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| INTERNATIONAL TELECOMMUNICATION UNION | **Focus Group onSmart Grid** |
| **TELECOMMUNICATIONSTANDARDIZATION SECTOR**STUDY PERIOD 2009-2012 | **Smart-O-30Rev.6** |
| **English only****Original: English** |
| **WG(s):** | ALL | Geneva, 18-21 December 2011 |
| **OUTPUT DOCUMENT** |
| **Source:** | Editors |
| **Title:** | Deliverable on Smart Grid Terminology |

FG-Smart Deliverable

**Terminology**

# Summary

This Deliverable collects the key terms which are closely related with grid and appeared in the deliverables on Overview, Use Cases, Requirements and Architecture. The corresponding definitions of these key terms are also provided in this deliverable.

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**Table of Contents**

[1 Scope 6](#_Toc312257616)

[2 References 6](#_Toc312257617)

[3 Definitions 6](#_Toc312257618)

[3.1 Access Network 6](#_Toc312257619)

[3.2 Actor 6](#_Toc312257620)

[3.3 Advanced Energy Service 6](#_Toc312257621)

[3.4 Advanced Metering Infrastructure (AMI) 6](#_Toc312257622)

[3.5 Aggregator 7](#_Toc312257623)

[3.6 Architecture 7](#_Toc312257624)

[3.7 Asset Management 7](#_Toc312257625)

[3.8 Automatic Voltage Regulator (AVR) 7](#_Toc312257627)

[3.9 Battery Management System（BMS） 7](#_Toc312257628)

[3.10 Biomass 7](#_Toc312257630)

[3.11 Building Automation System (BAS) 8](#_Toc312257631)

[3.12 Building Energy Management System (BEMS) 8](#_Toc312257632)

[3.13 Cogeneration 8](#_Toc312257633)

[3.14 Communication Network Provider 8](#_Toc312257634)

[3.15 Contingency Analysis (CA) 8](#_Toc312257635)

[3.16 Customer 8](#_Toc312257636)

[3.17 Customer Information System (CIS) 8](#_Toc312257637)

[3.18 Customer Premises Network (CPN) 9](#_Toc312257638)

[3.19 Demand Response (DR) 9](#_Toc312257640)

[3.20 Direct Current (DC) 9](#_Toc312257641)

[3.21 Distributed Energy Resources (DER) 9](#_Toc312257642)

[3.22 Distribution Management System (DMS) 9](#_Toc312257643)

[3.23 Domain 9](#_Toc312257644)

[3.24 Dynamic Pricing 10](#_Toc312257645)

[3.25 Electric Vehicle (EV) 10](#_Toc312257646)

[3.26 Electric Vehicle Roaming 10](#_Toc312257647)

[3.27 Energy device 10](#_Toc312257648)

[3.28 Energy Gateway 10](#_Toc312257649)

[3.29 Energy man-machine interface (MMI) device 10](#_Toc312257650)

[3.30 Energy Management System (EMS) 11](#_Toc312257651)

[3.31 Energy Service Company (ESCO) 11](#_Toc312257652)

[3.32 Energy Services Interface (ESI) 11](#_Toc312257653)

[3.33 Energy Storage 11](#_Toc312257654)

[3.34 Flexible Alternating Current Transmission System (FACTS) 11](#_Toc312257655)

[3.35 Gateway (GW) 11](#_Toc312257656)

[3.36 Geographic Information System (GIS) 12](#_Toc312257657)

[3.37 Heating, Ventilating, and Air Conditioning (HVAC) 12](#_Toc312257658)

[3.38 Home Appliances 12](#_Toc312257659)

[3.39 Home Area Network (HAN) 12](#_Toc312257660)

[3.40 Home Grid 12](#_Toc312257661)

[3.41 Home Server 12](#_Toc312257662)

[3.42 Independent Systems Operator (ISO) 12](#_Toc312257663)

[3.43 Information and Communications Technology (ICT) 12](#_Toc312257664)

[3.44 Integration Development Environment (IDE) 13](#_Toc312257665)

[3.45 Intelligent Electronic Device (IED) 13](#_Toc312257666)

[3.46 In Home Display (IHD) 13](#_Toc312257667)

[3.47 Intermediate Platform 13](#_Toc312257668)

[3.48 Load Management 13](#_Toc312257669)

[3.49 Local Area Network (LAN) 13](#_Toc312257670)

[3.50 Management Platform 14](#_Toc312257672)

[3.51 Meter Data Management System (MDMS) 14](#_Toc312257673)

[3.52 Metering Sensor 14](#_Toc312257674)

[3.53 Neighborhood Area Network (NAN) 14](#_Toc312257675)

[3.54 Network Management System (NMS) 14](#_Toc312257676)

[3.55 Next Generation Network (NGN) 14](#_Toc312257677)

[3.56 Off Peak 15](#_Toc312257678)

[3.57 Operator 15](#_Toc312257679)

[3.58 Outage Management 15](#_Toc312257680)

[3.59 Peak Demand 15](#_Toc312257681)

[3.60 Phasor Measurement Unit (PMU) 15](#_Toc312257682)

[3.61 Photo Voltaic System (PV) 15](#_Toc312257683)

[3.62 Plug-in Hybrid Electric Vehicle (PHEV) 15](#_Toc312257684)

[3.63 Power Grid 15](#_Toc312257685)

[3.64 Power Supply Unit (PSU) 16](#_Toc312257686)

[3.66 Remote Terminal Unit (RTU) 16](#_Toc312257687)

[3.67 Renewable energy 16](#_Toc312257688)

[3.68 Requirement 16](#_Toc312257689)

[3.69 Sensor 16](#_Toc312257690)

[3.70 Service Provider 16](#_Toc312257691)

[3.71 Session Initiation Protocol (SIP) 17](#_Toc312257692)

[3.72 Smart Grid 17](#_Toc312257693)

[3.73 Smart Meter 17](#_Toc312257694)

[3.74 Smart Renewable 17](#_Toc312257695)

[3.75 Substation 17](#_Toc312257696)

[3.76 Superconducting Magnetic Energy Storage (SMES) 17](#_Toc312257697)

[3.77 Supervisory Control And Data Acquisition (SCADA) 18](#_Toc312257698)

[3.78 Synchro-Phasor 18](#_Toc312257699)

[3.79 Telecommunications Company(Telco) 18](#_Toc312257700)

[3.80 Telecommunications Network 18](#_Toc312257701)

[3.81 Topology 18](#_Toc312257702)

[3.82 Use Case 19](#_Toc312257703)

[3.83 Utility Company 19](#_Toc312257704)

[3.84 Utility Network 19](#_Toc312257705)

[3.85 Vehicle to Grid (V2G) 20](#_Toc312257706)

[3.86 Vehicle to Infrastructure and Roadside Station (V2I/V2R) 20](#_Toc312257707)

[3.87 Vehicle to Vehicle (V2V) 20](#_Toc312257708)

[3.88 Wide Area Monitoring and Control System 20](#_Toc312257709)

[3.89 Wide Area Network (WAN) 20](#_Toc312257710)

[3.90 Wide Area Situational Awareness (WASA) 20](#_Toc312257711)

[4 Abbreviations 21](#_Toc312257712)

[Appendix. Other Smart Grid definitions 24](#_Toc312257713)

[Biblioghraphy 28](#_Toc312257714)

# Scope

This Deliverable is a collection of terms and definitions that other deliverables need to use. Definitions of some terms used in different deliverables are harmonized to be unified.

The abbreviations unique for the respective deliverable are not included in this deliverable.

# References

1. IEC 61970-2, Energy management system application program interface (EMS-API) – Part 2: Glossary
2. IEC Smart Grid Standardization Roadmap, Prepared by SMB Smart Grid Strategic Group (SG3) June 2010; Edition 1.0
3. IKB Common Vocabulary, <http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/CommonVocab>
4. The Internet Engineering Task Force (IETF), http://www.ietf.org

# Definitions

## Access Network

An access network is that part of a [network](http://en.wikipedia.org/wiki/Telecommunications_network) which connects subscribers to their immediate [service provider](http://en.wikipedia.org/wiki/Service_provider) (ISP). It is contrasted with the [core network](http://en.wikipedia.org/wiki/Core_network) used by wide area network.

## Actor

A generic name for devices, systems, or programs that make decisions and exchange information necessary for performing applications: smart meters, solar generators, and control systems represent examples of devices and systems.

## Advanced Energy Service

This service is to provide new emerging energy services based on IP based home area network to home energy customer. New various emerging energy services by using of dynamic pricing policy, smart energy device, and renewable and storage interaction are recommended. These new energy services are required to provide based on IP network communication system and protocol.

## Advanced Metering Infrastructure (AMI)

An AMI is the infrastructure relating to electric metering and communications, including meters capable of two-way communication[1]. Currently, utilities are focusing on developing AMI to implement residential demand response and to serve as the chief mechanism for implementing dynamic pricing. It consists of the communications hardware and software and associated system and data management software that creates a two-way network between advanced meters and utility business systems, enabling collection and distribution of information to customers and other parties, such as competitive retail suppliers or the utility itself. AMI provides customers real-time (or near real-time) pricing of electricity and it can help utilities achieve necessary load reductions.

## Aggregator

Aggregator is a system in smart grid for collecting the energy generated by residences and micro grids.

## Architecture

Architecture is the conceptual structure and overall organization of the Smart Grid from the point of view of its use or design. This includes technical and business designs, demonstrations, implementations, and standards that, together, convey a common understanding of the Smart Grid. The architecture embodies high-level principles and requirements that designs of Smart Grid applications and systems must satisfy.

## Asset Management

Asset management refers to procedures and policies intended to control costs, reduce risk, enhance performance, improve investment and project scheduling decisions, and deal with aged equipment.

## Automatic Voltage Regulator (AVR)

An automatic voltage regulator provides protection against over voltages and drops in voltage called breakout.

NOTE: A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

## Battery Management System（BMS）

The battery management system (BMS) provides control and management for the dynamic energy storage（ES）.

## Biomass

Biomass is considered a renewable fuel source for power generation. Biomass includes wood and wood waste, municipal solid waste, crops, and biogas[1].

## Building Automation System (BAS)

A Building Automation system is a system capable of computerized monitoring and control of a building's lighting and mechanical systems, and monitoring for performance and potential failure[1].

## Building Energy Management System (BEMS)

BEMS is a system to manage and improve the energy relevant operation of the facilities and components in a building. By utilizing the existing or deploying additional sensor, meter and control components based on ICT hardware and software, BEMS could monitor and manage all conventional Building Automation System (BAS) including electric power(electricity) BAS, HVAC( heating, ventilating, and air conditioning) BAS and FMS(facility management system). With the cooperation between BEMS and grid that the building connects, smart energy service could be provided in the building domain. A schematic diagram for a BEMS connected with smart grid services is shown in Figure III-1 in ‘Use Case for Smart Grid’ Deliverable.

## Cogeneration

Cogeneration is the reuse of thermal energy by connecting thermal electric generation with a thermal process, such as an industrial application[1].

## Communication Network Provider

An organization that maintains and operates communication network components required for Smart Grid functionality.

## Contingency Analysis (CA)

Contingency analysis is a method of treating uncertainty that explores the effect on the alternatives of change in the environment in which the alternatives are to function. This is a "what-if" type of analysis, with the what-ifs being external to the alternative, in contrast to a sensitivity analysis, where the parameters of the alternatives are varied.

## Customer

The end user of energy or services, who may also generate, store, and manage the energy. Traditionally, three customer types are discussed, each with its own domain: residential, commercial, and industrial.

## Customer Information System (CIS)

A software application for handling customer calls, billing, and related operations.

## Customer Premises Network (CPN)

Customer Premises Network is comprised of Home Area Network (HAN) in home, Building/business area Network (BAN) in buildings, Industrial Area Networks (IAN) in industrial areas, and Local Area Network (LAN). HAN, BAN, and IAN supports messaging between appliances, smart meters, energy management devices, energy usage or generation devices; LAN typically interconnects PCs, servers, and peripherals, and often connects to an outside Wide Area Network (WAN), usually the Internet.

## Demand Response (DR)

A Smart Grid feature that allows consumers to reduce or change their electrical use patterns during peak demand, usually in exchange for a financial incentive[1].

Mechanisms and incentives for utilities, business, industrial, and residential customers to cut energy use during times of peak demand or when power reliability is at risk. Demand response is necessary for optimizing the balance of power supply and demand.

## Direct Current (DC)

Direct current (DC) is the unidirectional flow of electric charge. Direct current is produced by such sources as batteries, thermocouples, solar cells, and commutator-type electric machines of the dynamo type. Direct current may flow in a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams. The electric charge flows in a constant direction, distinguishing it from alternating current (AC).

## Distributed Energy Resources (DER)

DER refers to energy generation and energy storage facilities located at the customer premises, or power transmission and distribution systems.

## Distribution Management System (DMS)

Distribution Management System (DMS) is the counterpart to the EMS and is therefore the control center for the distribution grid. In countries where outages are a frequent problem, the Outage Management System (OMS) is an important component of the DMS.

## Domain

A domain in smart grid represents a collection of devices and facilities that owned and operated by power operators or customers for achieving particular application purpose.

In the NIST Smart Grid Framework and Roadmap V1 document [3], shows a conceptual model of Smart Grid, consisting of seven major functional domains. Based on the considerations from ICT perspective that is essential to ITU-T studies, ITU-T Focus Group in Smart Grid simplified the NIST conceptual model into a five-domain model as shown in the Overview Deliverable. These five domains are Grid domain (involving bulk generation, distribution and transmission), smart metering (AMI), Customer domain (involving smart appliances, electric vehicles, and premises networks), Communication network, and Service provider domain (involving markets, operators, and service providers). See the Overview Deliverable for further descriptions about domains.

## Dynamic Pricing

Dynamic pricing is a policy of charging consumers varying rates for a service to reflect frequent cost fluctuations occurring over time, as opposed to fixed pricing.

## Electric Vehicle (EV)

EV includes all-electric vehicles or Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric vehicles (PHEVs), and plug-in conversions of hybrid electric vehicles. Plug-in electric vehicle (PEV), which is sometimes referred to as grid-enabled vehicle and also as electrically chargeable vehicle, is a motor vehicle that can be recharged from any external source of electricity and could work as a power providing system at the same time.

PEV is a system that can be operated as an electrical power consuming and an electrical providing system at the same time like an Energy storage system. The PEV contains internal BMS and the operating function which are controlled and managed by home energy management system. It is required that the control and management reflects the user’s PEV usage plan and dynamic price information.

## Electric Vehicle Roaming

The EV is connected with the visited utility whose location is different from the EV registered utility or both the location and operator of the visited utility are different from the EV registered utility. When roaming EV connects with the visited utility for obtaining the services (charging, electronic map, billing, etc.), the EV profile, such as EV ID/EV customer ID, need to be sent to home utility via the communication interface of the visited utility for authentication, authorization, billing and so on.

## Energy device

These devices are end devices that consume the electrical energy, control electrical energy usage, monitor energy usage, store electrical power, and recover and supply the electrical energy. Many various devices are used for these energy devices.

## Energy Gateway

See definition of ESI.

## Energy man-machine interface (MMI) device

These devices are to provide a customer with home electrical energy service interaction; display, control, selection, management, verification, and so forth. In-home display (IHD), smart meter, wall-pad and IPTV terminal are recommended energy MMI devices.

## Energy Management System (EMS)

Energy Management System (EMS) is a computer system comprising a software platform providing basic support services and a set of applications providing the functionality needed for the effective operation of electrical generation and transmission facilities so as to assure adequate security of energy supply at minimum cost.

## Energy Service Company (ESCO)

An energy service company is a commercial business providing a broad range of comprehensive energy solutions including designs and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management. The ESCO performs an in-depth analysis of the property, designs an energy efficient solution, installs the required elements, and maintains the system to ensure energy savings during the payback period. The savings in energy costs is often used to pay back the capital investment of the project over a five- to twenty-year period, or reinvested into the building to allow for capital upgrades that may otherwise be unfeasible. If the project does not provide returns on the investment, the ESCO is often responsible to pay the difference.

## Energy Services Interface (ESI)

ESI is a set of functions consisting of gateway functions and functions required for Smart Grid applications to control and manage the Smart Grid Services in the customer premises.

## Energy Storage

Energy storage provides storage functions of electricity using various types of batteries. One example usage of Energy Storage is used to respond effectively to dynamic price mechanism from utility network. The electric energy is stored to the storage during lower price period relatively, while the stored electric energy may replaces the higher price of electric power from utility network.

## Flexible Alternating Current Transmission System (FACTS)

A flexible alternating current transmission system is a system composed of static equipment used for the AC transmission of electrical energy. It is meant to enhance controllability and increase power transfer capability of the network. It is generally a power electronics-based system.

FACTS is defined by the IEEE as "a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability."

## Gateway (GW)

Gateway is a set of functions that connects a customer premises network to an access network; for example, between a NAN & HAN or WAN & LAN. It may include a firewall, access control functions, protocol translation/transport, addressing, discovery and communication related applications.

## Geographic Information System (GIS)

A geographic information system (GIS), geographical information system, or geospatial information system is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology.

## Heating, Ventilating, and Air Conditioning (HVAC)

HVAC (Heating, Ventilation, and Air Conditioning) refers to technology of indoor or automotive environmental comfort. HVAC system design is a major subdiscipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as HVAC&R or HVACR, or ventilating is dropped as in HACR (such as the designation of HACR-rated circuit breakers).

## Home Appliances

Home Appliances are key components in terms of energy consuming in home environments. Home appliances are composed of smart home appliances and legacy home appliances. The smart home appliances contain an electric metering and communicating capabilities, but legacy appliances are not. Thus, the legacy appliances are required to have additional metering sensor including communicating functions to control and manage the usage of electric energy.

## Home Area Network (HAN)

In the smart grid applications, A HAN refers to networks in the homes that interconnect energy devices, such as appliances, energy management station, plug-in electrical (PEV) vehicle chargers, energy sources, and other applications within a home environment that is on the home side of the electric meter. A HAN can be connected with a WAN using some gateways (as shown in Figure 8-3 of the Requirement Deliverable).

## Home Grid

Home Grid provides an electrical power distribution and control service inside home environment. It is related to just only electrical power system in home area.

## Home Server

A server located at home to control and manage the each premise appliances.

## Independent Systems Operator (ISO)

An independent, federally regulated organization established to coordinate regional transmission in a non-discriminatory manner and ensure the safety and reliability of the electric system.

## Information and Communications Technology (ICT)

Information and communications technology usually called ICT, is often used as an extended synonym for information technology (IT), but is usually a more general term that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), intelligent building management systems and audio-visual systems in modern information technology. ICT consists of all technical means used to handle information and aid communication, including computer and network hardware, communication middleware as well as necessary software. In other words, ICT consists of IT as well as telephony, broadcast media, all types of audio and video processing and transmission and network based control and monitoring functions.

## Integration Development Environment (IDE)

An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development.

## Intelligent Electronic Device (IED)

An Intelligent Electronic Device (IED) is a term used in the electric power industry to describe [microprocessor](http://encyclopedia.thefreedictionary.com/Microprocessor)-based controllers of power system equipment, such as [circuit breakers](http://encyclopedia.thefreedictionary.com/Circuit%2Bbreaker), [transformers](http://encyclopedia.thefreedictionary.com/Transformer), and [capacitor](http://encyclopedia.thefreedictionary.com/Capacitor) banks[2].

## In Home Display (IHD)

IHD is a use screen device to present home energy usage information. With the IHD, the customer can optionally control the smart grid HAN devices using user input interfaces. The control and usage information are transferred by HAN communication system environment. A user screen device can also be a Mobile/Smart Phone, (IP) TV, Internet Video Phone, PC or Tablet PC, Wall-pad, and etc.

## Intermediate Platform

The platform has common additional functions such as temporary storage of data and basic analysis of data etc.

## Load Management

A collection of strategies intended to reduce or move demand from peak to off-peak periods.

## Local Area Network (LAN)

A LAN is a network that connects computers and devices in a limited geographical area such as home, computer laboratory, office building, and closely positioned group of buildings. A LAN can be deployed in some domains if needed. A LAN provides intra-communication in same location and inter-communication over WAN.

## Management Platform

The platform has common functions such as the virtual device management and data conversion to facilitate providing with service by using various information from sensors.

## Meter Data Management System (MDMS)

Meter Data Management (MDM) refers to a key component in the Smart Grid infrastructure that is in the process of being evolved and adopted by utility companies. An MDM system performs long term data storage and management for the vast quantities of data that are now being delivered by smart metering systems. This data consists primarily of usage data and events that are imported from the head end servers that manage the data collection in Advanced Metering Infrastructure (AMI) or Automatic meter reading (AMR) systems.

An MDM system will typically import the data, then validate, cleanse and process it before making it available for billing and analysis. The more flexible the MDM application, the better it is able to integrate to existing enterprise applications and help to streamline utility business processes. Benefits can be seen in billing, customer service, outage management and analysis of utility operations.

## Metering Sensor

Metering sensor is a sensor device that can monitor electrical usage details of each home energy consuming device such as home appliances with various forms. It can be optionally accompanied to legacy home appliances which do not provide their own metering function.

## Neighborhood Area Network (NAN)

A NAN is an access network that allows smart grid end-devices and HAN to connect to a WAN. A NAN can be deployed between WAN and HAN. There are several types of management. It can be managed by Providers, Users or Careers. And sometimes, it can be wireless type or wired type.

## Network Management System (NMS)

A Network Management System (NMS) is a combination of hardware and software used to monitor and administer a network.

## Next Generation Network (NGN)

A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

## Off Peak

Off peak is a period of reduced electrical demand.

## Operator

An organization responsible for transmission and/or distribution of electricity.

## Outage Management

Incorporates technologies such as GIS and smart meters to quickly locate and manage outages.

## Peak Demand

The period of time when demand for electricity is at its highest.

## Phasor Measurement Unit (PMU)

Phasors help detect and mitigate congestion at various points on the grid by sampling voltage and current several times a second.

## Photo Voltaic System (PV)

A photovoltaic system (or PV system) is a system which uses one or more solar panels to convert sunlight into electricity. It consists of multiple components, including the photovoltaic modules, mechanical and electrical connections and mountings and means of regulating and/or modifying the electrical output.

## Plug-in Hybrid Electric Vehicle (PHEV)

A plug-in hybrid electric vehicle (PHEV), plug-in hybrid vehicle (PHV), or plug-in hybrid is a hybrid vehicle which utilizes rechargeable batteries, or another energy storage device, that can be restored to full charge by connecting a plug to an external electric power source (usually a normal electric wall socket). A PHEV shares the characteristics of both a conventional hybrid electric vehicle, having an electric motor and an internal combustion engine (ICE); and of an all-electric vehicle, having a plug to connect to the electrical grid. Most PHEVs on the road today are passenger cars, but there are also PHEV versions of commercial vehicles and vans, utility trucks, buses, trains, motorcycles, scooters, and military vehicles.

## Power Grid

Power grid is an interconnected network for delivering electricity. Its operations include electricity generation, electric power transmission, and electricity distribution.

## Power Supply Unit (PSU)

A power supply unit (PSU) supplies direct current (DC) power to the other components in a computer. It converts general-purpose alternating current (AC) electric power from the mains (110 V to 120 V at 60 Hz [115 V nominal] in North America, parts of South America, Japan, and Taiwan (China); 220 V to 240 V at 50 Hz [230 V nominal] in most of the rest of the world) to low-voltage (for a desktop computer: 12 V, 5 V, 5VSB, 3V3, −5 V, and −12 V) DC power for the internal components of the computer. Some power supplies have a switch to select either 230 V or 115 V. Other models are able to accept any voltage and frequency between those limits and some models only operate from one of the two mains supply standards.

1. **Regional Transmission Organization (RTO)**

A regional transmission organization (RTO) is an independent organization (profit or non-profit) established for the purpose of operating the transmission assets and providing wholesale transmission services within a defined (usually multi-state) geographic region. Typically, the RTO does not itself own the transmission facilities but instead operates them on behalf of the transmission-owning utilities.

## Remote Terminal Unit (RTU)

A Remote Terminal Unit (RTU) is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA (supervisory control and data acquisition system) by transmitting telemetry data to the system and/or altering the state of connected objects based on control messages received from the system.

## Renewable energy

Power provided by renewable sources such as wind, solar, geothermal, hydro, and biomass.

## Requirement

A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents.

## Sensor

Sensor is a significant component of the electrical grid; sensors are used in several ways: temperature monitoring, security, providing data for peak demand adjustment. They are an integral component of a Smart Grid.

## Service Provider

An organization providing services related to smart grid to electrical customers and utilities.

## Session Initiation Protocol (SIP)

SIP is an agile, general-purpose tool for creating, modifying, and terminating sessions that works independently of underlying transport protocols and without dependency on the type of session that is being established. SIP can also invite participants to already existing sessions, such as multicast conferences. Media can be added to (and removed from) an existing session. SIP transparently supports name mapping and redirection services, which supports personal mobility- users can maintain a single externally visible identifier regardless of their network location.

## Smart Grid

The "Smart Grid" is a two way electric power delivery network connected to an information and control network through sensors and control devices. This supports the intelligent and efficient optimization of the power network.

## Smart Meter

Smart Meter is a premise device to monitor and control of electrical power usage of home devices based on “Demand Response (DR) information” from home devices. But, it is not recommended that the Smart Meter controls directly per each premise appliances because of the private security policy. To control and manage the each premise appliances, it is required for home management system such as home gateway（HGW）and home server to support the control and management.

## Smart Renewable

Smart Renewable is an electrical power generating system to be used within the home environment. The generated energy by renewable in the home environment is primarily used in the internal home usage and it can be provided some extra energy to main grid utility network. A power supply unit (PSU) including inverter function, DC to AC conversion, is accompanied to connect to the Home Grid. To provide appropriate Smart Renewable function, it functions together with Energy Storage system.

## Substation

Substation is the site where equipment for switching or regulating electrical voltage is located.

## Superconducting Magnetic Energy Storage (SMES)

Superconducting Magnetic Energy Storage (SMES) systems store energy in the magnetic field created by the flow of direct current in a superconducting coil which has been cryogenically cooled to a temperature below its superconducting critical temperature.

## Supervisory Control and Data Acquisition (SCADA)

SCADA is a computer system that monitors an industrial, infrastructure, or facility-based control process.

## Synchro-Phasor

This system provides synchronized and time-tagged voltage and current phasor measurements to any protection, control, or monitoring function that requires measurements taken from several locations, whose phase angles are measured against a common, system wide reference. This is an extension of simple phasor measurements, commonly made with respect to a local reference. Present day implementations of many protection, control, or monitoring functions are hobbled by not having access to the phase angles between local and remote measurements. With system wide phase angle information, they can be improved and extended. The essential concept behind this system is the system wide synchronization of measurements sampling clocks to a common time reference.

In addition to providing synchronized measurements, the synchro-phasor system distributions the measurements. Voltages and currents are measured at many nodes throughput the power grid. Any protection, control, or monitoring function can access measurements from several nodes, either by subscribing to continuous streams of data, or requesting snapshots as needed. In principle, any function could request measurements from any node, though in practice most functions require data from only a few nodes.

## Telecommunications Company(Telco)

A Telecommunication Company is an organization that maintains and operates telecommunication network components.

## Telecommunications Network

Telecommunications Network is a communications network deployed and operated to support a set of generic communications services. The Telecommunications Network though not dedicated in its purpose may offer services, either as part of a generic offering or as part of a Virtual Private Network or equipment dedicated to the support of communications to Smart Grid. In the dedicated network case the Utility Carrier has responsibilities and rights on the operation. Both the Generic and Dedicated communications capabilities comprise types of the communications networks as described in WAN.

## Topology

Topology, usually network topology in computer and telecommunication field, is defined as the principle arrangement, ordering or relationships amongst objects and components used in describing a network, without regard to their actual occurrence in any real network. There are two basic categories of network topologies: physical and logical topologies. The physical topology reflects the cabling layout of the network, which includes the locations of nodes, the interconnections between nodes and the cabling. But the logical topology just shows the path that the message passes through in the network without consideration of physical connection of the nodes. The logical topology of a network might not be the same with its physical topology.

There are five basic network topologies:

1) Bus

A single bus cable connects each node in the network. When one of the nodes connected on the bus cable sends message, all the other nodes in the network can receive it.

2) Star

A central hub node connects each node in a point-to-point manner. The central hub node works as a repeater which forwards the message from the connected node to the destination node.

3) Ring

A ring network is a topology in which each node connects to two other nodes to form a closed-loop. Message is allowed to travel in one direction in the network. Each node on the ring assists in forwarding the message from other nodes.

4) Mesh

Mesh network, also called random network, is a type of topology in which the nodes in the network connect with each other in an irregular way.

5) Tree

A tree network is a hierarchical network in which there is only one node (‘root’ node) locating at the top level (first level) and it connects one or more nodes at one level lower(second level) in point-to-point manner. These nodes at the second level could also connect one or more nodes one level lower in the point-to-point manner in the network. Any network having tree topology must have at least three levels.

## Use Case

A use case is a system engineering tool for defining a system’s behaviour from the perspective of a user. In effect, a use case is a story told in structure and detailed steps—scenarios for specifying required usages of a system, including how a component, subsystem, or system should respond to a request that originates elsewhere.

## Utility Company

A utility company is an organization that provides electric power, gas, and water. In smart grid, Utility Company supplies electric power.

## Utility Network

Utility network is a dedicated communications network for electric power, gas or water supply companies. In smart grid, a Utility Network connects sensors, controls and management devices within the electric power grid.

## Vehicle to Grid (V2G)

V2G (Vehicle to Grid) relates to communications and bidirectional power transmission between an electric vehicle and utility grids for smart EV applications, such as smart charging and information services for EV. Ethernet over power-line adapter or GSM/UMTS/DSRC can be applied for this type of communication.

## Vehicle to Infrastructure and Roadside Station (V2I/V2R)

V2I/V2R relates to communications between a vehicle and a network infrastructure including Roadside Station through wireless access technologies such as 2G/3G, WiFi, WiMAX and also DSRC. Wire-line access technology such as power-line communication could also be used in V2I/V2R.

## Vehicle to Vehicle (V2V)

Vehicle to Vehicle (V2V) relates to communications between a vehicle and another vehicle to provide information exchanging services, such as safety critical information propagation within a short period of time under mobile environment. V2V is commonly based on wireless transmission and the interaction usually happens under mobile environment.

## Wide Area Monitoring and Control System

This is a system used to collect data on the state of the power system timely and accurately. With the assistance of PMU and GPS, it could provide synchronized observation of the dynamics of the power system which helps to manage the power system in a more efficient and responsive way and support the application of wide area control and protection schemes.

## Wide Area Network (WAN)

A wide area network (WAN) is a communication network that covers a wide geographical area and accommodates terminals and LANs.

## Wide Area Situational Awareness (WASA)

Monitoring and display of power-system components and performance across interconnections and over large geographic areas in near real-time. The goals of situational awareness are to understand and ultimately optimize the management of power-network components, behaviour, and performance, as well as to anticipate, prevent, or respond to problems before disruptions can arise.

# Abbreviations

|  |  |
| --- | --- |
| 2G | Second Generation Wireless Telephone Technology  |
| 3G | Third Generation Wireless Telephone Technology  |
| AC | Alterating Current |
| AM | Automated Mapping |
| AMI | Advanced Metering Infrastructure |
| API | Application Program Interface |
| BAS | Building Automation System |
| BEV | Battery Electric Vehicle |
| BMS | Battery Management System |
| BTS | Base Transceiver Station |
| CATV | Community Antenna TV |
| CIS | Customer Information System |
| DC | Direct Current |
| DER | Distributed Energy Resource |
| DR | Demand Response |
| DSRC  | Dedicated Short-Range Communications |
| EMS | Energy Management System |
| FMC | Fixed Mobile Convergence |
| EV | Electric Vehicle |
| FMS | Facility Management System |
| FTTH | Fiber to The Home |
| GIS | Geographic Information System |
| GSM | Global System for Mobile Communications |
| GW | Gateway |
| HAN | Home Area Network |
| HGW | Home Gateway |
| ICT | Information and Communications Technology |
| ID | Identity |
| IEC | International Electro technical Commission |
| IED | Intelligent Electronic Device |
| IEEE | Institute of Electrical and Electronics Engineers |
| IHD | In-home display |
| IPTV | Internet Protocol Television |
| ISP | Immediate Service Provider |
| ITU-T | International Telecommunication Union-Telecommunication Standardization Sector |
| LAN | Local Area Network |
| LTE | Long Term Evolution |
| MMI | Man-Machine Interface |
| NIST | National Institute of Standards and Technology |
| OMS | Outage Management System |
| PC | Personal Computer |
| PEV | Plug-in Electric Vehicle |
| PHEV | Plug-in Hybrid Electric Vehicle |
| PSU | Power Supply Unit  |
| QoS | Quality of Service |
| RAS | Remedial Action Schemes |
| WG1 | Work Group 1 on Use Cases |
| WG2 | Work Group 2 on Requirements |
| WG3 | Work Group 1 on Architecture |
| UMTS | Universal Mobile Telecommunications System |
| V2G | Vehicle to Grid |
| V2I | Vehicle to Infrastructure  |
| V2R | Vehicle to Roadside Station |
| V2V | Vehicle to Vehicle |
| WAN | Wide Area Network |
| WiFi | Wireless local area network(WLAN) products based on IEEE 802.11 standards[4] |
| WiMAX | Worldwide Interoperability for Microwave Access  |
| xDSL | Digital Subscriber Line  |

# Appendix. Other Smart Grid definitions

* + **From Wikipedia:** [www.wikipedia.org](http://www.wikipedia.org)

A Smart Grid is a form of electricity network utilizing digital technology. A Smart Grid delivers electricity from suppliers to consumers using two-way digital communications to control appliances at consumers’ homes; this saves energy, reduces costs and increases reliability and transparency. It overlays the ordinary electrical grid with an information and net metering system, that includes smart meters. Smart Grids are being promoted by many governments as a way of addressing energy independence, global warming and emergency resilience issues.

A Smart Grid is made possible by applying sensing, measurement and control devices with two-way communications to electricity production, transmission, distribution and consumption parts of the power grid that communicate information about grid condition to system users, operators and automated devices, making it possible to dynamically respond to changes in grid condition.

A Smart Grid includes an intelligent monitoring system that keeps track of all electricity flowing in the system. It also has the capacity of integrating renewable electricity such as solar and wind. When power is least expensive the user can allow the Smart Grid to turn on selected home appliances such as washing machines or factory processes that can run at arbitrary hours. At peak times it could turn off selected appliances to reduce demand.

* + **From US department of energy:** [www.oe.energy.gov](http://www.oe.energy.gov)

The electric grid delivers electricity from points of generation to consumers, and the electricity delivery network functions via two primary systems: the transmission system and the distribution system. The transmission system delivers electricity from power plants to distribution substations, while the distribution system delivers electricity from distribution substations to consumers. The grid also encompasses myriads of local area networks that use distributed energy resources to serve local loads and/or to meet specific application requirements for remote power, village or district power, premium power, and critical loads protection.

Electric grid stakeholders representing utilities, technology providers, researchers, policymakers, and consumers have worked together to define the functions of a Smart Grid. Through regional meetings convened under the Modern Grid Strategy project of the National Energy Technology Laboratory (NETL), these stakeholders have identified the following characteristics or performance features of a Smart Grid:

* Self-healing from power disturbance events;
* Enabling active participation by consumers in demand response;
* Operating resiliently against physical and cyber attack;
* Providing power quality for 21st century needs;
* Accommodating all generation and storage options;
* Enabling new products, services, and markets;
* Optimizing assets and operating efficiently.
	+ **From IEC Smart Grid Standardization Roadmap**

“Smart Grid” is today used as marketing term, rather than a technical definition. For this reason there is no well defined and commonly accepted scope of what “smart” is and what it is not. However smart technologies improve the observability and/or the controllability of the power system. Thereby Smart Grid technologies help to convert the power grid from a static infrastructure to be operated as designed, to a flexible, “living” infrastructure operated proactively. IEC SG3 defines Smart Grids as the concept of modernizing the electric grid. The Smart Grid is integrating the electrical and information technologies in between any point of generation and any point of consumption. Examples:

* Smart metering could significantly improve knowledge of what is happening in the distribution grid, which nowadays is operated rather blindly. For the transmission grid, an improvement of the observability of system-wide dynamic phenomena is achieved by Wide Area Monitoring and System Integrity Protection Schemes;
* HVDC and FACTS improve the controllability of the transmission grid. Both are actuators, e.g. to control the power flow. The controllability of the distribution grid is improved by load control and automated distribution switches;
* Common to most of the Smart Grid technologies is an increased use of communication and IT technologies, including an increased interaction and integration of formerly separated systems.
	+ **From European Smart Grids Technology Platform: Strategic deployment document – final version – 20 April 2010**

A Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.

Though elements of smartness also exist in many parts of existing grids, the difference between a today’s grid and a Smart Grid of the future is mainly the grid’s capability to handle more complexity than today in an efficient and effective way. A Smart Grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies in order to:

* Better facilitate the connection and operation of generators of all sizes and technologies;
* Allow consumers to play a part in optimizing the operation of the system;
* Provide consumers with greater information and options for how they use their supply;
* Significantly reduce the environmental impact of the whole electricity supply system. Maintain or even improve the existing high levels of system reliability, quality and security of supply;
* Maintain and improve the existing services efficiently;
* Foster market integration towards European integrated market.

The implementation of this concept will be made possible by the participation of all Smart Grids actors, according to their specific roles and responsibilities which are described in greater detail in the report of the Expert Group 3. Accordingly, Smart Grid participants are categorized in this report as follows:

* Network operators: transmission and distribution system/network operators (DSOs/DNOs);
* Grid users: generators, consumers (including mobile consumers), storage owners;
* Other actors: suppliers, metering operators3, ESCOs, aggregators, applications and services providers, power exchange platform operators.

Conceptually, some Smart Grid participants provide services, based on a combination of functionalities, to other Smart Grid participants. A Smart Grid service identifies, and can be commonly considered as, the outcome a user needs/will need from the electricity grid in a fully developed liberalised market; it is associated to one provider and to one or more primary beneficiaries, recognizing that the benefits will ultimately be reflected in consumer societal and environmental terms.

* + **From NIST Smart Grid Collaboration Wiki Smart Grid Interoperability Panel Site**

By integrating an end-to-end, advanced communications infrastructure into the electric power system, a Smart Grid can provide consumers near real-time information on their energy use, support pricing that reflects changes in supply and demand, and enable smart appliances and devices to help consumers avoid higher energy bills.

A more intelligent grid can also:

* reduce the duration and frequency of power outages
* lower generation requirements by reducing inefficiencies in energy delivery
* facilitate efficient charging of electric vehicles
* better integrate wind and solar resources
* provide more effective management of distributed generation and storage.

A Smart Grid uses information and communication technology to make the power grid more efficient, reliable, secure, and resilient while minimizing costly investments in new generation capacity.

* + **From State Grid Information & Telecommunication CO., LTD (SGIT), SGCC China, Smart-I-221Rev.1**

Smart Grid is a modern electricity network with ultra high voltage grid as its backbone and subordinate grids coordinated at all levels, which cover each facet of the power system including generation, transmission, transformation, distribution, consumption, dispatching. In support of advanced communication and information technologies, Smart Grid is featured as being IT-based, automatic and interactive, and being able to merge power flows, information flows, and business flows.

The connotation of Smart Grid includes the following five key aspects.

Some important aspects of smart grid are listed below:

1. Strong & reliable: robust grid structure, strong transmission capacity and secure and reliable power supply.

2. Economical & efficient: more efficient grid operation and power transmission, lower operation cost and more efficient use of energy resources and power assets.

3. Clean & environmentally friendly: more extensive use of renewable energy, less energy consumption and pollution emission, higher proportion of clean energy in end use of energy.

4. Open & transparent: a transparent and open platform for electricity market among grid, power sources and consumers, providing value-added services of high quality to the grid.

5. Friendly & interactive: flexible operation of power grid, to be friendly compatible with the access and exit of diverse power sources and end-users, so as to encourage the active participation of power sources and consumers into the balance of power grid.

# Biblioghraphy

1. <http://www.smartgridnews.com/artman/publish/Stimulus_Tools_Resources/Basic_Smart_Grid_Terms_and_Acrononyms-767.html>
2. [http://encyclopedia.thefreedictionary.com/Intelligent+Electronic+Device](http://encyclopedia.thefreedictionary.com/Intelligent%2BElectronic%2BDevice)
3. “NIST Framework and Roadmap for Smart Grid Interoperability Standards”, Release 1.0，NIST Special Publication 1108，January 2010 （1.3.1）

1. <http://www.webopedia.com/TERM/W/Wi_Fi.html>
2. http://www.wimaxforum.org/about