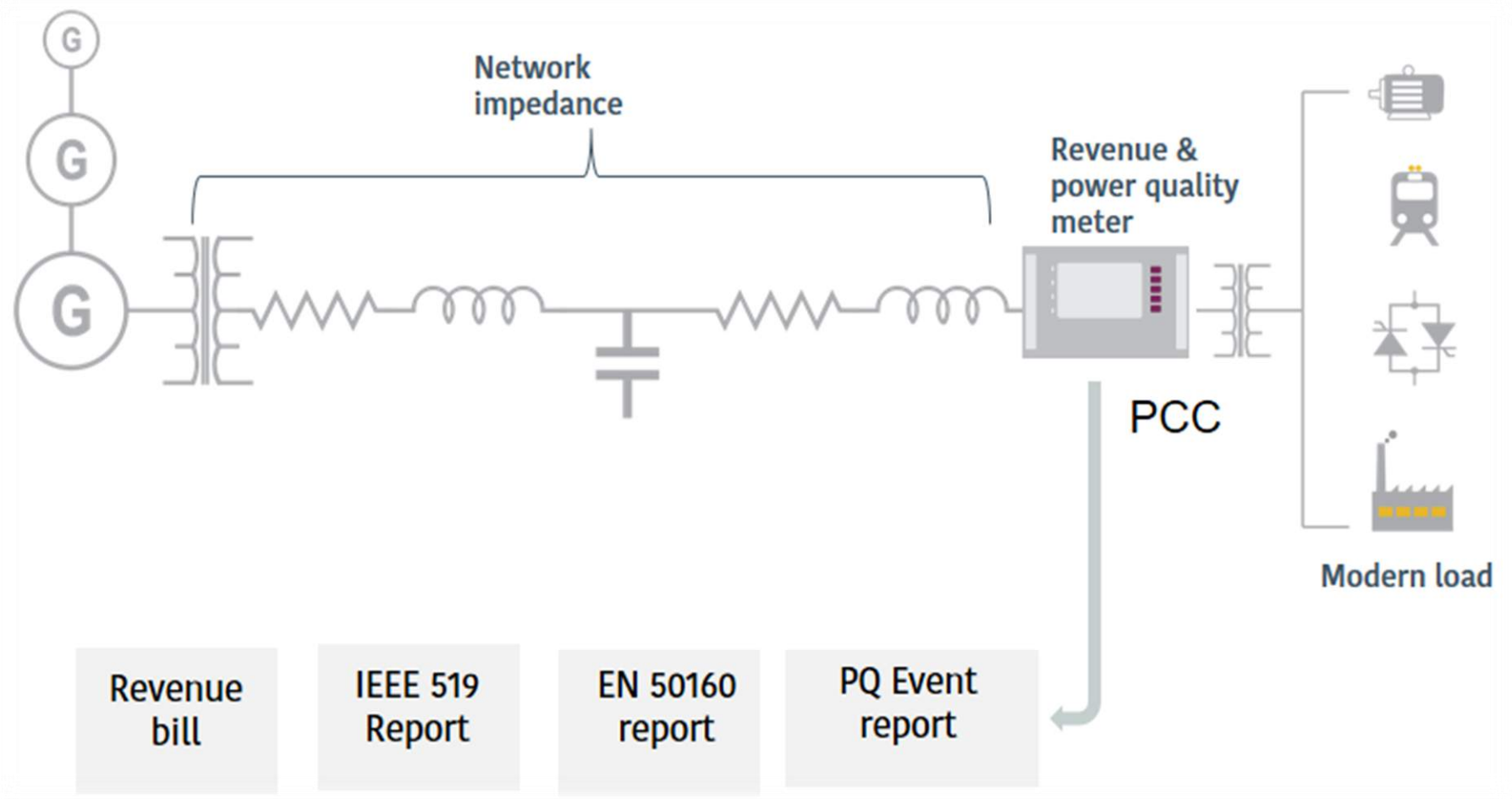
# A PQ deployment strategy (for industry)



# PQ monitoring system for Big industries/sub-station



# Integrated solution for revenue metering and power quality monitoring





# PQ monitoring options

- **Fixed PQ meters** over portable PQ meters
  - ensure compliance of supply
  - detect all PQ events: pre and post event conditions
  - early detection of PQ events, reducing down-time
- **Class A** over Class S
  - precise PQ measurements and matching results
  - data logged can help resolve contract related disputes
  - recommended for compliance verification
- **Integrated solution** over two box solution
  - single solution for revenue metering and PQ monitoring
  - authenticity is a concern in a two box solution
  - PQ based tariff can be applied for **penalization** or **incentives**



# Conclusion & recommendations

## Conclusion:

- PQ is an contributing factor to the development of any country
- Developed countries used PQ monitoring as a tool to identify weaknesses
- In developed countries, PQ issues and its impact on businesses & consumers reduced significantly

## Recommendations for India:

- Build awareness about power quality issues among utilities, Renewable generators & bulk consumer
- Assess the power quality status & create a baseline
- Regulatory bodies build and implement regulation framework with incentive and penalisation mechanism for power quality
- Display power quality performance in public domain

## Most importantly,

- Improvement in power quality is a regular process
- Aim is to build a robust grid & PQ responsive customers



Thanks