A. Glossary and Acronyms

These glossary and acronym entries clarify the terms and concepts used throughout this *2018 Integrated Resource Pan*, and aid in its comprehension and scope.

A

Advanced Distribution Management System (ADMS). A software platform that supports the full suite of distribution management and optimization functions that automate outage restoration and optimize the performance of the distribution grid. An ADMS is capable of collecting, organizing, displaying, and analyzing real-time or near real-time electric distribution system information, which allows operators to plan and execute complex distribution system operations to increase system efficiency, optimize power flows, and prevent overloads.

Advanced Metering Infrastructure (AMI). An integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers. Functions include automatically and remotely measuring electricity use, connecting and disconnecting service, detecting tampering, identifying and isolating outages, and monitoring voltage. When combined with customer technologies (such as in-home displays and programmable communicating thermostats), AMI can be used to offer time-based rates as well as incentives to reduce peak demand and to manage energy consumption and costs.

Alternating Current (AC). An electric current whose flow of electric charge periodically reverses direction. In many developed countries, alternating current is the form in which electric power is delivered to businesses and residences. The usual waveform of an AC power circuit is a sine wave. The usual power system frequency is 60 hertz (1 hertz (Hz), which is 60 cycles per second.

Ancillary Services. Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the electric grid in accordance with good utility practice.

Automatic Generation Control (AGC). A process for adjusting demand and resources from a central location to help maintain frequency. AGC helps balance supply and demand. (See also Regulating Reserves on page A-18.)

Auxiliary Load. The load that serves the power plant itself, normally served by the power plant itself, but also served by the power grid when the power plant is offline.

Avoided Costs. The costs that utility customers would avoid by having the utility purchase capacity or energy from another source (for example, energy storage or demand response) or from a third party, compared to having the utility generate the electricity itself. Avoided costs comprise two components:

- Avoided capacity costs, which includes avoided capital costs (for example, return on investment, depreciation, and income taxes) and avoided fixed operation and maintenance costs.
- Avoided energy costs, which includes avoided fuel costs and avoided variable operation and maintenance costs.

B

Balancing Authority (BA). The eastern United States and Canada interconnected grid is divided into over 100 balancing areas. A Balancing Authority is an area's main operator who matches generation with load.

Base Scenario. In resource planning: a set of assumptions used as a reference point for comparing other sets of assumptions.

Baseload. The minimum electric or thermal load that is supplied continuously over a period of time. (See also Load on page A-12.)

Baseload Capacity. See Capacity on page A-3.

Baseload Generation. Electric generation units that produce electricity at a constant rate—almost always at full capacity—to meet the system's baseload (continuous energy need). Baseload units have the lowest incremental cost of all units on the system; thus, are operated virtually continuously and are taken offline relatively infrequently.

Battery Energy Storage System (BESS). Any battery storage system used for contingency or regulating reserves, load shifting, ancillary services, peaking, or other utility or customer functions. (See also Energy Storage on page A-7.

Biomass. Organic non-fossil biological material constituting a renewable energy source that can be either processed into synthetic fuels or burned directly to produce steam or electricity.

Black Start Resource. A generating unit and its associated set of equipment that can be started without system support or can remain energized without connection to the remainder of the system, and that has the ability to energize a bus, thus meeting a restoration plan's needs for real and reactive power capability, frequency and voltage control, and is included in the restoration plan.

British Thermal Unit (Btu). A unit of energy equal to about 1055 joules that describes the energy (heat) content of fuels. A Btu is the amount of heat required to raise the temperature of 1 pound of water by 1°F at a constant atmospheric pressure. When measuring electricity, the proper unit would be Btu per hour (or Btu/h) although this is generally abbreviated to just Btu. The term MBtu means a thousand Btu; the term MMBtu means a million Btu. The price of fuel is typically expressed in dollars per million Btu (or $/MMBtu).

C

Cap-and-Trade. Financial incentives to control emissions reductions. A central authority (usually a government or international body) sets a limit or cap on the amount that can be emitted, then issue emission permits for a number of allowances (or credits) for emitting a specific amount that cannot exceed the cap, thus limiting total emissions. Utilities needing to increase their emissions must buy—trade—credits from utilities that emit less than their cap. This approach caps emissions at a preset

amount, regardless of which utilities is emitting them.

Capacitor. A device that stores an electrical charge to correct AC voltage so that the voltage is in phase with the AC current. Capacitors are typically installed in substations and on distribution system poles, at locations where local voltage correction can reduce system current flow, reducing losses and improves efficiency.

Capacity. The rated maximum continuous load-carrying ability, expressed in megawatts (MW) or megavolt-amperes (MVA), of an electric generation plant. Most generation plants are not operated at their maximum capacity rating. Types of capacity include the following:

- ***Baseload Capacity.*** Those generating facilities within a utility system that are operated to the greatest extent possible to maximize system mechanical and thermal efficiency and minimize system operating costs. Baseload capacity typically operates at high annual capacity factors, for example greater than 60%.
- ***Firm Capacity.*** Capacity that is intended to be available at all times during the period covered by a commitment, even under adverse conditions.
- ***Installed Capacity (ICAP).*** The total capacity of all generators able to serve load in a given power system, or the total wattage of all generation resources to serve a given service or control area.
- ***Intermediate Capacity.*** Flexible generators able to efficiently increase or decrease their power output across a wide band of loading conditions (referred to as load following). Also known as Cycling Capacity. Typically, annual capacity factors for intermediate duty generating units range from 20% to 60%. The incremental cost of operating these units is higher than baseload units, but less than peakers.
- ***Net Capacity.*** The maximum capacity (or effective rating), modified for ambient limitations, that a generating unit, power plant, or electric system can sustain over a specified period, less the capacity used to supply the demand of station service or auxiliary needs.
- ***Peaking and Emergency Capacity.*** Generators typically called on for short periods of time during system peak load conditions or as replacement resources following contingencies. Annual capacity factors for peaking generation are typically less than 20%. Peakers run at the highest incremental cost of all units on the system.

Capacity Factor. The ratio of the average operating load of a generation unit for a period of time to the full nameplate capacity during that same period of time, expressed as a percentage of the unit's maximum capacity.

Capital Expenditures. Funds expended by a utility to construct, acquire, or upgrade physical assets (generating plants, energy storage devices, transmission plant, distribution plant, general plant, major software systems, or IT infrastructure). Capital expenditures for a given asset include funds expended for the acquisition and development of land related to the asset, obtaining permits and approvals related to the asset, environmental and engineering studies specifically related to construction of the asset, engineering design of the asset, procurement of materials for the asset, construction of the asset, and startup activities related to the asset. Capital expenditures may be associated with a new asset or an existing asset (that is, renovations, additions, upgrades, and replacement of major components).

Carbon Dioxide (CO_2). A greenhouse gas produced as a by-product of burning fossil fuels and biomass.

Carbon Monoxide (CO). A major air pollutant produced in large quantities in the exhaust of gasoline-powered vehicles because of the incomplete combustion of carbon-containing substances.

Clean Air Act (CAA). The federal law that regulates emissions into the atmosphere nationwide. The Environmental Protection Agency, who has prime responsibility for administering the CAA, develops and enforces regulations to protect the general public from exposure to airborne contaminants.

Combined Cycle (CC). Twin-stage natural gas-fired power plants that deliver higher fuel efficiency. A combination of combustion turbine- and steam turbine-driven electrical generators, where the combustion turbine exhaust is passed through a heat recovery waste heat boiler which, in turn, produces steam which drives the steam turbine. Using the residual heat from the combustion turbine contributes to the unit's fuel efficiency. There are a number of possible configurations for combined cycle units. Three common configurations are: a 3x1 Combined-Cycle: three combustion turbines, three heat recovery waste heat boilers, and one steam turbine; a Dual-Train Combined-Cycle (DTCC): two combustion turbines, two heat recover waste heat boilers, and one steam turbine; and a Single-Train Combined-Cycle (STCC): one combustion turbine, one heat recovery waste heat boiler, and one steam turbine.

Combined Heat and Power (CHP). The simultaneous production of electric energy and useful thermal energy for industrial or commercial heating or cooling purposes. The Energy Information Administration (EIA) has adopted this term in place of cogeneration.

Combustion Turbine (CT). Any of several types of high-speed generators using principles and designs of jet engines to produce low cost, high efficiency power; also commonly referred to as a gas turbine. Combustion turbines typically use natural gas or liquid petroleum fuels to operate. Ambient air is compressed to high pressures in a compressor where a gaseous fuel source is added and combusted in the combustor. The resulting hot gases are then expanded through a turbine to drive both an electric generator and the compressor section.

Compact Fluorescent Lamp (CFL). A type of fluorescent lamp that uses less power and has a longer rated life than a comparable incandescent lamp. A CFL also gives off much less heat than an incandescent bulb, resulting in seasonal energy implications.

Comprehensive Energy Plan (CEP). As its name suggests, the CEP establishes specific, measurable goals and objectives in land use, buildings, transportation, and energy for Vermont, including a dramatic increase in renewable generation. Created by the Vermont Department of Public Service, and updated every three years. (See also Vermont Electric Plan on page A-23.)

Concentrated Solar Thermal Power (CSP). A technology that uses mirrors to concentrate solar energy to drive traditional steam turbines or engines to generate electricity. This class of solar technologies includes solar trough, power towers, parabolic dish-Stirling generator, and concentrating photovoltaics A CSP plant can store this energy until needed to meet demand.

Conductor. An object or type of material, almost always an aluminum or copper metal wire, that allows an electrical current to flow in one or more directions.

Conductor Sag. The distance between the connection point of a conductor (transmission and distribution line) and the lowest point of the line.

Connected Load. See Load on page A-12.

Contingency. An unplanned event that creates an outage of a transmission line, transformer, or generator.

Contingency Reserves. Reserves added to balancing reserves deployed to meet contingency disturbance requirements, typically based upon the largest single contingency on the grid. Contingency reserves are usually automatically initiated, and intended to bolster short-term reliability during forced outages.

Curtailment. Cutting back on variable resources to keep generation and consumption of electricity in balance.

Customer Average Interruption Duration Index (CAIDI). The average duration for customers experiencing an outage.

Cycling. The operation of generating units at varying load levels (including on-off and low load variations), in response to changes in system load requirements. Cycling causes a power plant's boiler, steam lines, turbine, and auxiliary components to go through unavoidably large thermal and pressure stresses.

D

Day-Ahead Energy Market. Energy trading that engages in forward markets covering the 24-hour period before any given day. It matches buyers and sellers in a financially binding commitment to purchase energy on the following day. (See also Real-Time Energy Market on page A-18.

Daytime Minimum Load (DML). The absolute minimum demand for electricity between 9 AM and 5 PM on one or more circuits each day.

Delivered Cost. The cost of power produced by a generating unit (or power purchase agreement) that includes the cost of delivering the electric power from the generating source to the load center.

Demand. The rate at which electricity is used at any one given time (or averaged over any designated interval of time). Demand differs from energy use, which reflects the total amount of electricity consumed over a period of time. Demand is measured in kilowatts or megawatts (kW = 1 kilowatt = 1,000 watts or 1 MW), while energy use is measured in kilowatt-hours or megawatt hours (for example, kWh = kilowatts x hours of use = kilowatt-hours). Load is considered synonymous with demand. (See also Load on page A-12.)

Demand Response (DR). Mechanisms that provide incentives to customers to reduce their load in response to high electric market prices, short-term demand spikes, or electric system reliability concerns. The underlying objective of demand response is to actively engage customers in reducing their demand for electricity to address system needs, in lieu of increasing the amount of utility-scale generation to address system needs. Demand response measures could include direct load control programs (such as cycling air conditioner load or slightly reducing the watt output of large-scale lighting) or customer-initiated load reductions. Demand response programs include real-time pricing, dynamic pricing, critical peak pricing, time-of-use rates, and demand bidding or buyback programs.

Demand-Side Management (DSM). The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand—in other words, managing demand patterns. It refers only to modifying energy and load-shapes that are undertaken in response to utility or third party-administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy efficiency standards. Demand-side management covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.

Demand-Side Resources. Resources on the customer side of the meter that reduce overall system load.

Direct Current (DC). An electric current whose flow of electric charge remains constant. Certain renewable power generators (such as solar photovoltaics) deliver DC electricity, which must first be converted to alternating current (AC) electricity, using an inverter, for use in the power system.

Direct Load Control (DLC). This demand-side management category represents the consumer load that can be interrupted by direct control by a utility system operator. For example, the utility may install a device (such as a radio-controlled device) on a customer's air conditioning equipment or water heater. During periods of system need, the operator sends a radio signal to device-equipped appliances to control the appliance for a set period of time.

Direct Transfer Trip (DTT). A protection mechanism that originates from station relays in response to a specific system event. Remote events, such as generator trips, can cause load shed through DTT.

Discount Rate. An interest rate used to convert future cash flows to present values.

Dispatchable Generation. A generation source controlled by a system operator or dispatcher who can increase or decrease the amount of power from that source as the system requirements change based upon economic or other considerations. Different types of generating units have varying degrees of dispatchability.

Distributed Energy Resources (DER). Decentralized small generation (such as rooftop solar panels), typically 10 megawatts or less, sited at or near load, attached to the distribution grid or a customer's electrical system. DERs serve as primary or backup energy sources, and use various technologies including combustion turbines, reciprocating engines, fuel cells, and wind generators, but mostly solar photovoltaics in the form of rooftop solar panels. Also known as Distributed Generation.

Distributed Energy Storage System (DESS). Energy storage systems on the distribution circuit, generally sited at substations and customer property.

Distributed Generation. See Distributed Energy Resources on page A-6.

Distribution Circuit. The physical elements of the grid involved in carrying electricity from the transmission system to end users.

Distribution Transformer. A transformer used to step down voltage from the distribution circuit to levels appropriate for customer use.

Disturbance Ride-Through. The capability of resources to remain connected to the grid during transient off-normal voltage and frequency conditions that occur for typical system disturbances.

Droop and Droop Response. The amount of speed (or frequency) change that is necessary to cause the main prime mover control mechanism to move from fully closed to fully open. In general, the percent movement of the main prime mover control mechanism can be calculated as the speed change (in percent) divided by the per unit droop. Droop response is the time it takes for online generators to pick up load following a contingency event. Electrical systems with faster droop response times can better withstand contingency events.

E

Economic Dispatch. The allocation of load to online dispatchable generating units based on their costs, to affect the most economical production of electricity for customers.

Efficiency Vermont (EVT). Founded in 2000 as the nation's first energy efficiency utility, Vermont's objective advisor to homeowners, businesses, and communities on saving energy through efficiency. EVT provides technical services and financial support as well as train and partner with local providers of efficient goods and services.

Electric Grid. See Grid (Electric) on page A-10.

Electric Power Research Institute (EPRI). A nonprofit research and development organization that conducts research, development, and demonstration relating to the generation, delivery, and use of electricity.

Electric Vehicle (EV). A vehicle that uses one or more electric motors or traction motors for propulsion.

Electric Vehicle Supply Equipment (EVSE). An element in an infrastructure that supplies electric energy for the recharging of electric vehicles (such as plug-in electric vehicles, electric cars, and plug-in hybrids); also called an electric vehicle (EV) charging station, electric recharging point, charging point, charge point, or electronic charging station (ECS).

Electricity. The set of physical phenomena associated with the presence and flow of electric charge.

Emissions. Polluting discharges (such as carbon dioxide and sulfur dioxide) into the atmosphere from electric power plants, commercial and industrial facilities, residential chimneys, and from vehicle (automobile, locomotive, or aircraft) exhaust during normal operation. These pollutants may be classified as primary (emitted directly from the source) or secondary (formed in the atmosphere from primary pollutants). The pollutants emitted vary based on the type of fuel.

Energy. The amount of electricity a generation resource produces, or an end user consumes, in any given period of time. Energy is computed as capacity or demand (kilowatts, megawatts, or gigawatts) multiplied by time (hours). For example, a one-megawatt power plant running at full output for one hour produces one megawatt-hour (1,000 kilowatt-hours) of electrical energy.

Energy Efficiency (EE). Actions taken by customers to reduce their overall consumption of electric energy. Reductions are generally achieved by substituting more energy efficient equipment (such as high-efficiency appliances, water heaters, and CLF or LED light bulbs), improving the thermal envelopes of structures, or changing behavior. Energy efficiency improvements can be encouraged through utility-sponsored programs, mandated by building codes or other standards, implemented by the customer, or prompted by Efficiency Vermont.

Energy Information Administration (EIA). A principal agency of the United States Federal Statistical System (within the U.S. Department of Energy) responsible for collecting, analyzing, and disseminating energy information. One of its major roles is to provide publicly available fuel price projections for the power generation industry.

Energy Management System (EMS). A centralized system of computer-aided tools used to monitor, control, and optimize the performance of the utility power system and interconnected resources.

Energy Storage. A system or a device capable of storing electrical energy for future use. Three major types of energy storage are:

- ***Battery.*** An energy storage device composed of one or more electrolyte cells that stores chemical energy. A large-scale battery can provide a number of ancillary services, including frequency regulation, voltage support (dynamic reactive power supply), load following, and black start capability as well as providing energy services such as peak shaving, valley filling, and potentially energy arbitrage. (See also Battery Energy Storage System on page A-2 and Distributed Energy Storage System on page A-6.)
- ***Flywheel.*** A cylinder that spins at very high speeds, storing rotational kinetic energy. A flywheel can be combined with a device that operates either as an electric motor that accelerates the flywheel to store energy or as a generator that produces electricity from the energy stored in the flywheel. The faster the flywheel spins, the more energy it retains. Energy can be drawn off as needed by slowing the flywheel. A large flywheel plant can provide a number of ancillary services including frequency regulation, voltage support (dynamic reactive power supply), and spinning reserve.
- ***Pumped Storage Hydroelectric.*** Pumped storage hydro facilities typically use off-peak electricity to pump water from a lower reservoir into one

at a higher elevation storing potential energy. When the water stored in the upper reservoir is released, it is passed through hydraulic turbines to generate electricity. The off-peak electrical energy used to pump the water uphill can be stored indefinitely as gravitational energy in the upper reservoir. Thus, two reservoirs in combination can be used to store electrical energy for a long period of time, and in large quantities. A modern pumped-storage facility can provide a number of ancillary services, such as frequency regulation, voltage support (dynamic reactive power), spinning and non-spinning reserve, load following, and black start capability as well as energy services such as peak shaving and energy arbitrage.

- **Thermal Energy Storage.** Allows excess thermal energy to be stored and used hours, days, or months later to balance energy demand between daytime and nighttime, storing summer heat for winter heating, or winter cold for summer air conditioning; considered an important method to inexpensively balance high penetration of variable renewable electricity. Storage media include water heater tanks or ice-slush tanks. Sources of thermal energy for storage include heat or cold produced with heat pumps from off-peak, lower cost electric power; heat from combined heat and power (CHP) plants; and heat produced by renewable energy that exceeds grid demand.

Environmental Protection Agency (EPA). The federal agency established in 1970 to research, monitor, and establish standards that protect human health and the environment. The EPA also has the authority to enforce regulations when necessary, although normally the states implement them.

Expense. An outflow of cash or other consideration (for example, incurring a commercial credit obligation) from a utility to another person or company in return for products or services (such as fuel expense, operating expense, maintenance expense, sales expense, customer service expense, or interest expense). An expense might also be a non-cash accounting entry where an asset (created as a result of a capital expenditure) is used up (for example, depreciation expense) or a liability is incurred.

F

Fast Frequency Response (FFR1 and FFR2). Reduces the rate of change of frequency (RoCoF) with a response proportional to the generation contingency, and quickly restores the balance between supply and demand following a loss of load, thus reducing operational down reserves from synchronous generation. FFR1 is a proportional response that reduces the RoCoF caused by the loss of generation. FFR2 reduces the RoCoF caused by the loss of generation. FFR2 is considered fixed because, once committed, it cannot be altered; however, the amount available can be variable because the FFR2 capacity depends on customer load.

Fault. Any abnormal electric current, a deviation from the expected values of voltage, on an open electric circuit.

Federal Energy Regulatory Commission (FERC). The federal agency that regulates the interstate transmission of electricity and natural gas and their wholesales transactions; regulates the transportation of oil by pipeline; and licenses non-federal hydropower projects. FERC also reviews proposals to build interstate natural gas pipelines, natural gas storage projects, and liquefied natural gas (LNG) terminals.

Feeder. A circuit carrying power from a major conductor to a one or more distribution circuits.

Firm Capacity. See Capacity on page A-3.

Feed-In Tariff (FIT). A policy mechanism for the rate at which exported DERs are compensated by the

utility, designed to accelerate investments in renewable energy.

Flywheel. See Energy Storage on page A-7.

Forced Outage. See Outage on page A-15.

Forced Outage Rate. See Outage on page A-15.

Forward Capacity Market (FCM). A market operated by ISO-New England to ensure that their jurisdictional area will have sufficient resources to meet future needs. FCM uses an auction system for purchasing sufficient power capacity for reliable system operation for a future year at competitive prices where both new and existing resources can participate.

Fossil Fuel. Any naturally occurring fuel formed from the decomposition of buried organic matter, essentially coal, petroleum (oil), and natural gas. Fossil fuels take millions of years to form, and thus are non-renewable resources. Because of their high percentages of carbon, burning fossil fuels produces about twice as much carbon dioxide (a greenhouse gas) as can be absorbed by natural processes.

Frequency. The number of cycles per second through which an alternating current passes. Frequency has been standardized in the United States electric utility industry at 60 cycles per second (60 Hz). The balancing authority and utility operator strive to maintain the system frequency as close as possible to 60 Hz at all times by varying the output of dispatchable generators, typically through automatic means. In general, if demand exceeds supply, the frequency drops below 60 Hz; if supply exceeds demand, the frequency rises above 60 Hz. If the system frequency drops to an unacceptable level (under-frequency) or rises to an unacceptable level (over-frequency), a system failure can occur. Accordingly, system frequency is an important indicator of the power system's condition at any given point in time.

Frequency Regulation. The effort, within fractions of seconds, to keep an alternating current at a consistent 60 hertz per second (or other fixed standard).

Fuel Cell. A device that converts chemical energy into electrical energy using a fuel. Fuel cells require a constant supply of fuel and oxygen for its chemical reaction, unlike batteries where the chemicals react with each other to provide the electricity.

Full-Forced Outage. See Outage on page A-15.

G

Generating Capacity. See **Capacity** on page A-3.

Generation (Electricity). The process of producing electrical energy from other forms of energy; also, the amount of electric energy produced, usually expressed in kilowatt-hours (kWh) or megawatt hours (MWh). Generation output can be specified as either:

- ***Nameplate Generation (Gross Generation).*** The electrical output at the terminals of the generator, usually expressed in megawatts.
- ***Net Generation.*** Gross generation minus station service or unit service power requirements, usually expressed in megawatts. For example, the energy required for pumping at a pumped storage hydroelectric facility is regarded as plant use and must be deducted from the gross generation.

Generator (Electric). A machine that transforms mechanical, chemical, or thermal energy into electric energy, which includes wind generators, solar PV generators, and other systems that convert energy of one form into electric energy.

Geographic Information System (GIS). A computer system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.

Gigawatt (GW). A unit of power, capacity, or demand equal to one billion watts, one million kilowatts, or one thousand megawatts.

Gigawatt-Hour (GWh). A unit of electric energy equal to one billion watt-hours, one million kilowatt-hours, or one thousand megawatt-hours.

Greenhouse Gases (GHG). Any gaseous substance (mostly carbon dioxide, methane, sulfur dioxide, and nitrogen oxides) that has been shown to warm the earth's atmosphere by trapping solar radiation. Greenhouse gases also include chlorofluorocarbons, a group of chemicals used primarily in cooling systems and which are now either outlawed or severely restricted by most industrialized nations.

Grid (Electric). An interconnected network of electric transmission lines and related facilities. The United States power grid comprises the eastern interconnection (including parts of Canada), the western interconnection (including parts of Canada and Mexico), and the Texas interconnection. These networks include extra-high-voltage connections between individual utilities, which transfer electrical energy from one part of the network to another. The interconnects distribute electricity in their respective areas via a network of smaller units that enable better management of power distribution.

Grid-Scale Generation. See Utility-Scale Generation on page A-22.

Gross Generation. See Generation (Electricity) on page A-9.

H

Heat Rate. A measure of thermal energy required to produce a given amount of electric energy, usually expressed in British thermal units per net kilowatt-hour. Heat rate indicates the efficiency with which thermal energy is converted into electric energy, and thus measures the performance of power plants. Heat rate is measured by dividing the rate of fuel consumption (Btu per hour) by the resulting generated electric energy (net kilowatt-hours).

Heat Recovery Steam Generator (HRSG). An energy recovery heat exchanger that recovers heat from a hot exhaust gas stream, and produces steam that can be used in a process (cogeneration) or used to drive a steam turbine in a combined-cycle plant.

Hydrokinetic Energy. Several technologies that capture the energy from flowing water that occurs in rivers and mostly in ocean currents, including tidal range, tidal stream, ocean current energy (river in-stream energy), ocean wave energy, ocean thermal energy conversion (OTEC), and salinity gradient.

I

Impacts. The positive or negative consequences of an activity. For example, there may be negative consequences associated with the operation of power plants from the emission discharge or release of a material to the environment (for example, health effects). There may also be positive consequences resulting from the construction and siting of power plants which could affect society and culture.

Impedance. A measure of the opposition to the flow of power in an alternating current circuit.

Independent Power Producer (IPP). Any entity that owns or operates an electricity generating facility that is not included in an electric utility's rate base. This term includes, but is not limited to, co-generators (or combined heat and power generators) and small power producers (including net metered and feed-in tariff systems) and all other non-utility electricity producers (such as exempt wholesale generators who sell electricity or exchange electricity with the utility). IPPs are sometimes referred to as non-utility generators.

Independent System Operator (ISO). An independent, member-based, nonprofit organization that oversees the operation of a bulk electric power

system, its transmission lines, and the electricity market generated and transmitted by its member utilities. The goal of an ISO is to operate the grid reliably and efficiently, provide fair and open transmission access, promote environmental stewardship, and facilitate effective markets and promote infrastructure development (similar to the goals of a regional transmission organization). ISO-New England is responsible for the transmission grid in all six New England states, including Vermont. Several ISOs operate within the electric power grid in the United States and Canada; not all areas of the electric grid, however, are covered by an ISO (or an RTO). (See also Regional Transmission Organization on page A-18.

Inertia. The response of generators from the kinetic energy in the rotating masses that remain online as frequency starts to drop following a contingency event. Inertia provides ride-through of momentary system disruptions to avoid a system contingency. Inertia reduces the rate of change of frequency (RoCoF), allowing slower governor actions to catch up and contribute to frequency stabilization. Electrical systems with high inertia are more robust and can better withstand contingency events.

Installed Capacity. See Capacity on page A-3.

Integrated Resource Plan (IRP). The plan created by electric utilities to identify the resources mix for meeting near-term and long-term energy needs. An IRP conveys the results from a planning, analysis, and decision-making process that examines and determines how a utility will meet future demands. Developed in the 1980s, the IRP process integrates efficiency and load management programs, considered on par with supply resources; broadly framed societal concerns, considered in addition to direct dollar costs to the utility and its customers; and public participation into the utility planning process. A number of factors—the massive influx of DERs and the resulting decentralization of generation, flat and declining demand, energy efficiency, renewable generation targets, two-way distribution systems and the resulting distribution planning, lower emission standards, and many others—are affecting a fundamental transformation in the IRP process, creating a more volatile planning environment and shorter planning horizons.

Interconnection Charge. A one-off charge to DER customers reflecting costs of studies and any potential upgrades (such as transformer upgrades) associated with distributed generation.

Intermediate Capacity. See Capacity on page A-3.

Internal Combustion Engines (ICE). A heat engine that combines fuel with an oxidizer (usually air) in a combustion chamber that creates pressure and mechanical force to generate electricity.

Inverter. A device that converts direct current (DC) electricity to alternating current (AC) either for stand-alone systems or to supply power to an electricity grid. An appropriately designed inverter can provide dynamic reactive power as well as real power and disturbance ride-through capability. A solar PV system uses inverters to convert DC electricity to AC electricity for use in the grid, or directly by a customer.

Investment Tax Credit (ITC). A financial vehicle that allows customers to take a dollar-for-dollar reduction in federal income taxes for qualified energy investments. Depending on the technology, certain energy property can also be considered qualified facilities for a production tax credit (PTC). Customers, however, must choose only one tax credit for facilities that qualify for both an ITC and a PTC. (See also Production Tax Credit on page A-17.

Islanding. A condition in which a circuit remains powered by non-utility generation (that is, distributed generation resources) even when the circuit has been disconnected from the wider utility power network.

ISO-New England (ISO—NE). ISO-New England is responsible for the transmission grid in all six New England states, including Vermont.

K

Kilowatt (kW). A unit of power, capacity, or demand equal to one thousand watts. The demand for an individual electric customer, or the capacity of a distributed generator, is sometimes expressed in kilowatts. The standard billing unit for electric tariffs with a demand charge component is the kilowatt. (See also Watt on page A-24.)

Kilowatt-Hour (kWh). A unit of electric energy equal to one thousand watt-hours. The standard billing unit for electric energy sold to retail consumers is the kilowatt-hour. (See also Watt-Hour on page A-24.)

L

Levelized Cost of Energy (LCOE). The price per kilowatt-hour for an energy project to break even; it does not include risk or return on investment.

Life-Cycle Costs. The total cost impact over the life of a program or the life of an asset. Life-cycle costs include capital expenditures, operation, maintenance and administrative expenses, and the costs of decommissioning.

Light-Emitting Diode (LED). A semiconductor light source used for lighting. LEDs present many advantages over incandescent light sources including lower energy consumption, improved robustness, smaller size, faster switching, greater durability and reliability, and lower generated heat.

Load. The moment-to-moment measurement of power that an end-use device or an end-use customer consumes. The total of this consumption plus planning margins and operating reserves is the entire system load. (Load is often used synonymously with demand. While related, the two concepts are fundamentally different.) Load consists of:

- ***Baseload.*** The constant generation of electric power load to meet demand.
- ***Connected Load.*** The sum of the capacities or ratings of the electric power consuming devices connected to a supplying system, or any part of the system under consideration.

Load Balancing. The efforts of the system operator to ensure that the load is equal to the generation. During normal operating conditions, the system operator utilizes load following and frequency regulation for load balancing.

Load Control Program. A program offering some form of compensation (for example, a bill credit) in return for having permission to remotely control a customer's energy use (such as an air conditioner or water heater) for defined periods of time in response to short-term increases in demand. (See also Demand Response on page A-5.)

Load Following. The ability of a generation resource to increase or decrease its power output in response to operator control to match near-simultaneous increases and decreases in load.

Load Forecast. An estimate of the level of future energy needs of customers in an electric system. Bottom-up forecasting uses utility revenue meters to develop system-wide loads; used often in projecting loads of specific customer classes. Top-down forecasting uses utility meters at generation and transmission sites to develop aggregate control area loads; useful in determining reliability planning requirements, especially where retail choice programs are not in effect.

Load Management. Electric utility or third-party marketing programs designed to encourage the utility's customers to adjust the timing of their energy consumption. By coordinating the timing of its customers' consumption, the utility can achieve a variety of goals including reducing the utility's peak system load; increasing the utility's minimum system load; and meeting unusual, transient, or critical system operating conditions.

Load Profile. Measurements of a customer's electricity usage over a period of time, which shows how much and when a customer uses electricity.

Load profiles can be used by suppliers and transmission system operators to forecast electricity supply requirements and to determine the cost of serving a customer.

Load Shedding. A purposeful, immediate response to curtail electric service. Load shedding is typically used to curtail large blocks of customer load (for example, particular distribution feeders) during an under-frequency event (when frequency drops below a certain level) when demand for electricity exceeds supply (for example, during the sudden loss of a generating unit).

Load Tap Changer (LTC). A substation controller used to regulate the voltage output of a transformer.

Locational Marginal Pricing (LMP). A method to establish a wholesale electric energy price that reflects the value of the energy at a specific location; the time it is delivered; and the patterns of load, generation, and physical limitations of the system. The purpose is to balance generation throughout the electric system by raising energy prices in constrained areas and reducing energy prices in unconstrained areas.

Loss-of-Load Probability (LOLP) or Loss of Load Expectation (LOLE). The probability that a generation shortfall (loss of load) would occur over a broad period of time. This probability can be used as a consideration in generation adequacy requirements. The LOLE is usually set as one day in ten years.

Low Voltages. Voltages above 0.9 per unit that are of concern because these voltages can become an under-voltage violation in the future.

M

Maintenance Outage. See Outage on page A-15.

MBtu. A thousand Btu. (See also British Thermal Unit on page A-2.)

Megawatt (MW). A unit of power, capacity, or demand equal to one million watts or one thousand kilowatts. Generating capacities of power plants and system demand are typically expressed in megawatts. (See also Kilowatt on page A-12 and Watt on page A-24.)

Megawatt-Hour (MWh). A unit of electric energy equal to one million watt-hours or one thousand kilowatt-hours. The energy output of generators or the amount of energy purchased from independent power producers is oftentimes specified in megawatt-hours. (See also Kilowatt-Hour on page A-12 and Watt-Hour on page A-24.)

Mercury and Air Toxics Standard (MATS). A federal standard that requires coal- and oil-fired power plants to limit the emissions of toxic air pollutants: particular matter (such as arsenic), heavy metals (such as mercury) and acid gases (such as carbon dioxide).

MMBtu. One million Btu. (See also British Thermal Unit on page A-2.)

Must-Run Unit. A generation facility that must run continually because of operational constraints or system requirements to maintain system reliability; typically a large thermal or nuclear power plant.

Must-Take Generation. Electricity produced from a generation unit (whether owned by the utility, and independent power producer, or a customer) that must be taken onto the power grid when produced. Sometimes refers to qualifying facilities under the Public Utility Regulatory Policies Act (PURPA).

N

N–1 or N–1–1 Contingency. The unexpected failure or outage of one (N–1) or two (N–1–1) system components (such as a generator, transmission line, circuit breaker, switch, or other electrical element); and can include multiple electrical elements if they are linked so that failures occur simultaneously at the loss of the single component. "N" refers to the total number of components that the system relies on to operate.

Nameplate Generation. See Generation (Electricity) on page A-9.

National Ambient Air Quality Standards (NAAQS). A Federal standard, set by the Environmental Protection Agency (EPA) under authority of the Clean Air Act, to limit the emission of six "criteria" pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particulate matter, and sulfur dioxide (SO_2). These regulations apply to all fuel-fired power plants.

National Pollutant Discharge Elimination System (NPDES). As authorized by the Clean Water Act, the NPDES program permits, administers, and enforces a program that regulates pollutants discharged into water sources.

National Renewable Energy Laboratory (NREL). The Federal laboratory dedicated to researching, developing, commercializing, and using renewable energy and energy efficiency technologies. NREL creates a wealth of well-researched studies that utilities across the country rely on for planning to integrate renewable generation.

Net Capacity. See Capacity on page A-3.

Net Metering. A financial arrangement between a customer with a renewable distributed generator and the utility, where the customer only pays for the net amount of electricity taken from the grid, regardless of the time periods when the customer imported from or exported to the grid. Under a net-metered arrangement, the customer is allowed to remain connected to the power grid, so that the customer can take advantage of the grid's reliability infrastructure (such as ancillary services provided by generators, energy storage devices, and demand response programs), use the grid as a "bank" for power generated by the customer in excess of the customer's needs, and use the grid as a backup resource for times when the power generated by the customer is less than the customer's needs. Power produced under a net-metered arrangement is almost always must-take generation.

Net Generation. See Generation (Electricity) on page A-9.

Net Present Value (NPV). Method for evaluating the cost or profitability of an investment. Individual future cash amounts are discounted back to their present values and then summed.

New Source Review (NSR). A permitting process created by Congress in 1977 as an amendment to the Clean Air Act requiring pre-construction review for environmental controls for building new facilities or modifying existing facilities (not routine scheduled maintenance) that would significantly increase a regulated pollutant. NSR was designed to eventually force the modernization of existing generation assets to comply with air emission regulations.

New Source Performance Standards (NSPS). Created as part of the Clean Air Act in 1970 to establish limits for certain air pollution emissions and water pollution discharges for how much certain categories of new facilities or modified existing facilities (such as boilers) can emit.

Nitrogen Oxide (NOx). Compounds of nitrogen and oxygen formed by combusting fuels under high temperature and high pressure, creating a strong pollutant and greenhouse gas.

Nominal Dollars. At its most basic, nominal dollars are based on a measure of money over a period of time that *has not been* adjusted for inflation. Nominal value represents a cost usually in the current year. As such, nominal dollars can also be referred to as current dollars; in other words, what it costs to buy

something today. Nominal dollars are often contrasted with real dollars. (See also Real Dollars on page A-18.

Non-Spinning Reserves. A generating reserve not connected to the system but capable of serving demand within a specified time, usually ten minutes.

Non-Transmission Alternative (NTA). Programs and technologies that complement and improve operation of existing transmission systems that individually or in combination defer or eliminate the need for upgrades to the transmission system.

North American Electric Reliability Corporation (NERC). An international non-governmental regulatory authority with a statutory responsibility to ensure the reliability of the North American electric grid by regulating bulk power system users, owners, and operators through the adoption and enforcement of standards for fair, ethical, and efficient practices. (APS)

O

Ocean Thermal Energy Conversion (OTEC). A process that can produce electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters.

Off-Peak Energy. Electric energy supplied during periods of relatively low system demand, or the use of electricity during that period when the overall demand for electricity is below normal.

Once-Through Steam Generator (OTSG). A specialized type of HRSG without boiler drums that enables the inlet feedwater to follow a continuous path (without segmented sections for economizers, evaporators, and superheaters) allowing it to grow or contract based on the heat load being received from the gas turbine exhaust. OTSGs can be run dry, meaning the hot exhaust gases can pass over the tubes with no water flowing inside the tubes.

On-Peak Energy. Electric energy supplied during periods of relatively high system demand.

Operating Reliability. The ability of the electric system to withstand sudden disturbances, such as electric short circuits or unanticipated loss of system components. Operating reliability is synonymous with system security. (See also System Security on page A-21.)

Operating Reserves. That portion of generation above firm system demand (called the reserve margin) required to provide regulation, load forecasting error, equipment forced and scheduled outages, and local area protection. It consists of spinning and non-spinning reserves. Utilities generally carry a 15% reserve margin, however with the influx of DERs, reserve margins have been steadily increasing. (See also Non-Spinning Reserves on page A-15, Spinning Reserves on page A-20, and Reserve Margin on page A-19.)

Operation and Maintenance (O&M) Expense. The recurring costs of operating, supporting, and maintaining facilities (including costs for labor, fuel, materials, and supplies, and other current expenses) to ensure proper operation and to achieve optimum efficiency levels.

Outage. The period during which a generating unit, transmission line, or other facility is out of service. The following are types of outages or outage-related terms.

- ***Forced Outage.*** The removal from service availability of a generating unit, transmission line, or other facility for emergency reasons or a condition in which the equipment is unavailable because of an unanticipated failure.
- ***Forced Outage Rate.*** The hours a generating unit, transmission line, or other facility is removed from service, divided by the sum of the hours it is removed from service plus the total number of hours the facility was connected to the electricity system; expressed as a percent.

- ***Full-Forced Outage.*** The net capability of main generating units that is unavailable for load for emergency reasons.
- ***Maintenance Outage.*** The removal of equipment from service availability to perform work on specific components that can be deferred, but requires the equipment be removed from service before the next planned outage. Typically, a maintenance outage can occur anytime during the year, have a flexible start date, and may or may not have a predetermined duration.
- ***Partial Outage.*** The outage of a unit or plant auxiliary equipment that reduces the capability of the unit or plant without causing a complete shutdown. It may also include the outage of boilers in common header installations.
- ***Planned (or Scheduled) Outage.*** The shutdown of a generating unit, transmission line, or other facility, for inspection or maintenance, in accordance with an advance schedule.

Outage Management System (OMS). A computer system that provides the capability to efficiently identify, analyze, and resolve unplanned outages.

P

Partial Outage. See Outage on page A-15.

Particulate Matter (PM). A complex mixture of extremely small particles and liquid droplets made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

Peak Demand. The maximum amount of power necessary to supply customers; in other words, the greatest demand occurring in a given period (for example, an hour, a day, month, season, or year). Peak demand equals the sum of the metered net outputs of all generators within a system and the metered line flows into the system, less the metered line flows out of the system. From a customer's perspective, peak demand is the maximum power used during a specific period of time.

Peaker. A generation resource that can quickly ramp up and down to meet spikes in demand, usually during the late afternoon and early evening when demand is highest. Peakers are often used for supplemental reserves, generally operate less than 10% of available hours, and cost the most to operate.

Peaking Capacity. See Capacity on page A-3.

Photovoltaic (PV). Electricity from solar radiation typically produced with photovoltaic cells (also called solar cells): semiconductors that absorb photons and then emit electrons.

Planned Outage. See Outage on page A-15.

Planning Reserves. The difference between a control area's expected annual peak capability and its expected annual peak demand expressed as a percentage of the annual peak demand.

Power. The rate at which energy is supplied to a load (consumed), usually measured in watts (W), kilowatts (kW), megawatts (MW), gigawatts (GW), and terawatts (TW).

Power Factor. A dimensionless quantity that measures the extent to which the current and voltage sine waves in an AC power system are synchronized. If the voltage and current sine waves perfectly match, the power factor is 1.0. Power factors not equal to 1.0 result in dissipation (losses) of electric energy.

Power Purchase Agreement (PPA). A bilateral wholesale or retail power short-term or long-term contract to purchase energy or capacity from a commercial source (for example, an independent power producer) at a predetermined price or based on pre-determined pricing formulas and delivered to an agreed-upon point. (Also referred to as a purchased power agreement.)

Public Utility Regulatory Policies Act (PURPA). Enacted by Congress in 1978, PURPA encouraged a number of energy initiatives in response to the 1973 energy crisis that utilities above a certain threshold "must consider". In effect, though, PURPA created a market for independent power producers, increased energy efficiency, boosted hydroelectric power development, and outlined other measures that, in total, promoted renewable energy. An update to the Act in 2005 outlined new Federal standards for net metering, additional fuel sources, generation efficiency, time-based metering, and distribution interconnection. Another update in 2007 added standards for integrated resource planning, rate design to promote investments in energy efficiency, and smart grid investment.

Present Value. The value of an asset, taking into account the time value of money—a future dollar is worth less today. Present value dollars are expressed in constant year dollars (usually the current year). Future dollars are converted to present dollars using a discount rate. For example, borrowing money with a payback agreement of $1.00 in one year at a discount rate of 10% would result in an available loan amount of $0.90. Utility planners use present value as a way to directly compare the economic value of multi-year plans with different future expenditure profiles. Net present value (NPV) is the difference between the present value of all future benefits, less the present value of all future costs.

Primary Frequency Response (PFR). Primary frequency response is the reserve capacity from online synchronous generation that provides both regulating reserves and contingency reserves. PFR is available to handle the sudden loss of a generator or major transmission line with a response proportional to the changes in frequency. In general, the largest online unit tends to determine the amount of PFR available to the system following a contingency event. If this largest unit trips offline, then the generators already online (and "spinning") can quickly pick up load within a defined time period to keep the system running.

Production Tax Credit (PTC). A tax credit for the generation of qualified energy from qualified facilities. The PTC amounts, credit periods, and definitions of qualified facilities are technology-specific. Qualified energy resources include wind, closed-loop biomass, open-loop biomass, geothermal, solar, small irrigation power, municipal solid waste, qualified hydropower production, and marine and hydrokinetic renewable energy. Customers, however, must choose only one tax credit for facilities that qualify for both an ITC and a PTC. (See also Investment Tax Credit on page A-11.)

Pumped Storage Hydroelectric. See Energy Storage on page A-7.

Q

Qualitative. Consideration of externalities which assigns relative values or rankings to the costs and benefits. This approach allows expert assessments to be derived when actual data from conclusive scientific investigation of impacts are not available.

Quantitative. Consideration of externalities which provides value based on available information on impacts. This approach allows for the quantification of impacts without assigning a monetary value to those impacts.

R

Ramp Rate. A measure of the speed at which a generating unit can increase or decrease output, generally specified as MW per minute.

Rate Base. The value of property which a utility is permitted to earn a specified rate of return as established by a regulatory authority. The rate base generally represents the book value of property used by the utility in providing service and may be calculated by any one or a combination of the following accounting methods: fair value, prudent investment, reproduction cost, or original cost. Depending on which method is used, the rate base includes net cost of plant in service, working cash, materials and supplies, and deductions for accumulated provisions for depreciation, contributions in aid of construction, customer advances for construction, accumulated deferred income taxes, and accumulated deferred investment tax credits.

Reactive Power. The portion of electricity that establishes and sustains the electric and magnetic fields of alternating-current equipment. Reactive power is provided by generators, synchronous condensers, or electrostatic equipment (such as capacitors), and directly influences electric system voltage.

Real Dollars. At its most basic, real dollars are a measure of money over a period of time that *has been* adjusted for inflation. Real dollars represent the true cost of goods and services sold because the effects of inflation are stripped from the cost. Over time, real dollars are a measure of purchasing power. As such, real dollars can also be referred to as constant dollars; in other words, if the price of something goes up over time at the same rate as inflation, the cost is the same in real dollars. Real dollars are often contrasted with nominal dollars. (See also Nominal Dollars on page A-14.

Real-Time Energy Market. Energy trading that involves the current price of energy based on supply. Prices are determined by the locational marginal pricing (LMP) algorithm for balancing supply from available generating units. (See also Day-Ahead Energy Market on page A-5, and Locational Marginal Pricing on page A-13.

Reciprocating Internal Combustion Engines (RICE). An engine using the reciprocating movement of pistons to create pressure that is converted into electricity.

Regional Transmission Organization (RTO). An independent, member-based, nonprofit organization that coordinates, controls, and monitors the electric grid over multiple states while promoting economic efficiency, reliability, and non-discriminatory practices. An RTO is essentially similar to an independent system operator (ISO), albeit with greater responsibility for the transmission network. Several RTOs operate within the electric power grid in the United States and Canada; not all areas of the electric grid, however, are covered by an RTO (or an ISO). (See also Independent System Operator on page A-10.)

Regulating Reserves (RegUp & RegDown). The service used to maintain system frequency in response to supply and demand imbalances over short time frames, typically on the order of one to several seconds. RegUp and RegDown resources adjust their generation or load levels in response to automatic generation control (AGC) signals provided by the system operator. (See also Automatic Generation Control on page A-1.)

Reliability. The degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired. Reliability may be measured by the frequency, duration and magnitude of adverse effects on the electric supply. Electric system reliability can be addressed by considering two basic and functional aspects of the electric system, adequacy of supply and system security. (See also System Reliability on page A-21.)

Renewable Energy Credit (REC). Intangible assets that represent the environmental attributes of a renewable generation project and are issued for each MWh of energy generated from such resources. RECs are a commodity that can be traded to comply with Renewable Portfolio Standards (RPS) or, in Vermont, with the Renewable Energy Standard (RES).

Renewable Energy Resources. Energy resources that are naturally replenished and are virtually inexhaustible, but are limited in the amount of energy that is available over a given period of time (capacity factor). The amount of some renewable resources (such as geothermal and biomass) might be limited over the short term as stocks are depleted by use, but on a time scale of decades or perhaps centuries, they can likely be replenished.

Renewable energy resources currently in widespread use include photovoltaics, biomass, hydroelectric, geothermal, solar, and wind. Other renewables resources still under development include ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, on-site electricity generation, distributed electricity generation, non-grid-connected generation, and demand-reduction (energy efficiency) technologies.

Unlike fossil fuel generation plants (which can be sited where most convenient because the fuel is transported to the plant), most renewable energy generation plants must be sited where the energy is available; that is, a wind plant must be sited where a sufficient and relatively constant supply of wind is available. In other words, fossil fuels can be brought to their generation plants whereas most renewable energy generating plants must be brought to the renewable energy source. Some renewable resources are exceptions; their fuels (such as biomass and biofuels), like fossil generation, can be brought to the generation plant.

Renewable Energy Standard (RES). In Vermont, a statute that requires electric distribution utilities to obtain a defined percentage of their total retail electric sales from renewable energy (essentially similar to an RPS). RES requirements are divided into three tiers:

- Tier I requires procurement of a defined percentage of retail electric sales from any source of renewable energy.
- Tier II requires procurement a defined percentage of retail electric sales from *new distributed* renewable generation.
- Tier III requires either the procurement of additional Tier II energy or reduce the fossil-fuel consumption and the greenhouse gas emissions associated with that consumption.

Renewable Portfolio Standards (RPS). A statutory goal that requires electric utilities to acquire a minimum percentage of their electricity sales from renewable energy resources. Approximately 40 states have RPS requirements.

Replacement Reserves (RR). Offline, quick-start resources used as replacement reserves provided they can be started and synchronized to the grid within a 10-minute or 30-minute timeframe depending upon system needs. These resources may be used for restoring load, regulation, or supporting and replacing contingency reserves.

Request for Proposal (RFP). A competitive solicitation for suppliers to submit a proposal on a specific commodity or service, often through a bidding process.

Reserves. See Operating Reserves on page A-15 and Planning Reserves on page A-16.

Reserve Margin (Planning). The amount of unused available capability of an electric power system at peak load for a utility system as a percentage of total capability. Planning reserve margin is designed to measure the amount of generation capacity available to meet expected demand in a planning horizon. Coupled with probabilistic analysis, calculated planning reserve margins is a relative indication of adequacy of supply.

Resiliency. The ability to quickly locate faults and automatically restore service after a fault, using FLISR (Fault Location, Isolation, and Service Restoration).

Retail Rate. The rate at which specific classes of customers compensate the utility for grid electricity.

Reverse Flow. The flow of electricity from the customer site onto the distribution circuit or from the distribution circuit through the substation to higher voltage lines. Also called backfeed.

S

Scheduled Outage. See Outage on page A-15.

Service Charge. A fixed customer charge intended to allocate the cost of servicing the grid to all customers, regardless of capacity needs.

Simple-Cycle Combustion Turbine (SCCT). A generating unit in which the combustion turbine operates in a stand-alone mode, without waste heat recovery.

Single-Train Combined Cycle (STCC). See Combined Cycle on page A-4.

Smart Grid. A platform connecting grid hardware devices to smart grid applications, including Advanced Metering Infrastructure (AMI), Volt/VAR Optimization (VVO), Direct Load Control (DLC), and electric vehicle charging. A smart grid enables the communication of massive amounts of system data that better enable a utility to manage their power grid.

Solar Photovoltaic. See Photovoltaic on page A-16.

Spinning Reserves. Available generating capacity that is synchronously connected to the electric grid and capable of automatically responding to frequency deviations on the system. (See also Operating Reserves on page A-15 and Primary Frequency Response on page A-17.)

Standard Offer Program. See Sustainably Priced Energy Enterprise Development (SPEED) Program on page A-21.

Steam Turbine (ST). A turbine that is powered by pressurized steam and provides rotary power for an electrical generator.

Stochastic Modeling. Modeling analysis using as input a random collection of variables that represent the uncertainties associated with those variables (as opposed to deterministic modeling that analyzes a single state). Stochastic modeling analyzes multiple states and the range of their uncertainty, then captures the probabilities of those uncertainties. Stochastic modeling can analyze how different generation portfolios perform with regard to cost and risk across a wide range of potential future input assumptions (including, but not limited to, power prices, hydro generation, wind generation, DERs, solar generation, loads, plant forced outages, and REC prices.

Sulfur Oxide (SOx). A precursor to sulfates and acidic depositions formed when fuel (oil or coal) containing sulfur is combusted. Sulfur oxide, a regulated pollutant, refers to many types of sulfur and oxygen containing compounds, such as sulfur dioxide (SO_2).

Substation. A small building or fenced in yard containing switches, transformers, and other equipment and structures for stepping up or stepping down voltage, switching and monitoring transmission and distribution circuits, and other service functions. Electricity, as gets closer to where it is to be used, goes through a substation where the voltage is lowered so it can be used by customers.

Supervisory Control and Data Acquisition (SCADA). A system used for monitoring and control of remote equipment using communications networks.

Supply-Side Management. Actions taken to ensure the generation, transmission, and distribution of energy are conducted efficiently.

Supply-Side Resources. Generating plants that supply power into the electric grid that originate on the utility side of the meter.

Sustainably Priced Energy Enterprise Development (SPEED) Program. Established by the Vermont Legislature in 2005 to encourage the development and purchase of renewable energy resources. In 2009, the Vermont Energy Act (Act 45) implemented the SPEED Standard Offer Program as one of the nation's first feed-in tariff (FIT) programs, essentially to create access to fixed-price long-term renewable contracts. In 2012, Act 170 increased the amount available through the program to 127.5 MW.

Switching Station. An electrical substation, with a single voltage level, whose only function is switching actions.

System. A generic term to describe the utility power grid: a combination of generation, transmission, and distribution components.

System Average Interruption Duration Index (SAIDI). The average annual outage duration experienced by the average customer. SAIDI is a reliability indicator.

System Average Interruption Frequency Index (SAIFI). The average number of interruptions that a utility customer would experience. SAIFI is a reliability indicator.

System Reliability. Broadly defined as the ability of the electric power grid to meet the demand of its customers while maintaining system stability. Reliability can be measured in the number of hours that system demand is met.

System Security. The ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements. (See also Operating Reliability on page A-15.)

T

Tariff. A published volume of rate schedules and general terms and conditions under which a product or service will be supplied.

Terawatt (TW). A unit of power, capacity, or demand equal to one trillion watts, one billion kilowatts, one million megawatts, or one thousand gigawatts. The total power used by humans worldwide is commonly measured in terawatts.

Terawatt Hour (TWh). A unit of electric energy equal to one trillion watt-hours, one billion kilowatt-hours, one million megawatt-hours, or one thousand gigawatt-hours.

Time-of-Use (TOU) Rates. The pricing of electricity based on the estimated cost of electricity during a particular time block. Time-of-use rates are usually divided into three or four time blocks per twenty-four hour period (on-peak, mid-peak, off-peak and sometimes super off-peak) and by seasons of the year (summer and winter). The purpose of TOU rates is to price usage based on when it is consumed, and to encourage usage shifting as a means of lowering peak demand periods.

Total Resource Cost (TRC). A method for measuring the net costs of a conservation, load management, or fuel substitution as a resource option, based on the total costs of the participants and the utility.

Transformer. A device used to change voltage levels to facilitate the transfer of power from the generating plant to the customer. A transformer is necessary because higher voltages are best used to move power over long distances, while lower voltages are best for consumption. A step-up transformer increases voltage (power) while a step-down transformer decreases it.

Transmission and Distribution (T&D). Transmission of the bulk transfer of electric power across the power system, typically from generators to load centers, often intended to refer specifically to

high-voltage (69,000 volts or higher) electricity. Distribution is the transfer of electric power from the bulk power level to end-users and from distributed generators into the bulk power system.

Two-Way Communications. The platform and capabilities required to allow bi-directional communication between the utility and elements of the grid (including customer-sited advanced inverters), and control over key functions of those elements. The platform must include monitor and control functions, be TCP/IP addressable, be compliant with IEC 61850, and provide cyber security at the transport and application layers as well as user and device authentication.

U

Under Frequency Load Shedding (UFLS). A system protection scheme used during transient adverse conditions to balance load and generation. The term essentially explains the process: when frequency drops below a certain point, this scheme sheds load to keep from completely losing the system.

Under Voltage Load Shedding (UVLS). A system protection scheme used during low voltage conditions to avoid a voltage collapse.

Unit Contingency PPA. A unit contingent sale is contingent on a particular generating unit being available to deliver power. Generally, this means that there is some allowed portion of time during which the unit is expected to be unavailable and therefore not deliver power.

United States Department of Energy (DOE). An executive department of the U.S. government that is concerned with the United States' policies regarding energy, environmental, and nuclear challenges.

United States Energy Information Administration (EIA). The principal agency responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy. The EIA conducts independent comprehensive data collection of energy sources, end uses, and energy flows; generates short- and long-term domestic and international energy projections; and performs informative energy analyses. EIA programs cover data on coal, petroleum, natural gas, electric, renewable, and nuclear energy.

United States Environmental Protection Agency (EPA). An executive department of the U.S. government whose mission is to protect human health and the environment.

Utility-Scale Generation. The designation for any small- or large-scale generation facility—usually a variable renewable resource such as solar PV or wind—either owned by the utility or owned by an independent power producer (IPP). While generally not defined by output, their generation capabilities can range from as small as 1 MW to much larger (such as 100 MW or more). Sometimes referred to as grid-scale generation.

V

Variable Renewable Energy. Generation whose output varies with the availability of its primary energy resource, such as wind, the sun, and flowing water. The primary energy source cannot be controlled in the same manner as firm, conventional, fossil-fuel generators. Specifically, while a variable generator (without storage) can be dispatched to operate below the available energy, it cannot be increased above what can be produced by the available resource energy. Variable energy can be coupled with storage, or the primary energy source can be stored for future use (such as with solar thermal storage, or when converted into electricity via storage technologies). Also referred to as intermittent and as-available renewable energy.

Vermont Comprehensive Energy Plan. See Comprehensive Energy Plan on page A-4.

Vermont Electric Plan. Published by the Vermont Public Service Department, this plan serves as a basis for state electric energy policy. It includes a 20-year outlook, an assessment of all energy resources available to the state for electricity generation or to supply electric power, estimates of electric energy demand, and specific strategies for reducing electric rates. Among other objectives, it also considers the protection of public health and safety and the preservation of environmental quality. The Vermont Electric Plan is wholly encompassed in the Vermont Comprehensive Energy Plan (CEP). (See also Comprehensive Energy Plan on page A-4.)

Vermont Electric Power Company (VELCO). Formed in 1956, VELCO manages the safe, reliable, cost-effective, interconnected transmission grid capable of sharing electrical energy throughout Vermont. VELCO manages 738 miles of transmission lines and 55 substations, switching stations, and terminal facilities.

Vermont Energy Education Program (VEEP). A not-for-profit Vermont corporation that administers two of Vermont's renewable energy programs under contract with the Vermont Public Utility Commission (VPUC). VEEP acts as the purchasing agent for existing VPUC Rule 4.100 Projects, and as the facilitator for existing and new Standard Offer Projects.

Vermont Energy Investment Corporation (VEIC). A nonprofit organization whose goal is to reduce the economic and environmental costs of energy consumption through energy efficiency and renewable energy adoption.

Vermont Public Service Board (PSB). The former name of the Vermont Public Utility Commission. See Vermont Public Utility Commission on page A-23.

Vermont Public Service Department (PSD). Housed within the executive branch of Vermont state government, this department represents the public interest in energy, telecommunications, water, and wastewater utility matters. PSD also represents the public interest in utility cases before state and federal agencies and courts. More specifically, PSF provides long-range planning for Vermont's energy and telecommunications needs through Vermont Comprehensive Energy Plan (which also encompasses the Vermont Electric Plan) and the Vermont Telecommunications Plan. (See also Comprehensive Energy Plan on page A-4).

Vermont Public Utility Commission (VPUC). An independent, three-member, quasi-judicial commission that regulates the siting of electric and natural gas infrastructure and supervises the rates, quality of service, and overall financial management of Vermont's public utilities: electric, gas, energy efficiency, telecommunications, cable television (terms of service only, not rates), water, and large wastewater companies. Formerly known as the Vermont Public Service Board.

Volt-Ampere Reactive (VAR). A unit by which reactive power is expressed in an AC electric power system.

Voltage. Voltage is a measure of the electromotive force or electric pressure for moving electricity.

Voltage Regulation. The control of voltage to keep the value within a specified target or range.

W

Waste-to-Energy (WTE). A process of generating electricity from the primary treatment (usually burning) of waste. WTE is a form of energy recovery.

Watt. The basic unit of measure of electric power, capacity, or demand; specifically, the rate of energy transfer equivalent to one ampere flowing because of an electrical pressure of one volt at unity power factor. Named after the Scottish engineer James Watt (1736–1819).

Watt-Hour. The total amount of energy used in one hour by a device that requires one watt of power for continuous operation. Electric energy sold to retail customers is commonly measured in kilowatt-hours, or one thousand watt-hours.

Wave and Tidal Power. A process that captures the power of waves and tides and converts it into electricity. While the arrival of waves at a power facility is somewhat predictable (mainly because waves travel across the ocean), tides are extremely predictable because they are driven by the gravitational pull of the moon and sun.