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Grid Modernization Laboratory Consortium (GMLC)

Grid Architecture Power Systems Glossary

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Foreword

Some terms in this glossary may have a definition in the grid architecture domain. In such cases, this document provides the power systems definition only. For the grid architecture definition, and other grid architecture terms and definitions, please see the *GMLC Grid Architecture Glossary* (LLNL-MI-723063).

Adaptability: Generally, the ease with which a system or component can be modified for use in environments other than those for which it was specifically designed. For example, from the power system perspective, it includes the ability to respond to change in demand and supply, to support changes in fuel mix, to accommodate various **Distributed Energy Resource** penetration levels, to accommodate weather, seasonal and climatic changes, etc.

Advanced Flexible Distribution: A distribution system where power can be derived from a variable mix of grid and local sources. Involves the application of advanced control mechanisms, distributed generation and storage, demand response, and topological changes, to a conventional distribution grid.

Advanced Metering Infrastructure (AMI): Systems that use two-way communications to read utility meter data remotely and automatically and perform other related functions.

Aggregator (Demand Response): A municipality or other governmental entity, an energy services provider, a scheduling coordinator, a utility distribution company, or any other entity representing single or multiple loads for providing demand reduction service to the **Independent System Operator**.

Ancillary Service: Services that assist the grid operator in maintaining system balance. These include regulation and the contingency reserves: spinning, non-spinning, and in some regions, supplemental operating reserve.

Balancing Area: The balancing area is a metered segment of the power system in which electrical balance is maintained by the balancing area authority. The fundamental balance that is required is that the total of all generation must equal the total of all loads, although this relationship is modified by electrical imports or exports into or out of the balancing area.

Balancing Authority: The responsible entity that integrates resource plans ahead of time, maintains demand and resource balance within a **Balancing Authority Area**, and supports **Interconnection** frequency in real time.

Balancing Authority Area (BAA): The region managed by a **Balancing Authority** for generation dispatch and balance, power interchange with neighboring Balancing Authority Areas, and load frequency control.

Base-Load Generating Plants: Typically coal or nuclear generating units, these plants are usually committed and dispatched at constant or near-constant levels, with minimum cycling. They are often the sources of lowest-cost of energy when run at very high capacity factors.

Base Load: The minimum amount of electric power delivered or required over a given period at a constant rate.

Bilateral Market: In bilateral energy markets, electric utility providers build and own their own generating facilities or do so jointly with other utilities, form long-term purchase arrangements with independent facility developers and operators, or engage in transactions with neighboring utilities to

their mutual benefit. A contract in a bilateral market allows a buyer and a seller to exchange electricity or rights to generating capacity under mutually agreeable terms for a specified period of time.

Black Start: The process of restoring an electric power station or a part of an electric grid to operation without relying on the external transmission network.

Branch: One, two, or more circuits whose main power is connected through the same main switch or device.

Building to Grid (B2G): The interaction of buildings and grids, wherein services may be exchanged in either direction.

Bulk Power System: An interconnected system for the movement or transfer of electric energy in bulk on transmission levels. As defined by the regional reliability organization, the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are generally not included in this definition.

Bulk System Reserve: The capacity, in equipment and conductors, installed on the bulk system in excess of that required to carry the peak load.

Bus: A conductor, or group of conductors, that serves as a common connection for two or more circuits.

Circuit Breaker: A mechanical switching device, capable of making, carrying, and breaking currents under normal circuit conditions and also, making and carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short circuit. A circuit breaker is usually intended to operate infrequently, although some types are for frequent operation.

Circuit: A conductor or system of conductors through which an electric current is intended to flow.

Circuit, Unbalanced: A circuit, the two sides of which are inherently electrically unlike with respect to a common reference point, usually ground.

Cogeneration: The generation of electric energy and commercial or industrial quality heat or steam from a single facility.

Contingency: The unexpected failure or outage of a system component, such as a generator, transmission line, circuit breaker, switch or other electrical element.

Contingency Analysis (CA): A "what if" scenario simulation that evaluates, provides and prioritizes the impacts on an electric power system when **Contingency** events occur. CA is used as a study tool for the off-line analysis of contingency events, and as an on-line tool to show operators what would be the effects of future outages. This allows operators to be better prepared to react to outages by using pre-planned recovery scenarios.

Contingency Reserve: Reserve services that are sufficient to cover the unplanned trip (disconnect) of a large generator or transmission line and maintain system balance. Contingency reserves are generally split between spinning and non-spinning reserves and are often based on the largest single hazard (generator or transmission capacity). Contingency events are big (many megawatts) and fast (within a few cycles). Forecast errors for variable generation are too slow to be contingency events.

Control Area: A power system, a part of a power system, or a combination of several power systems under common control for which a single area control error is defined.

Day Ahead Market: A forward market for electric energy, capacity, or ancillary services that will be provided or purchased during the next day.

Demand Response: Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

Distributed Energy Resource (DER): Small-scale distributed generation and storage, usually connected to a distribution grid. Some definitions also include **Demand Response** (see **Responsive Load** below) in DER.

Distributed Generation (DG): Electric generation that is not centralized and connected to transmission, but rather is decentralized and connected to distribution; individual units are typically much smaller in generation capacity than centralized generation plants.

Distribution System: That portion of an electric system that delivers electric energy from transformation points on the transmission system to the customer. The distribution system is generally considered to be anything from the distribution substation fence to the customer meter. Often the initial overcurrent protection and voltage regulator are within the substation fence.

Distribution System Operator: A single entity that operates each local distribution area and is responsible for providing reliable real-time distribution service, including the operation of **Distributed Energy Resource**. This could be an incumbent distribution provider or a new independent entity.

Distribution Transformer: A transformer for transferring electrical energy from a primary distribution circuit to a secondary distribution circuit or consumer's service circuit. Distribution transformers are usually rated on the order of 5–500 kVA.

Droop Speed Control: A generator speed control mode that enables synchronous generators to be run in parallel, such that load is shared among generators in proportion to their power rating.

Economic Dispatch: The optimization of the incremental cost of delivered power by allocating generating requirements among the on-control units with consideration of such factors as incremental generating costs and incremental transmission losses. Once a generating plant has been committed, it can then be operated over a range of possible output levels. The economic dispatch process is a method by which system operators decide how much output should be scheduled from the plants that have been

committed, and/or plants that can be started quickly and don't require a lengthy start-up or commitment process.

Electric Cooperative: A private, not-for-profit business governed by its consumers (known as consumer-members).

Electric Coupling: The interconnection and interaction of elements in ways that may be planned and useful, or may be unplanned and harmful. The most basic form of coupling in the grid is direct electric interconnection.

Electric Generator: A machine that transforms mechanical power into electric power.

Electric Load Shaping: The scheduling and operation of generating resources to meet changing load levels. On a hydroelectric system, this usually involves the adjustment of reservoir releases so that generation and loads are continuously in balance.

Electric Supply Reserve Capacity: Extra generating capacity available either to meet unanticipated demands for power or to generate power in the event of loss of generation resulting from scheduled or unscheduled outages of regularly used generating capacity. Reserve capacity to meet the latter situation also known as forced outage reserve.

Electrical Network: An arrangement of electrical components via interconnecting conductors.

Energy Imbalance Service: A market service that provides for the management of unscheduled deviations in individual generator output or load consumption.

Energy Transaction: An agreement to transfer energy from a seller to a buyer that crosses one or more **Balancing Authority Area** boundaries.

Fast Bilateral Storage: Energy storage for the grid having symmetric characteristics in terms of charging and discharging and capable of responding to fast grid dynamics. Electric batteries combined with power electronics and advanced controls constitute fast bilateral storage; pumped hydroelectric storage does not.

Fault: An abnormal connection of relatively low impedance, whether made accidentally or intentionally, between two points of different potential in a circuit.

Federal Energy Regulatory Commission (FERC): An independent agency that regulates the interstate transmission of natural gas, oil, and electricity. FERC also regulates natural gas and hydropower projects.

Feeder: All circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the final branch-circuit overcurrent device.

Feeder, Primary: A feeder operating at primary voltage supplying a distribution circuit. A primary feeder is usually considered as that portion of the primary conductors between the substation or point of supply and the center of distribution. Typically carries medium voltage.

Flexibility: The ability of the generation fleet to change its output (ramp) rapidly, start and stop with short notice, and achieve a low minimum-turn-down level.

Flexible Distribution: An augmentation of a conventional distribution system with increased meshing, power flow control, energy storage, significant penetration of distributed generation and demand response, laminar coordination, volt/VAr control, and a **Distribution System Operator** model for distributed reliability. A flexible distribution system can operate reliably with power derived a variable mix of grid and local sources.

Forward Capacity Market: A **Market** whose purpose is ensure that a power system will have sufficient resources to meet the future demand for electricity.

Forward Capacity Auction: An auction where resources compete to obtain a commitment to supply capacity in exchange for a market-priced capacity payment.

Frequency Response: Generation (and responsive load) capability to increase output (or reduce consumption) in response to a decline in system consumption) in response to an increase in system frequency. For generators, this requires governor response.

Fuse: An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of the overcurrent through it.

Generation: The production or storage, or both, of electric energy with the intent of enabling practical use of commercial sale of the available energy. This includes photovoltaic, wind- farm, hydroelectric, etc., as well as normal commercial and industrial thermal sources.

Generation Bifurcation: The trend of the conventional power grid generation model to shift from centralized generation connected to transmission, to a mix of that and distributed generation connected to distribution.

Generation Dispatch: The process of varying the output from generation on a moment-to-moment basis to meet changing supply requirements.

Generator Trip: Electrical or mechanical malfunctions can sometimes cause a generator to fail and cause a contingency condition on the power system. A generator trip occurs very quickly, usually within a few cycles. Contingency reserves are held so that there is sufficient online generation that can replace the generator that tripped offline.

Grid Instability: A phenomenon, typically with respect to voltage, that causes an electric grid to fail due to collapsing voltage that propagates across the grid.

Grid Service: Conventional **Ancillary Services**, and other emerging services that facilitate particular grid qualities.

Grid: Historically, a network, usually of a power company, for transmitting and distributing electrical power. The modern grid is complex enough to be thought of as an **Ultra-Large-Scale** system, a network of structures consisting of electric infrastructure, control structure, regulatory structure, industry structure, digital superstructure, convergent networks, and coordination frameworks. Such a system is subject to hidden and overt interactions and cross-couplings, complex constraints, dependencies, and convergences.

Grid, Smart/Intelligent: An electric power system that utilizes information exchange and control technologies, distributed computing and associated sensors and actuators.

Grid, Local: A **Microgrid** or **Nanogrid**. Local grids are not encumbered by regulation or complications from multiple management domains.

High Voltage: Voltages between 100 KV and 230 KV.

Independent System Operator (ISO): A non-profit, public-benefit organization that carries out system planning, grid operations, and regional reliability activities. Responsible for maintaining system balance, reliability, and electricity market operation.

Interchange Authority: The responsible entity that authorizes the implementation of valid and balanced **Interchange Schedules** between **Balancing Authority Areas**, and ensures communication of interchange information for reliability assessment purposes.

Interchange Schedule: An agreed-upon interchange transaction size (megawatts), start and end time, beginning and ending ramp times and rate, and type required for delivery and receipt of power and energy between the source and sink **Balancing Authorities** involved in the transaction.

Interconnection: The physical plant and equipment required to facilitate the transfer of electric energy between two or more entities. It can consist of a substation and an associated transmission line and communications facilities or only a simple electric power feeder.

Intermediate Generating Plant: Generating units that provide most or all of their energy during the day when energy demand increases. Intermediate generators can either turn off or cycle to a low minimum run level at night so they can match the diurnal demand patterns. Although some coal plants can provide this capability, it is more often gas, oil, or hydroelectric plants that provide this service.

Intermittent Renewables: Intermittent renewables include solar, wind, ocean wave, tidal and, in some cases, hydroelectric. One important characteristic of intermittent renewable energy generation is that the power output can change rapidly over short periods of time.
Inter-tie Switch: A switch that connects two or more independent sources of power. Inter-tie switches are sometimes used to connect feeders for the purposes of re-routing power after sectionalizing a portion of a feeder circuit for fault isolation or for maintenance work.

Investor-Owned Utility: A utility whose assets are owned by investors (as distinct from public power agencies, cooperatives, and municipal utilities).

Island: A part of an electric power system that is disconnected from the remainder of the interconnected system, but remains energized. An island can be either the result of the action of automatic protections or the result of a deliberate action.

Islanding: The process whereby a **Microgrid** separates itself electrically from the main power grid and operates independently, using its own internal power source(s); it may later rejoin the main grid.

Lateral: A terminating branch of an underground conduit run, extending from a manhole or handhole to a nearby building, handhole, or pole.

Load Following: The use of on-line generation, storage, or load equipment to track the intra- and inter-hour changes in customer loads. Load following ensures that, under normal operating conditions, a control area is able to balance generation and load.

Load Forecasting: Load forecasts are predictions of future demand. For normal operations, daily and weekly forecasts of the hour-by-hour demand are used to help develop generation schedules to ensure that sufficient quantities and types of generation are available when needed.

Load Frequency Control (LFC): The regulation of the power output of electric generators within a prescribed area in response to changes in system frequency, tie line loading, or the relation of these to each other, to maintain the scheduled system frequency or the established interchange with other areas within predetermined limits or both.

Load-Interchange-Generation Balance: Aggregate load is balanced with aggregate generation, accounting for energy imports and exports (also known as interchange) with neighboring systems.

Locational Marginal Price (LMP): This is the price of a unit of energy at a particular electrical location at a given time. LMPs are influenced by the nearby generation, load level, and transmission constraints and losses.

Low Voltage: Voltages less than 1 KV.

Market: Demand and supply of goods and services; the entire economic ecosystem around the **Grid**.

Medium Voltage: Voltages between 1 KV and 100 KV.

Mesh Network: A highly-connected network topology. At the bulk system level, circuits are strongly meshed. Secondary electrical distribution systems may sometimes be meshed in highly dense urban areas. Such networks are fed at many points by distribution primary feeders, while using network protectors to prevent reverse power flow into network transformers.

Micro-generator: A source of electric energy and all associated interface equipment able to be connected to a regular electric circuit in a low-voltage electrical installation and designed to operate in parallel with a public low-voltage distribution network.

Microgrid: Electricity distribution systems containing loads and **Distributed Energy Resources** (such as distributed generators, storage devices, or controllable loads) that can be operated in a controlled, coordinated way either while connected to the main power network or while islanded. A Microgrid is under the control of a single management entity.

Microgrid, Utility: A portion of a utility infrastructure that can operate independently of the rest of the utility grid, with the scale of a few, to a few hundred, buildings.

Milligrid: A **Utility Microgrid** with local generation or storage.

Minigrid: A grid, similar to a traditional utility grid, but with limited geography and capacity.

Minimum Run (turn-down) Level: Minimum level of output that can be provided from a generator. Different generators have different minimum run levels based in part on fuel source, plant design, or common use.

Nanogrid: A single domain of power; single physical layer of power distribution, reliability, quality, capacity, price and administration.

Network Protector: An assembly comprising a circuit breaker and its complete control equipment for automatically disconnecting a transformer from a secondary network in response to predetermined electrical conditions on the primary feeder or transformer, and for connecting a transformer to a secondary network either through manual control or automatic control responsive to predetermined electrical conditions on the feeder and the secondary network. The network protector is usually arranged to connect automatically its associated transformer to the network when conditions are such that the transformer, when connected, will supply power to the network and to automatically disconnect the transformer from the network when power flows from the network to the transformer.

Network Transformer: A transformer designed for use in a vault to feed a variable capacity system of interconnected secondaries. A network transformer may be of the submersible or of the vault type. It usually, but not always, has provision for attaching a network protector.

Non-spinning Reserve: Generation and responsive load that is not -line but can be fully responsive within 30 minutes. Contingency reserves include a component that is non-spinning. Non-spinning reserve can also be used to help manage solar variability and uncertainty for time-frames that exceed 10 minutes (load following).

North American Electric Reliability Corporation (NERC): A not-for-profit international regulatory authority whose mission is to assure the reliability of the bulk power system in North America.

On the Margin: Power system operators dispatch generators based on cost and physical capabilities. Generators are dispatched sequentially from lowest to highest cost. The last generator to be d at any point in time is referred to as the marginal generator, and typically sets the market price for that market period.

Online Tap Changer (OLTC): A selector switch device, which may include current interrupting contactors, used to change transformer taps with the transformer energized and carrying full load. An OLTC raises or lowers feeder voltage by small amounts for voltage regulation purposes.

Operating Reserves: A combination of contingency reserves, regulation reserves, and sometimes load-following reserves. This term is not standard; different definitions are relatively widespread.

Passive Load: Loads that behave in a manner that approximates simple impedance (e.g. HVAC and lighting); some loads may have special characteristics in terms of inrush current, flicker, etc.

Peaking Plants: These plants are often combustion turbines with low capital cost and high or very high fuel costs. They are therefore used sparingly, often only a handful of times a year during extreme peak periods of demand.

Picogrid: An individual device with its own internal battery for operation when external sources are not available or not preferred, and for managed use of the battery.

Power Distribution: Technology and infrastructure that moves electrons from devices where they are available to devices where they are wanted.

Power Flow: The flow of electric power in a (transmission) system.

Power Flow Control: The process of controlling the path(s) through which power flows, to achieve a specific objective; for example, to improve the utilization of transmission lines.

Power Quality: Any power problem manifested in voltage, current, or frequency deviations that results in failure or misoperation of customer equipment. In many cases, power quality refers to voltage quality.

Power System: The generation resources and/or transmission facilities operated as an entity to meet load and/or interchange commitments.

Power Transformer: A transformer that transfers electric energy in any part of the circuit between the generator and the distribution primary circuits.

Prosumer: In the context of distributed energy resources, an energy consumer that is also individually capable of storing and producing electricity.

Protection System: An arrangement of one or more protection equipments and other devices intended to perform one or more specified protection functions. A protection system includes one or more protection equipments, instrument transformer(s), wiring, tripping circuit(s), auxiliary supply(s) and, where provided, communication system(s). Depending upon the principle(s) of the protection system, it may include one end or all ends of the protected section and, possibly, automatic reclosing equipment.

Public Utility District (PUD): A special-purpose jurisdiction that provides public utility services.

Public Utility Commission: The state agency that regulates the activities of investor-owned utilities (and also municipal utilities in some states).

Regional Transmission Organization (RTO): A non-profit, public-benefit organization that carries out system planning, grid operations, and regional reliability activities. Generally has greater responsibility for a transmission network as established by FERC, and may cover a larger geographical area than an **Independent System Operator**.

Regional Transmission Organization (RTO): Responsible for maintaining system balance, reliability, and electricity market operation.

Radial Feeder: A feeder supplying electric energy to a substation or a feeding point that receives energy by no other means. The normal flow of energy in such a feeder is in one direction only.

Ramp Rate: Ramp rate describes the ability of a generating unit to changes its output, and is often measured in megawatts/min.

Ramp: A change in generation output over some unit of time.

Rated Capacity: Maximum capacity of a generating unit.

Reactive Power: The product of voltage and out-of-phase component of alternating current. In a passive network, reactive power represents the alternating exchange of stored energy (inductive or capacitive) between two areas. Reactive power is developed when there are inductive, capacitive, or nonlinear elements in the system. It does not represent useful energy that can be extracted from the system but it can cause increased losses and excessive voltage peaks. Reactive power flow causes undesirable effects in the power grid but does not generate revenue for the utility.

Reactive Supply: The supply of dynamic reactive power, typically from generation, to control transmission system voltages.

Real (Active) Power: The time average of the instantaneous power over one period of the wave. For sinusoidal quantities in a two-wire circuit, it is the product of the voltage, the current, and the cosine of the phase angle between them. For non-sinusoidal quantities, it is the sum of all the harmonic components, each determined as above. In a polyphase circuit, it is the sum of the active powers of the individual phases. Real power performs useful work at the load, as opposed to reactive power, which does not.

Real-time Market: The competitive generation market controlled and coordinated by the **Independent System Operator** for arranging real-time imbalance power. Also referred to as spot market.

Recloser (Automatic Circuit Recloser, ACR): A self-controlled device for automatically interrupting and reclosing an alternating-current circuit, with a predetermined sequence of opening and reclosing followed by resetting, hold-closed, or lockout operation. When applicable, it includes an assembly of control elements required to detect overcurrents and control the recloser operation. Reclosers improve average reliability by avoiding whole feeder circuit breaker trips for small temporary faults.

Regulation Reserve: Capacity that is devoted to providing the fast up and down balancing service. In the US, regulating capacity is controlled by computers (automatic generation control, or AGC). Regulation duty can sometimes be procured in a market.

Regulation: The use of on-line generation, storage, or load that is equipped with automatic generation control (AGC) and that can change output quickly (megawatts/min) to track the moment-to-moment fluctuations in customer loads and to correct for the unintended fluctuations in generation. Regulation helps to maintain interconnection frequency, manage differences between actual and scheduled power flows between control areas, and match generation to load within the control area.

Reliability: The probability that a system will perform its intended functions without failure, within design parameters, under specific operating conditions, and for a specific period of time. In the utility industry, reliability is often expressed as system reliability indices, for example Customer Average Interruption Duration Index (CAIDI), Average Service Unavailability Index (ASUI), and many others.

Reliability Coordinator: The entity that is the highest level of authority who is responsible for the reliable operation of the **Bulk Power System**, has the wide area view of the **Bulk Power System**, and has the operating tools, processes and procedures, including the authority to prevent or mitigate emergency operating situations in both next-day analysis and real-time operations.

Reliability Region: The collection of generation, transmission, and loads within the boundaries of the

Reliability Coordinator. Its boundary coincides with one or more **Balancing Authority Areas**.

Requirement: A desired feature, property, or behavior of a system.

Resilience: The degree to which an electric grid is hardened to natural and man-made disasters, and may include damage prevention, recovery (rapid damage assessment, deployment of repair crew, and availability of replacement components), and survivability (the ability to maintain a basic level of electrical functionality to consumers and communities in the event of a complete loss of electrical service from a distribution system).

Responsive Load: Customer load that can respond to signals from the utility to aid in grid operations; commercial building and residential **Demand Response** are two conspicuous examples.

Reverse Power Flow (Backfeeding): To energize a section of a power network that is supplied from a source other than its normal, upstream source. This can occur in distribution networks, for example, under certain conditions with **Distributed Generation**, sometimes with negative consequences.

Rotating Machine: An electric apparatus depending on electromagnetic induction for its operation and having one or more component members capable of rotary movement.

Scheduling: The general practice of ensuring that a generator is committed and available when needed. It also can refer to scheduling of imports or exports of energy into or out of a balancing area.

Sectionalization: A process in a self-healing distribution circuit whereby the circuit is divided into sections through the opening of remote-controlled switches and/or reclosers, to isolate a fault.

Self-healing Distribution Circuit: A distribution circuit with technologies that support fault location, isolation and service restoration (FLISR). The operation of field devices, software, and dedicated communication networks are coordinated to automatically determine the location of a fault, and rapidly reconfigure the flow of electricity so that some or all of the customers can avoid experiencing outages.

Settlement: Settlements are the calculation, billing, and invoicing of charges and payments for market and transmission-related activities between market participants and an **Independent System Operator.**

Small Signal Oscillation: The result of poor electromechanical damping that may lead to large-amplitude oscillations which can negatively affect a power system. Low damping of such signals indicates potential system stability issues.

Smart Grid: See **Grid, Smart/Intelligent**.

Solar Photovoltaic (PV): Technology for generating electricity directly from sunlight using the photovoltaic property of silicon.

Spinning Reserve: Generation and responsive load that is on-line, begins responding immediately, and is fully responsive within ten minutes. Part of contingency reserves must be spinning reserve.

Spot Network: A small network, usually at one location, consisting of two or more primary feeders, with network units and one or more load service connections.

Stack: The collection of available generators arranged in economic order. This term is often applied in the context of a specific type of system operation. For example, the dispatch stack refers to all generating units that are available for dispatch (have been committed or are quick-start units). The commitment stack refers to all generation units that have been committed or are available for commitment.

Sub-hourly Energy Markets: Electricity markets that operate on time steps of 5 minutes. Approximately 60% of all electricity in the U.S. is currently traded in sub-hourly markets, running at 5-minute intervals so that maximum flexibility can be obtained from the generation fleet.

Substation: An assemblage of equipment for purposes other than generation or utilization, through which electric energy in bulk is passed for the purpose of switching or modifying its characteristics. Service equipment, distribution transformer installations, or other minor distribution or transmission equipment are not classified as substations. A substation is of such size or complexity that it incorporates one or more buses, a multiplicity of circuit breakers, and usually is either the sole receiving point of commonly more than one supply circuit, or it sectionalizes the transmission circuits passing through it by means of circuit breakers.

Supplemental Reserve: Generation and responsive load that is off-line but can be fully responsive within 10 minutes to replace spinning reserve that has been activated in response to a contingency or other power system need. Supplemental operating reserve is one of the contingency reserves.

Switchgear: A general term covering switching and interrupting devices and their combination with associated control, instrumentation, metering, protective and regulating devices, also assemblies of these devices with associated interconnections, accessories and supporting structures used primarily in connection with the generation, transmission, distribution, and conversion of electric power.

Synchronization: The state where connected alternating-current systems, machines, or a combination operate at the same frequency and where the phase angle displacement between volt- ages in them are constant, or vary about a steady and stable average value.

Synchronous Machine: A machine in which the average speed of normal operation is exactly proportional to the frequency of the system to which it is connected.

System Control: The central control function performed by the system operator that controls generation, demand response, and transmission assets to reliably and economically serve load.

System Inertia: The sum of rotational inertias exerted by the various rotating machine generators connected to a transmission grid.

Three-Phase: A combination of circuits energized by alternating electromotive forces that differ in phase by one-third of a cycle (120 degrees).

Tie Line: Individual **Balancing Authority Areas** (BAAs) have transmission connections to neighboring BAAs. The electrical configuration of these connections, called tie lines, vary significantly. Part of the job of balancing supply and demand includes maintaining balance on the tie lines. Thus actual flows must equal scheduled flows, within a small allowable tolerance.

Tier Hopping: Distributed Energy Resource dispatch mechanisms used by some **Independent System Operators** and **Regional Transmission Organizations** that bypass local distribution companies.

Top-down: Deriving a hierarchical structure by successive subdivision from the top. Also known as stepwise refinement.

Topology: The interconnection pattern of nodes in a network. With respect to the grid, it is the interconnection pattern of entities that facilitate power generation, transmission, distribution and consumption.

Transactive Building: A building that participates in grid management by supplying services to the grid in a transactive energy mode; transactive energy refers to techniques for managing the generation, consumption or flow of electric power within an electric power system through the use of economic or market based constructs while considering grid reliability constraints. The term "transactive" comes from considering that decisions are made based on a value. These decisions may be analogous to or literally economic transactions.

Transactive Control: Control systems and signals that support **Transactive Energy**.

Transactive Energy: Techniques for managing the generation, consumption or flow of electric power within an electric power system through the use of economic or market based constructs while considering grid reliability constraints.

Transmission Loading Relief (TLR): A process that allows **Reliability Coordinators** to mitigate potential or actual operating security limit violations while respecting transmission service reservation priorities.

Transmission Operator: The entity responsible for the reliability of its local transmission system, and that operates or directs the operations of the transmission facilities.

Transmission System: An interconnected group of electric transmission lines and associated equipment for the movement or transfer of electric energy in bulk between points of supply and points for delivery.

Trip: The action associated with the opening of a circuit breaker or other interrupting device.

Turn-down Capability: The minimum stable generation level that can be achieved by a generating unit.

Uninterruptable Power Supply (UPS): A system designed to provide power automatically, without delay or transients, during any period when the normal power supply is incapable of performing acceptably.

Unit: A single generator that may be part of a multiple-generator power plant.

Unit Commitment: The process of starting up a generator so that boilers reach operating temperature and the plant is synchronized to the grid. This process can take many hours for a steam generator, depending on whether the plant is warm or hot from previous commitment.

Unloaded Capacity: Generating capacity that is spinning and synchronized to the grid, but is not providing energy.

Utility: A provider of electricity, gas, water, telecommunications, or related services to a community.

Utilization Voltage: For 120–600 V systems, optimally 110–125 V (Range A).

Vertically Integrated Utility: A utility that owns and operates all elements of the utility infrastructure and that provides all customer services.

Volt-Amperes Reactive (VAr): The units in which reactive power is measured (real power consumed by the utility customer is measured in watts). Volts are the units for the pressure that causes electricity to flow in a circuit; amperes are the units of current flow.

Volt-VAr Control (VVC): The process of managing voltage levels and reactive power throughout a power distribution system. VVC can be performed locally or centrally.

Voltage Regulation: The degree of control or stability of the root mean square (RMS) voltage at the load. Often specified in relation to other parameters, such as input voltage changes, load changes, or temperature changes.

Wholesale Energy Market: The buying and selling of power between the generators and resellers. Resellers include electricity utility companies, competitive power providers and electricity marketers. For most regions within the US, the operation of, and transactions in, the wholesale market, are regulated by the **Federal Energy Regulatory Commission**.

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