

**SASO IEC/TR 63213:2020  
IEC/TR 63213:2019**

**POWER MEASUREMENT APPLICATIONS WITHIN ELECTRICAL  
DISTRIBUTION NETWORKS AND ELECTRICAL  
INSTALLATIONS**

**ICS 17.220.20**

**Saudi Standards, Metrology and Quality Org (SASO)**

---

this document is a draft saudi standard circulated for comment. it is, therefore subject to change and may not be referred to as a saudi standard until approved by the board of directors

## **Foreword**

The Saudi Standards ,Metrology and Quality Organization (SASO)has adopted the International standard No. IEC 6313:2019 “POWER MEASUREMENT APPLICATIONS WITHIN ELECTRICAL DISTRIBUTION NETWORKS AND ELECTRICAL INSTALLATIONS ” issued by (IEC). The text of this international standard has been translated into Arabic so as to be approved as a Saudi standard.



## CONTENTS

INTRODUCTION.....	3
1 Scope.....	4
2 Normative references .....	4
3 Terms, definitions and notations .....	4
3.1 Measurement definitions .....	4
3.2 Measurement applications .....	6
3.3 Grid definitions .....	6
3.4 Stakeholder definitions.....	8
3.5 Notations .....	10
3.5.1 Abbreviated terms .....	10
3.5.2 Indices.....	10
4 State-of-the-art measurement applications .....	10
4.1 General.....	10
4.2 Grid power quality.....	11
4.2.1 General .....	11
4.2.2 State of the art on measurement to perform .....	11
4.2.3 State of the art on standards .....	11
4.3 Power monitoring application .....	12
4.3.1 General .....	12
4.3.2 Power monitoring application, general .....	12
4.3.3 Power monitoring application, demand side power quality.....	13
4.4 Billing application.....	14
4.4.1 General .....	14
4.4.2 State of the art on measurement to perform .....	15
4.4.3 State of the art on standards .....	15
4.5 Energy management application .....	16
4.5.1 General .....	16
4.5.2 Energy management application, cost management.....	16
4.5.3 Energy management application, energy efficiency.....	17
Annex A (informative) Example of electrical installation for a mall .....	19
Annex B (informative) Explanation about measurements performed by PQIs (IEC 62586), PMDs (IEC 61557-12) and analogue meters (IEC 60051 series) .....	20
B.1 General.....	20
B.2 Differences .....	20
B.3 Differences between power quality, power monitoring and troubleshooting .....	21
B.3.1 General .....	21
B.3.2 Power quality.....	21
B.3.3 Power monitoring.....	21
B.3.4 Troubleshooting.....	21
B.4 Key parameters measured .....	22
Annex C (informative) Explanation about measurements performed by PMD (IEC 61557-12), IEC 62053-2x, MID .....	23
Annex D (informative) Explanation about the scope of various standards .....	24

Bibliography.....	25
Figure 1 – Measurement applications within the grid.....	10
Figure A.1 – Example of shops within a mall, where all shops are final energy users .....	19
Table 1 – List of main applications .....	11
Table 2 – Standards for grid power quality application .....	12
Table 3 – Benefits of measurements for power monitoring application .....	13
Table 4 – Standards for power monitoring application .....	13
Table 5 – Standards for demand side power quality application .....	14
Table 6 – Simplified overview of billing application.....	15
Table 7 – Benefits of measurements for billing application .....	15
Table 8 – Standards for billing application.....	15
Table 9 – Simplified overview of EM/cost management application .....	16
Table 10 – Benefits of measurements for EM/cost management application.....	16
Table 11 – Benefits of measurements for EM/energy efficiency application .....	17
Table 12 – Benefits of measurements for EM/energy efficiency application in industrial processes .....	18
Table 13 – Standards for EM/energy efficiency application .....	18
Table B.1 – Rough comparison between devices .....	20
Table B.2 – Measurement needs.....	22
Table C.1 – Rough comparison of energy measurement standards .....	23
Table D.1 – Rough comparison of measurement parameters .....	24

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## **INTRODUCTION**

Utility engineers and facility managers are requesting rich power and energy data from many locations, with guaranteed and reliable accuracy. This data is essential for helping to understand and ensure the reliability, efficiency, and cost effectiveness of their power distribution systems and the energy generated or consumed.

A good understanding of the different kinds of measurement applications is critical to choosing the proper type and capabilities of measuring devices for each location that will deliver the required information.

To achieve these goals, a complete energy measurement plan supported by a network of metering devices.

This report offers an overview of the different categories of measurement applications, with detailed descriptions and illustrations of each, including references to the most relevant international standards.

# POWER MEASUREMENT APPLICATIONS WITHIN ELECTRICAL DISTRIBUTION NETWORKS AND ELECTRICAL INSTALLATIONS MEASUREMENT APPLICATIONS WITHIN ELECTRICAL

## 1 Scope

This Technical Report intends to provide state-of-the-art information on the various electricity measurement applications made in the grid (supply side) or in electrical installation (demand side), and on the related standards covering these applications.

This Technical Report does not address measurements made for specific purposes such as protection, control, automation or indication.

## 2 Normative references

There are no normative references in this document.

## 3 Terms, definitions and notations

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1 Measurement definitions

#### 3.1.1

#### **power quality instrument**

#### **PQI**

instrument whose main function is to measure, record and possibly monitor power quality parameters in power supply systems, and whose measuring methods (class A or class S) are defined in IEC 61000-4-30

[SOURCE: IEC 62586-1:2017, 3.1.1]

#### 3.1.2

#### **power quality assessment function**

power quality functions whose measurement methods are defined in IEC 61000-4-30

[SOURCE: IEC 61557-12:2018, 3.1.2]

#### 3.1.3

#### **energy meter**

instrument intended to measure electrical energy by integrating power with respect to time

[SOURCE: IEC 60050-313:2001, 313-01-35]

#### **3.1.4**

##### **watt-hour meter**

##### **active energy meter**

##### **energy meter**

instrument intended to measure active energy by integrating active power with respect to time

[SOURCE: IEC 60050-313:2001, 313-06-01, modified – The term "(active) energy meter" has been changed to "active energy meter" and the term "energy meter" has been added to comply with the ISO/IEC Directives Part 2:2018]

#### **3.1.5**

##### **var-hour meter**

##### **reactive energy meter**

instrument intended to measure reactive energy by integrating reactive power with respect to time

[SOURCE: IEC 60050-313:2001, 313-06-02]

#### **3.1.6**

##### **power metering and monitoring device**

##### **PMD**

combination in one or more devices of several functional modules dedicated to metering and monitoring electrical parameters in energy distribution systems or electrical installations, used for applications such as energy efficiency, power monitoring and network performance

Note 1 to entry: Under the generic term "monitoring" are also included functions of recording, alarm management, etc.

Note 2 to entry: These devices may include demand side quality functions for monitoring inside commercial/industrial installations.

[SOURCE: IEC 61557-12:2018, 3.1.1, modified – Note 3 to entry has been deleted.]

#### **3.1.7**

##### **revenue meter**

##### **utility meter**

##### **billing meter**

##### **electricity meters for billing**

energy meter used to meter energy delivered by an energy supplier and to calculate the related amount of money according to an agreed contract, defining the rate(s) and the time of use

Note 1 to entry: These devices are used to bill or invoice final customers.

#### **3.1.8**

##### **rate**

amount to be paid per unit purchased (e.g. 1 kWh, 1 kW, 1 kVA)

[SOURCE: IEC 60050-691:1973, 691-11-21]

#### **3.1.9**

##### **time of use**

segregation of energy rates based on the time in which the energy is being consumed

#### **3.1.10**

##### **meter index**

non-resettable numerical value representing the total energy measured by the meter



### 3.2 Measurement applications

#### 3.2.1

##### **grid power quality assessment**

process that allows energy suppliers and/or their customers to verify that the quality of energy delivered/received fulfils requirements of a defined contract or regulation

Note 1 to entry: Limits for European public networks are defined in EN 50160.

#### 3.2.2

##### **power monitoring**

process that allows a facility manager to monitor its electrical installation in order to ensure availability and reliability of energy as well as durability of electrical equipment.

#### 3.2.3

##### **energy management**

process that allows a facility manager to monitor and control the energy consumption according to the uses and the cost of energy within an electrical installation

#### 3.2.4

##### **billing**

process that allows energy suppliers or their representatives to invoice their customers according to a defined contract

Note 1 to entry: These applications can be covered by international standards, regulations such as MID in Europe or NMI in Australia, and/or utility specifications.

#### 3.2.5

##### **sub-billing**

process that allows a landlord, property management firm, condominium association, homeowner association or other multi-tenant property to spread out invoice over energy users (assign portions of invoice to users), for measured usages or services.

Note 1 to entry: This fee is usually combined with other tenant's facility fees.

Note 2 to entry: The landlord does not commit on the quality of the supply.

#### 3.2.6

##### **cost allocation**

process that allows a facility manager to account for energy costs from internal cost centres that consume energy

EXAMPLE: process line, test and inspection, administration.

#### 3.2.7

##### **calculation of tax incentives**

process that allows an owner to get incentives from the state, based on measurements showing improvement in energy efficiency, according to a regulation

### 3.3 Grid definitions

#### 3.3.1

##### **electric power system**

##### **electricity supply system**

all installations and plant provided for the purpose of generating, transmitting and distributing electricity

[SOURCE: IEC 60050-601:1985, 601-01-01, modified – The term "electricity supply system (in a broad sense)" has been changed to "electricity supply system" in order to comply with the ISO/IEC Directives Part 2:2018.]

### 3.3.2

#### **generation of electricity**

process whereby electrical energy is obtained from some other form of energy

[SOURCE: IEC 60050-601:1985, 601-01-06]

### 3.3.3

#### **distribution of electricity**

transfer of electricity to consumers within an area of consumption

[SOURCE: IEC 60050-601:1985, 601-01-10]

### 3.3.4

#### **power station**

#### **electrical generating station**

installation whose purpose is to generate electricity, and which includes civil engineering works, energy conversion equipment and all the necessary ancillary equipment

[SOURCE: IEC 60050-601:1985, 601-03-01]

### 3.3.5

#### **substation**

<of a power system> part of an electrical system, confined to a given area, mainly including ends of transmission or distribution lines, electrical switchgear and control gear, buildings and transformers

Note 1 to entry: The substation can be qualified according to the designation of the system of which it forms a part. Examples: transmission, substation (transmission system), distribution substation, 400 kV or 20 kV substation.

Note 2 to entry: A substation generally includes safety or control devices (for example, protection).

[SOURCE: IEC 60050-601:1985, 601-03-02, modified – In order to comply with the ISO/IEC Directives Part 2:2018, "(of a power system)" has been deleted from the term and added as a domain, and the last sentence of the definition has been moved to Note 2 to entry.]

### 3.3.6

#### **supply side**

part of the grid where electric energy is generated, transmitted and distributed to end-use customers through the public supply network

Note 1 to entry: This definition encompasses micro-grids, decentralised generators or renewable energy generators.

Note 2 to entry: This definition encompasses the electric power system defined in IEC 60050-601:1985, 601-01-01.

[SOURCE: IEC 61557-12:2018, 3.1.3, modified – Note 2 to entry has been added.]

### 3.3.7

#### **demand side**

part of the grid where electric energy is consumed by end-use customers within their electric distribution system

Note 1 to entry: This concept also encompasses prosumers.

[SOURCE: IEC 61557-12:2018, 3.1.4, modified – Note 1 to entry has been added.]

**3.3.8****power quality**

characteristics of the electric current, voltage and frequencies at a given point in an electric power system, evaluated against a set of reference technical parameters

Note 1 to entry: These parameters might, in some cases, relate to the compatibility between electricity supplied in an electric power system and the loads connected to that electric power system

[SOURCE: IEC 60050-617:2009, 617-01-05]

**3.4 Stakeholder definitions****3.4.1****electricity supplier****supplier****energy supplier**

party having a contract to supply electric power and energy to a customer

[SOURCE: IEC 60050-617:2009, 617-02-08, modified – The term "energy supplier" has been added.]

**3.4.2****final customer****end-use customer**

party purchasing electric power for a given interval and energy for its own use

[SOURCE: IEC 60050-617:2009,617-02-04]

**3.4.3****wholesale customer****wholesaler**

party purchasing electric power for a given interval and energy for the purpose of their sale inside or outside the electric power system to which the party is connected

[SOURCE: IEC 60050-617:2009, 617-02-03]

**3.4.4****owner****landlord**

consumer that owns a property

Note 1 to entry: Property management firms, condominium associations, homeowner associations or multi-tenant properties are considered to be owners.

**3.4.5****tenant**

consumer that rents a property from an owner or a landlord

**3.4.6****final energy user**

user of energy-consuming assets located in individual units of multi-apartment or multi-purpose buildings, where such units are supplied from a central source, and where energy is not purchased, but inclusive or reimbursed

Note 1 to entry: Examples of final energy users are:

- service users, where energy cost is usually included in the service itself, e.g. hotel customers;

- mall shops, where energy cost is usually included in reimbursement fees, in the framework of a flat rate pricing contract, based on steady figures such as surfaces or volumes;
- colocation data centres, where energy cost is usually included in reimbursement fees, in the framework of a sub-metering pricing contract.

**3.4.7****facility manager**

party that operates, maintains and secures a facility or a plant

**3.4.8****cost centre**

defined department, division, or unit of an organization, or alternatively area, machine, or person to whom direct and indirect costs can be allocated

**3.4.9****contract**

document agreed between two or more parties and committing both parties

**3.4.10****commercial transaction****trading transaction**

interaction between two or more parties in which goods, services or something of value is exchanged for some type of remuneration, resulting in the issuance of an invoice

Note 1 to entry: A transaction that consists in dividing an invoice between parties without any profit is not considered as a commercial transaction.

**3.4.11****incentive**

inducement or supplemental reward that serves as a motivational means for a desired action or behaviour

**3.4.12****dispute**

disagreement followed by opposition against something

**3.4.13****invoice****bill**

non-negotiable commercial instrument issued by a seller to a buyer that identifies both the trading parties and defines the items sold, shows the date of shipment and mode of transport, prices and discounts (if any), and delivery and payment terms

**3.4.14****reimbursement fee**

portion of an invoice in contracts based on cost reimbursement pricing

Note 1 to entry: In sub-metering pricing contracts, the portion is calculated according to metered figures, e.g. a measured consumption of electrical energy.

Note 2 to entry: In flat rate pricing contracts, the portion is calculated according to steady figures, e.g. a shop surface.

Note 3 to entry: Each invoice (related to electricity, gas water, cleaning, services, etc.) can be spread out between final energy users. The sum of each fee results into "fees".

**3.4.15****prosumer**

network user that consumes and produces electrical energy

[SOURCE: IEC 60050-617:2009,617-02-16]

**3.5 Notations**

**3.5.1 Abbreviated terms**

- N.R. Not requested
- N.A. Not applicable

**3.5.2 Indices**

- min minimum value
- max maximum value

**4 State-of-the-art measurement applications**

**4.1 General**

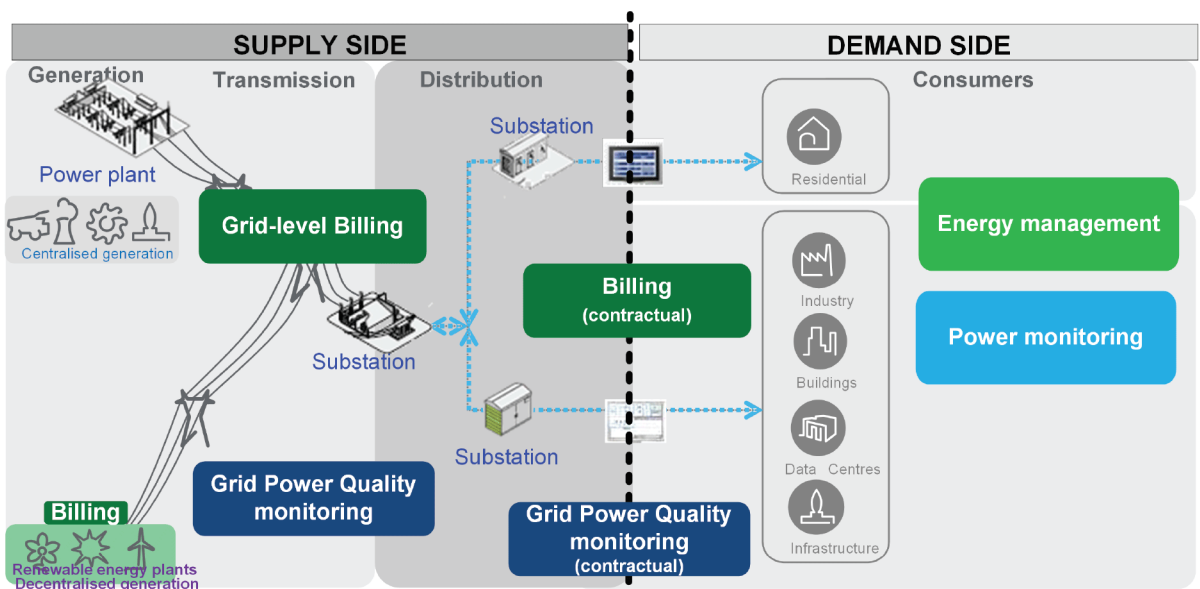
Power generation, transmission, and distribution are typically terms of the "supply side". Within this side, there are two main categories of contractual applications:

- BIL: billing application
- GPQ: grid power quality monitoring application

Industrial, commercial, and institutional facilities represent the demand side of energy. For these users, electrical system designers shall specify solutions within two categories of application:

- EM: energy management applications (cost allocation, bill checking, sub-billing, energy efficiency and cost savings, energy usage analysis).
- PM: power monitoring (power availability and reliability, network monitoring).

These categories of application are illustrated in Figure 1:



IEC

**Figure 1 – Measurement applications within the grid**

Table 1 provides a definition of the main applications.

**Table 1 – List of main applications**

Type	Application	Purpose	Stakeholder
GPQ	Grid power quality monitoring	to verify the quality of energy delivered/received fulfils requirements of a defined contract or regulation.  For example, limits for European public networks are defined in EN 50160.	Energy suppliers and/or their customers
PM	Power monitoring, network monitoring, facility planning.	to monitor its electrical installation in order to ensure availability and reliability of energy as well as durability of electrical equipment.	Facility manager
BILL	Billing	to invoice customers according to a defined contract regarding their energy consumption, for measured usage or services.  These applications can for example be covered by international standards or covered by regulations such as MID in Europe or NMI in Australia most often in addition to utility specifications.	Energy suppliers or their representatives
EM	Energy management	to monitor and control the energy consumption according to the uses and the cost of energy within an electrical installation.	Facility managers

## 4.2 Grid power quality

### 4.2.1 General

According to relevant standards (see Table 2), class A power quality measurements are suitable for contractual applications that can require resolving disputes and verifying compliance with standards.

Class S power quality measurements are used for statistical applications such as surveys or power quality assessment.

### 4.2.2 State of the art on measurement to perform

The class of power quality measurements should be selected based on the applicable regulations, assessment rules, and the scope of the survey.

### 4.2.3 State of the art on standards

Table 2 specifies the state of the art related to standards.

Table 2 – Standards for grid power quality application

Application assessment standards or rules	Method standards	Usual product standards
<p><b>EN 50160</b> Voltage characteristics of electricity supplied by public electricity networks</p> <p><b>IEC/TS 62749</b> Assessment of power quality – Characteristics of electricity supplied by public electricity networks</p>	<p><b>IEC 61000-4-30<sup>(a)</sup> (c) class A</b></p> <p>Testing and measuring techniques – Power quality measurement methods</p>	<p><b>Power quality instruments (PQI)<sup>(b)</sup></b></p> <p><b>IEC 62586-1</b> Power quality instruments (PQI)</p> <p>+</p> <p><b>IEC 62586-2<sup>(a)</sup></b> Functional tests and uncertainty requirements</p>
<p>(a) Compliance with IEC 62586-2 means compliance with IEC 61000-4-30</p> <p>(b) Usually, energy providers are checking the power quality they deliver to users with a PQI-A, and energy users are checking the power quality they receive from energy providers with a PQI-A.</p> <p>(c) IEC 61000-4-30 provides the following definitions:</p> <p>Class A: this class is used where precise measurements are necessary, for example, for contractual applications that may require resolving disputes, verifying compliance with standards, etc. Any measurements of a parameter carried out with two different instruments complying with the requirements of Class A, when measuring the same signals, will produce matching results within the specified uncertainty for that parameter.</p> <p>Class S: this class is used for statistical applications such as surveys or power quality assessment, possibly with a limited subset of parameters. Although it uses equivalent intervals of measurement as Class A, the Class S processing requirements are much lower. Some surveys may assess power quality parameters of several measurement sites on a network; other surveys assess power quality parameters at a single site over a period of time, or at locations within a building or even within a single large piece of equipment.</p>		

### 4.3 Power monitoring application

#### 4.3.1 General

Information about the difference between PMDs (compliant with IEC 61557-12 measurement methods) and PQIs (compliant with IEC 62586-1 and 62586-2 and based on IEC 61000-4-30 measurement methods) is provided in Annex B.

#### 4.3.2 Power monitoring application, general

##### 4.3.2.1 General

Power monitoring is recommended to prevent unwanted outages, premature failures of electrical equipment and other abnormal operation of the electrical installation. It is also a tool to improve and to optimize the electrical installation.

##### 4.3.2.2 State of the art on measurements to perform

Table 3 specifies the state of the art related to measurements.

Table 3 – Benefits of measurements for power monitoring application

Electrical quantities to measure	Symbol	Benefits of measurement
Current	$I, I_N$	Detect overheating or conditions that may lead to nuisance trips.
Voltage	$U, V$	Detect abnormal supply conditions of sensitive loads (e.g. motors) leading to premature failure.
Frequency	$f$	Detect abnormal speed of rotating machines.
Individual voltage harmonics, $THD_u$	$U_h, THD_u$	Monitor non-positive-sequence harmonics causing overheating of components (motors, transformers, cables, capacitors...), and motor shaft vibrations, resulting in premature failure.
Individual current harmonics, $THD_i$	$I_h, THD_i$	
Voltage unbalance	$U_{nb}$	Monitor non-positive-sequence voltage causing motors and generators to overheat and fail prematurely.
Current unbalance	$I_{nb}$	
Voltage dips, voltage interruptions Voltage swells	$U_{dip}, U_{int}$ $U_{swl}$	Detect degradation of supply quality before it leads to process stoppages with financial impact.
Power demand or Current demand	$P$	Optimize the load distribution, determine where new loads may be placed, or which feeder needs to be upgraded to serve the planned capacity.
Load profiles	$LP$	Detect abnormal load profiles
Reactive power	$Q$	Detect abnormal reactive power consumption
Apparent power	$S$	Detect abnormal apparent power consumption
NOTE In general, it is useful to detect drifts, to log measurements and possibly to alarm if a measurement is out of some specified limits.		

#### 4.3.2.3 State of the art on standards

Table 4 specifies the state of the art related to standards.

Table 4 – Standards for power monitoring application

Application assessment standards or rules	Method standards	Usual product standards
Electrical distribution monitoring, asset management, facility planning	included in IEC 61557-12	<b><u>PMD (Power Metering and Monitoring Devices)</u></b> IEC 61557-12 Power metering and monitoring devices (PMD)
	included in IEC 60051 series	<b><u>Analog electrical measuring instruments</u></b> IEC 60051 series Direct acting indicating analogue electrical measuring instruments

#### 4.3.3 Power monitoring application, demand side power quality

##### 4.3.3.1 General

Demand side power quality relates to power quality events appearing inside consumer electrical distribution network (see Figure 1), downstream from the utility service entrance.



#### 4.3.3.2 State of the art on measurement to perform

Measurements to perform depend on the kind of plant or network to assess.

#### 4.3.3.3 State of the art on standards

Table 5 specifies the state of the art related to standards.

**Table 5 – Standards for demand side power quality application**

Application assessment standards or rules	Method standards	Usual product standards
<b>IEC TR 63191</b> Demand side power quality	included in IEC 61557-12	<b><u>PMD (Power Metering and Monitoring Devices)</u></b> <b>IEC 61557-12</b> Power Metering and Monitoring devices (PMD)
	<b>IEC 61000-4-30</b> <sup>(a)</sup> class S or class A Testing and measuring techniques – Power quality measurement methods	<b><u>Power quality instruments (PQI-S<sup>(b)</sup> or PQI-A)</u></b> <b>IEC 62586-1</b> Power quality instruments (PQI) + <b>IEC 62586-2<sup>(a)</sup></b> Functional tests and uncertainty requirements
<sup>(a)</sup> Compliance with IEC 62586-2 means compliance with IEC 61000-4-30. <sup>(b)</sup> Usually PQI-S are used for this purpose.		

## 4.4 Billing application

### 4.4.1 General

Legal metrology requirements usually cover billing applications, to ensure a fair trading, by:

- protecting consumers:
  - preventing consumers from being over-invoiced;
  - give consumers a way to verify that the invoice index is consistent with the meter index displayed on the meter.
- protecting energy suppliers against unintentional misuses or fraudulent uses of the meter, usually installed in customer premises.

Table 6 shows a simplified overview of the billing application.

Table 6 – Simplified overview of billing application

Application	Interaction between:		2nd party needs to access the energy index displayed on the meter operating in his premises?	Transaction	
	1 <sup>st</sup> party	2 <sup>nd</sup> party		Profit on kWh price	Money exchange mean
Billing	Energy supplier <sup>a</sup>	Final customer	Yes, in order to let the 2 <sup>nd</sup> party verify his invoice in comparison with the meter index	Yes <sup>b</sup>	Invoice (commercial transaction, including state taxes, e.g. VAT)
<p><sup>a</sup> Billing is also covering the case of energy resale (e.g. through a wholesaler)</p> <p><sup>b</sup> Profit is usually made on the kWh price (this rate can be different for each time of use).</p> <p>NOTE Billing is part of legal metrology applications, these applications usually require a meter that is approved by an accredited test laboratory, and/or a government legal metrology agency.</p>					

#### 4.4.2 State of the art on measurement to perform

Table 7 specifies the state of the art related to measurements.

Table 7 – Benefits of measurements for billing application

Electrical quantities to measure	Symbol	Benefits of measurement
Active energy	$E_a$	Calculate energy consumption per time of use.
Reactive energy	$E_r$	Calculate energy consumption per time of use.
Demand active power	$P_{demand}$	Calculate the active power demand
<p>NOTE 1 There can be other electrical billing quantities such as demand, cos phi, PF, THD, etc. used for direct billing or penalties, especially where a contract with a utility is involved.</p> <p>NOTE 2 There can be billing based on quadrant measurements.</p>		

#### 4.4.3 State of the art on standards

Table 8 specifies the state of the art related to standards.

Table 8 – Standards for billing application

Application assessment standards or rules or regulation	Methods standards	Usual product standards for revenue meter, utility meter, billing meter, billing electricity meters
Any countries can define its own regulation and/or can refer to international standards.	---	IEC 62052-11 and IEC 62053-2x
European regulation (MID Measuring Instruments Directive)	---	EN 50470
US state regulations	---	ANSI C12
Australian regulation	---	NMI M 6
NOTE This list of standards is far from being exhaustive		

## 4.5 Energy management application

### 4.5.1 General

The main applications for energy management concern the management of energy costs and the optimization of electrical consumptions. PMD complying with IEC 61557-12 are recommended for energy management applications owing to additional useful embedded features. PMDs are able to operate in harsh environmental conditions (especially those of switchboards, panels and cubicles).

### 4.5.2 Energy management application, cost management

#### 4.5.2.1 General

Table 9 shows a simplified overview of EM/cost management application.

**Table 9 – Simplified overview of EM/cost management application**

Application	Interaction between:		2nd party needs to access the energy index displayed on the meter operating in his premises?	Transaction	
	1 <sup>st</sup> party	2 <sup>nd</sup> party		Profit on kWh price	Money exchange mean
Cost allocation	Final customer	Cost centre managed by the final customer	No, the meter is usually installed in the 1 <sup>st</sup> party premises <sup>a</sup>	No	No money exchange
Sub-billing	Final customer	Final energy user	No, the meter is usually installed in the 1 <sup>st</sup> party premises <sup>a b</sup>	No <sup>b</sup>	Fee (combined with other fees)
<p><sup>a</sup> When the meter is located within a switchboard, a panel or a cubicle, usually the meter display cannot be accessed for safety reasons, except by the facility manager. The meter index is then transmitted to a remote system via a communication line.</p> <p><sup>b</sup> In case of profit on kWh price, the first party would become a wholesaler, it would then not be a sub-billing application anymore.</p>					

An example of sub-billing application is provided in Annex A.

#### 4.5.2.2 State of the art on measurement to perform

Table 10 specifies the benefits of measurements for EM/cost management application.

**Table 10 – Benefits of measurements for EM/cost management application**

Electrical quantities to measure	Symbol	Benefits of measurement
Active energy	$E_a$	Calculate energy consumption per time of use.
Reactive energy	$E_r$	Calculate energy consumption per time of use.
Apparent energy	$E_{ap}$	Calculate energy consumption per time of use.
Power, power demand	$P$	Better control the demand in order to optimize the supply contract.
Power factor	$PF, \cos\phi$	Optimize power factor to avoid penalties.

NOTE These measurements are usually performed in combination with other applications, e.g. power monitoring or energy efficiency.

#### 4.5.2.3 State of the art on standards

Legal metrology requirements usually apply to billing applications (see 4.4) for the measurement of active energy, in the framework of a commercial transaction between an energy supplier and a final consumer.

For other applications, PMDs complying with IEC 61557-12 are recommended.

In some countries, IEC 62053-2x may be also be recommended even though this set of standards specifies requirement only for active and reactive energy measurement. IEC 61557-12 provides requirements for all electrical measurements (U, I, P, PF, THD...).

Annex C and Annex D provide information about IEC 61557-12 and IEC 62053-2x standards.

#### 4.5.3 Energy management application, energy efficiency

##### 4.5.3.1 General

Energy efficiency management concerns the optimization of electrical consumptions, one goal being the reduction of the global electrical energy cost.

##### 4.5.3.2 State of the art on measurement to perform

Table 11 specifies the benefits of measurements.

**Table 11 – Benefits of measurements for EM/energy efficiency application**

Electrical quantities to measure	Symbol	Benefits of measurement
Active energy	$E_a$	Monitor energy and manage costs more closely, by zone and/or usage.
Reactive energy	$E_r$	Monitor energy and manage costs more closely, by zone and/or usage. Monitor the operation of reactive loads e.g. motors, transformers, capacitors.
Power, power demand	$P$	Better control the demand in order to optimize the supply contract.
Power factor	$PF, \cos\phi$	Optimize power factor to avoid penalties.
Load profiles (energy consumption)	$LP$	Optimize the supply contract
NOTE One intent of energy efficiency is to optimize the supply contract and to avoid penalties.		

In the framework of an industrial process, other factors part of power monitoring can contribute to the EE assessment, see IEC 60364-8-1. Table 12 specifies the benefits of measurements.

**Table 12 – Benefits of measurements for EM/energy efficiency application in industrial processes**

Electrical quantities to measure	Symbol	Benefits of measurement
Voltage harmonics	$THD_u$	Detect non-positive-sequence harmonics causing excessive energy losses in motors or transformers.
Current harmonics	$THD_i$	
Frequent deviations of voltage	$U$	Detect devices frequently operating outside their specified range and over consuming energy.
Voltage unbalance	$U_{nb}$	Detect non-positive-sequence components causing excessive energy losses in motors.

#### 4.5.3.3 State of the art on standards

Table 13 specifies the state of the art related to standards.

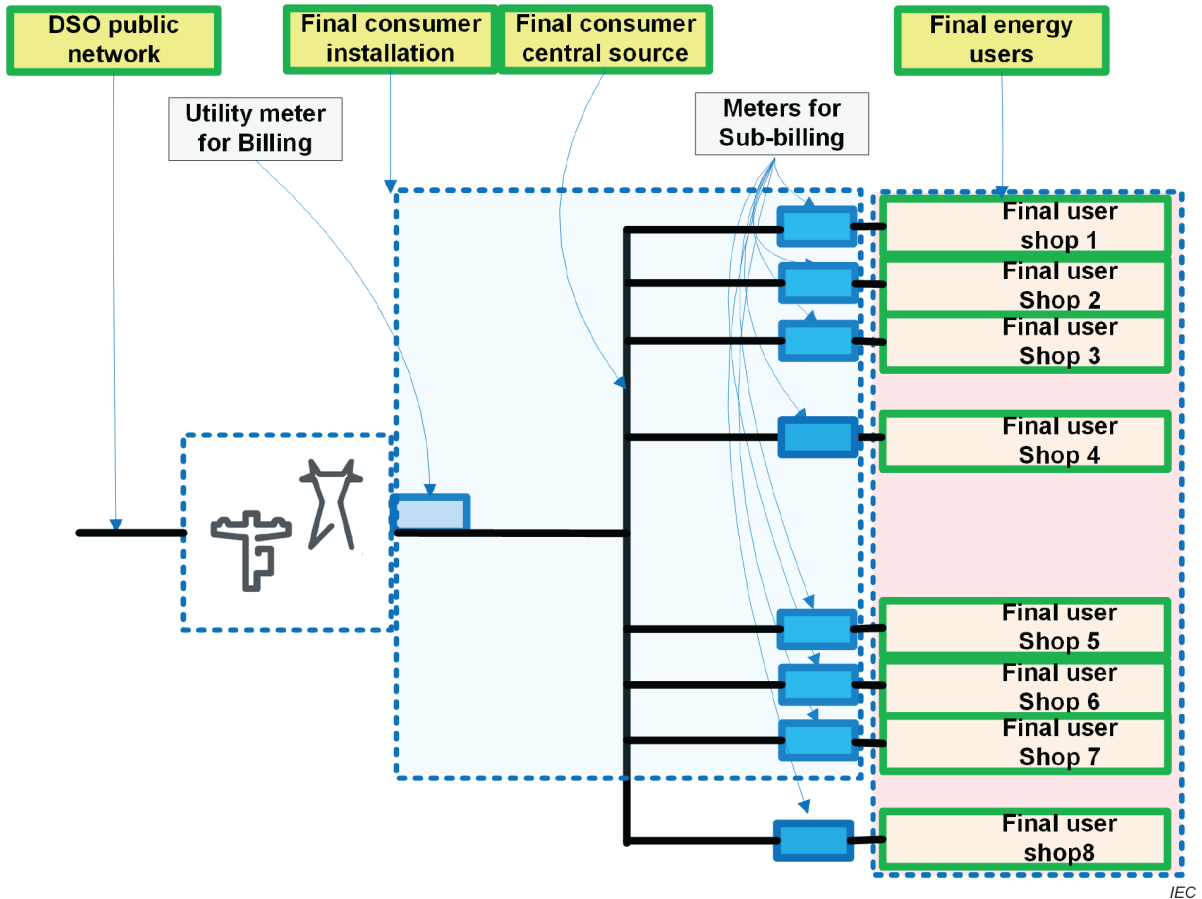
**Table 13 – Standards for EM/energy efficiency application**

Methodology standards or Rules (for an organisation, e.g. a plant, commercial building, ...)	Application standards (applicable to a plant, commercial building, ...)	Usual product standards
<b>ISO 50001</b> Energy management systems – Requirements with guidance for use  <b>Green labels for buildings</b> (LEED, BREEAM, HQE, E+C-, DGNB, Passivhaus, Title24, Minergie, ...)	<b>ISO 50006</b> Energy Baseline (EnBs) & Energy Performance Indicators (EnPIs)  <b>IEC 60364-8-1</b> Low voltage installations – Part 8-1: Energy Efficiency  <b>EN 17267</b> Energy measurement and monitoring plan: Design and implementation  <b>EN 50600-2-2</b> Information technology – Data centre facilities and infrastructures – Part 2-2: Power distribution	<b><u>PMD (Power Metering and Monitoring Devices)</u></b> <b>IEC 61557-12</b> Power metering and monitoring devices (PMD)  <b><u>Gateways, energy servers, data loggers</u></b> <b>IEC 62974-1</b> Monitoring and measuring systems used for data collection, gathering and analysis – Part 1: Device requirements
NOTE Energy efficiency and cost savings, energy usage analysis is the process that allows a facility manager to assign energy consumption/costs to zones (plant, floor, workshop...) and to usages (HVAC, lighting, appliances, process...) over the time in order to allow optimization of energy consumption and energy costs.		

**Annex A**  
(informative)

**Example of electrical installation for a mall**

Figure A.1 provide examples of distribution systems within a mall with shops.



**Figure A.1 – Example of shops within a mall, where all shops are final energy users**

## Annex B (informative)

### Explanation about measurements performed by PQIs (IEC 62586), PMDs (IEC 61557-12) and analogue meters (IEC 60051 series)

#### B.1 General

For a simple parameter such as voltage, 2 different meters can provide 2 different measurement results, depending on the measurement method used by the meter:

- the measurement time (e.g. is measurement resulting from a 20 ms sampling time period, or from a 1 s sampling time period?);
- the measurement method (e.g. is THD based on an arithmetic measurement or on a vector measurement?).

Measurement may be identical in steady-state conditions, but it may happen to be drastically different in other conditions. The below study aims at specifying the main differences between devices.

#### B.2 Differences

Table B.1 provides a rough comparison of devices with power measurement functions.

**Table B.1 – Rough comparison between devices**

Criteria for comparison	Product standards			
	PQI-A acc to IEC 62586-1	PQI-S acc to IEC 62586-1	PMD acc to IEC 61557-12	Analog meters acc to IEC 60051 series
Device price	++++	+++	++	+
Repeatability	2 instruments will provide comparable results <sup>a</sup>	2 instruments will provide similar results <sup>b</sup>	2 instruments will provide similar results for steady states <sup>c</sup>	2 instruments will provide similar visual results for steady states <sup>d</sup>
Accuracy	As specified in IEC 61000-4-30 class A	As specified in IEC 61000-4-30 class S	As designed among the list of classes defined in IEC 61557-12	As designed among the list of classes defined in IEC 60051 series
Grid power quality assessment (EN 50160, IEC/TS 62479, ...)	Mandatory in contractual applications	---	---	---
Grid power Quality survey	Possible	Best compromise between cost and functions	---	---
Demand side power quality	Possible	Best compromise between cost and functions	Possible	---
Power monitoring or problem identification	Possible	Possible	Best compromise between cost and functions	Possible
Troubleshooting	Best compromise between cost and functions	Possible	Possible	---

NOTE 1 Class A measurement methods are all fully specified

NOTE 2 Class S measurement methods are for the most fully specified, but some parts depend on manufacturer implementations.

NOTE 3 IEC 61557-12 measurement methods are, for the most, well specified, but some parts depend on manufacturer implementations

NOTE 4 IEC 60051 series measurement methods are, for the most, roughly specified

### **B.3 Differences between power quality, power monitoring and troubleshooting**

#### **B.3.1 General**

Power quality usually refers to parameters measured for contractual or regulatory reasons, while power monitoring usually refers to supervising some key measured parameters, and while trouble shooting usually refers to solving issues.

#### **B.3.2 Power quality**

Power quality is usually related to parameters that are measured for regulatory conformity (EN 50160, ...) or measured for contractual conformity (contracts between an energy provider and a final consumer).

But power quality tends to address also wider applications, e.g. the demand side power quality.

#### **B.3.3 Power monitoring**

Power monitoring is usually related to supervising energy distribution systems or electrical installations in progress to ensure they are on-course and on-schedule in meeting the objectives and performance targets. Under the generic term "monitoring" are also included functions of recording, alarm management, etc.

#### **B.3.4 Troubleshooting**

Troubleshooting is a form of problem solving, often applied to repair failed products or processes on a machine or a system. It is a logical, systematic search for the source of a problem in order to solve it and make the product or process operational again. Troubleshooting is needed to identify the symptoms. Determining the most likely cause is a process of elimination – eliminating potential causes of a problem. Finally, troubleshooting requires confirmation that the solution restores the product or process to its working state.

In general, troubleshooting is the identification or diagnosis of "trouble" in the management flow of a corporation or a system caused by a failure of some kind. The problem is initially described as symptoms of malfunction, and troubleshooting is the process of determining and remedying the causes of these symptoms.

A system can be described in terms of its expected, desired or intended behaviour (usually, for artificial systems, its purpose). Events or inputs to the system are expected to generate specific results or outputs (for example, selecting the "print" option from various computer applications is intended to result in a hardcopy emerging from some specific device). Any unexpected or undesirable behaviour is a symptom. Troubleshooting is the process of isolating the specific cause or causes of the symptom. Frequently, the symptom is a failure of the product or process to produce any results (nothing was printed, for example). Corrective action can then be taken to prevent further failures of a similar kind.

The methods of forensic engineering are especially useful in tracing problems in products or processes, and a wide range of analytical techniques are available to determine the cause or causes of specific failures. Corrective action can then be taken to prevent further failure of a similar kind. Preventative action is possible using failure mode and effects (FMEA) and fault tree analysis (FTA) before full-scale production, and these methods can also be used for failure analysis.



**B.4 Key parameters measured**

Table B.2 provides a rough list of key parameters to measure for every kind of application.

**Table B.2 – Measurement needs**

Electrical quantities to measure	Symbol	Power quality needs	Power monitoring needs	Troubleshooting needs
Current	$I, IN$		x	x
Voltage	$U, V$	x	x	x
Frequency	$f$	x	x	x
Individual voltage harmonics, $THD$	$U_h, THD_u$	x	x	x
Individual current harmonics	$I_h, THD_i$	x	x	x
Voltage unbalance	$U_{nb}$	x	x	x
Current unbalance	$I_{nb}$	x	x	x
Voltage dips, voltage interruptions	$U_{dip}, U_{int}$	x		x
Voltage swells	$U_{swl}$			
Power demand or current demand	$P$		x	x
Load profiles	$LP$		x	
Reactive power	$Q$		x	
Apparent power	$S$		x	

**Annex C**  
(informative)

**Explanation about measurements performed  
by PMD (IEC 61557-12), IEC 62053-2x, MID**

Several measurement features are available, and Table C.1 provides a rough comparison:

**Table C.1 – Rough comparison of energy measurement standards**

Criteria of comparison	Product standards			
	EN 50470 (related to MID)	IEC 62053-2x	IEC 61557-12	IEC 60051 series
Measurements (see Annex D)	Active energy	Active and reactive energy	Energies, powers, power factor, voltage, dips, swells, current, harmonic distortion, unbalance, frequency, ...	Single measurement by device (powers, voltage, currents, frequency, ...)
Accuracy	According to performance or accuracy classes			
Anti-tampering	++++	Partially specified	Not specified	Not specified
Display on the device	yes	Not specified	Not specified	Needle or pointer
Third party certification	Yes, via a notified body	Not specified	Not specified	Not specified
Billing application	Mandatory in Europe	Recommended	---	---
Sub-billing application	Case-by-case approach			---
Cost allocation application	Possible	Possible	Best compromise between cost and functions	Possible
Energy efficiency application	Possible if only energy is at stake	Possible if only energy is at stake	Best compromise between cost and functions	---

**Annex D**  
(informative)

**Explanation about the scope of various standards**

Standards are not specifying the same measurement parameters, and Table D.1 provides a rough comparison.

**Table D.1 – Rough comparison of measurement parameters**

	IEC 61557-12	IEC 62053-2x	IEC 60051 series	IEC 62586-1
Active energy	x	x		
Active power	x		x	
Reactive energy	x	x		
Reactive power	x		x	
Apparent energy	x			
Apparent power	x		x	
Frequency	x		x	x
Phase current	x		x	x
Measured neutral current	x		x	
Calculated neutral current	x			
Voltage	x		x	x
Power factor	x		x	
Flicker	x			x
Dips and swells measurement	x			x
Voltage interruption	x			x
Voltage unbalance	x			x
Voltage harmonics	x			x
Voltage <i>THD</i>	x			
Current unbalance	x			x
Current harmonics	x			x
Current <i>THD</i>	x			

## Bibliography

- IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*
- IEC 60364-8-1:2014, *Low-voltage electrical installations – Part 8-1: Energy efficiency*
- IEC 61000-4-30:2015, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*
- IEC 61557-12:2018, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)*
- IEC 62052-11:2003, *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment*
- IEC 62053 (all parts), *Electricity metering equipment (a.c.) – Particular requirements*
- IEC 62586-1:2017, *Power quality measurement in power supply systems – Part 1: Power quality Instruments (PQI)*
- IEC 62586-2, *Power quality measurement in power supply systems – Part 2: Functional tests and uncertainty requirements*
- IEC TS 62749, *Assessment of power quality – Characteristics of electricity supplied by public networks*
- IEC 62974-1, *Monitoring and measuring systems used for data collection, gathering and analysis – Part 1: Device requirements*
- IEC TR 63191, *Demand Side Power Quality Management*
- ISO 50001, *Energy management systems – Requirements with guidance for use*
- ISO 50006, *Energy management systems – Measuring energy performance using energy baseline (EnB) and energy performance indicators (EnPI) – General principles and guidance*
- ANSI C12 (all parts), *American National Standard for Electricity Meters*
- OIML, *Organisation Internationale de la Métrologie Légale*
- OIML R46-1/-2:2012, *Active electrical energy meters – Part 1: Metrological and technical requirements Part 2: Metrological controls and performance tests*
- NMI M 6 (all parts), *Electricity Meters*
- EN 17267, *Energy measurement monitoring plan: Design and implementation.*
- EN 50160, *Voltage characteristics of electricity supplied by public electricity networks*
- EN 50470 (all parts), *Electricity metering equipment (a.c.)*
- EN 50600-2-2, *Information technology – Data centre facilities and infrastructures – Part 2-2: Power distribution*