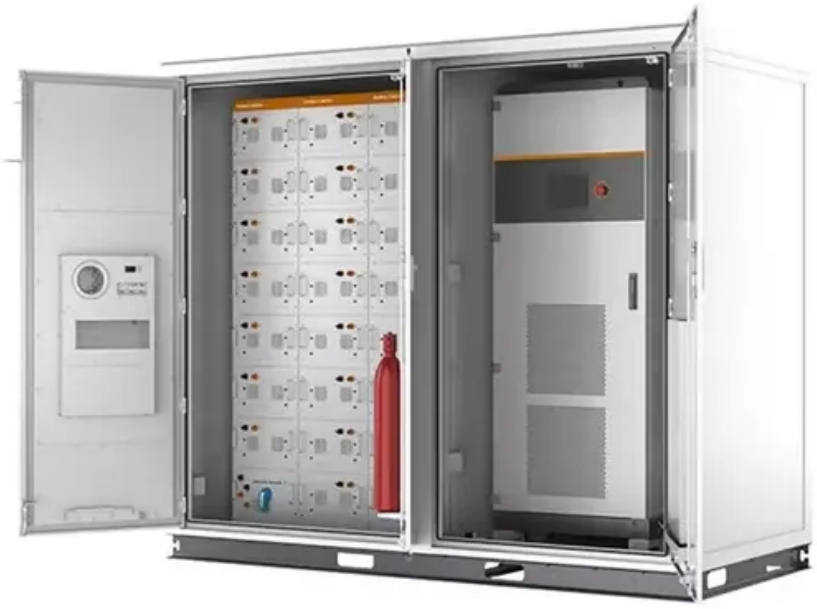
Distributed energy



Overview

Distributed generation, also distributed energy, on-site generation (OSG), or district/decentralized energy, is electrical and performed by a variety of small, -connected or distribution system-connected devices referred to as distributed energy resources (DER). Conventional, such as -fired,, and plants, as well as dams and large-scale Distributed generation, also distributed energy, on-site generation (OSG), or district/decentralized energy, is electrical and performed by a variety of small, -connected or distribution system-connected devices referred to as distributed energy resources (DER). Conventional, such as -fired,, and plants, as well as dams and large-scale, are centralized and often require electric energy to be over long distances. By contrast, DER systems are decentralized, modular, and more flexible technologies that are located close to the load they serve, albeit having capacities of only 10 (MW) or less. These systems can comprise multiple generation and storage components; in this instance, they are referred to as systems. DER systems typically use sources, including,,,,, and, and increasingly play an important role fo. Historically, central plants have been an integral part of the electric grid, in which large generating facilities are specifically located either close to resources or otherwise located far from populated . These, in turn, supply the traditional transmission and distribution (T&D) grid that distributes bulk power to load centers and from there to consumers. These were developed when the costs of transporting fuel and integrating generating technologies into populated areas far exceeded the cost of developing T&D facilities and tariffs. Central plants are usually designed to take advantage of available economies of scale in a site-specific manner, and are built as "one-off", custom projects. These began to fail in the late 1960s and, by the start of the 21st century, Central Plants could arguably no longer deliver competitively cheap and reliable electricity to more remote customers through the grid, because the plants had come to cost less than the grid and had become so reliable that nearly all power failures originated in the grid. Thus, the grid had become the main driver of remote customers' power costs and power quality problems, which became more acute as digital equipment required extremely reliable electricity. Efficiency gains no longer come from increasing generating capacity, but from smaller units located closer to sites of demand. For example, are built away from cities to prevent their heavy air pollution from affecting the populace. In addition, such plants are often built near to minimize the cost of transporting coal. plants are by their nature limited to operating at sites with sufficient water flow. Low pollution is a crucial advantage of combined cycle plants that burn . The low pollution permits the plants to be near enough to a city to provide and cooling. Distributed energy

resources are mass-produced, small, and less site-specific. Their development arose out of: 199 concerns over perceived externalized costs of central plant generation, particularly environmental concerns;299 the increasing age, deterioration, and capacity constraints upon T&D for bulk power;399 the increasing relative economy of mass production of smaller appliances over heavy manufacturing of larger units and on-site construction;499 Along with higher relative prices for energy, higher overall complexity and total costs for regulatory oversight, tariff administration, and metering and billing.Capital markets have come to realize that right-sized resources, for individual customers, distribution substations, or microgrids, are able to offer important but little-known economic advantages over central plants. Smaller units achieved greater economic benefits through mass-production than larger units gained from their size alone. The increased value of these resources—resulting from improvements in financial risk, engineering flexibility, security, and environmental quality—often outweighs their apparent cost disadvantages. Distributed generation (DG), vis-à-vis central plants, must be justified on a life-cycle basis. Unfortunately, many of the direct, and virtually all of the indirect, b. Distributed energy resource (DER) systems are small-scale power generation or storage technologies (typically in the range of 1 kW to 10,000 kW) used to provide an alternative to or an enhancement of the traditional electric power system. DER systems typically are characterized by high initial per kilowatt. DER systems also serve as storage device and are often called Distributed energy storage systems (DESS). DER systems may include the following devices/technologies: • (CHP), also known as cogeneration or trigeneration• • (and systems)• (MicroCHP)• • (typically)• • Small wind power systems• • or a combination of the above. For example, hybrid, CHP and systems can provide full electric power for single family residences without extreme storage expenses. Distributed sources use steam turbines, natural gas-fired, or to turn generators. The hot exhaust is then used for space or, or to drive an for cooling such as . In addition to natural gas-based schemes, distributed energy projects can also include other renewable or low carbon fuels including biofuels,,,,, and . Delta-ee consultants stated in 2013 that with 64% of global sales, the fuel cell passed the conventional systems in sales in 2012. 20.000 units were sold in in 2012 overall within the Ene Farm project. With a of around 60,000 hours for units, which shut down at night, this equates to an estimated lifetime of between ten and fifteen years. For a price of $22,600 before installation. For 2013 a state subsidy for 50,000 units is in place. In addition, and using natural gas, such as the ones from and the, or waste-to-energy processes such as the Gate 5 Energy System are used as a distributed energy resource. , by far the most important solar technology for distributed generation of, uses assembled into to convert sunlight into electricity. It is a technology doubling its worldwide installed capacity every couple of years. range from distributed, residential, and commercial or

installations, to large, centralized utility-scale . For reasons of reliability, distributed generation resources would be interconnected to the same transmission grid as central stations. Various technical and economic issues occur in the integration of these resources into a grid. Technical problems arise in the areas of, voltage stability, harmonics, reliability, protection, and control. Behavior of protective devices on the grid must be examined for all combinations of distributed and central station generation. A large scale deployment of distributed generation may affect grid-wide functions such as frequency control and allocation of reserves. As a result, functions, and such as stations are added to the grid. Conflicts occur between utilities and resource managing organizations. Each distributed generation resource has its own integration issues. Solar PV and wind power both have intermittent and unpredictable generation, so they create many stability issues for voltage and frequency. These voltage issues affect mechanical grid equipment, such as load tap changers, which respond too often and wear out much more quickly than utilities anticipated. Also, without any form of energy storage during times of high solar generation, companies must rapidly increase generation around the time of sunset to compensate for the loss of solar generation. This high ramp rate produces what the industry terms the that is a major concern for grid operators in the future. Storage can fix these issues if it can be implemented. Flywheels have shown to provide excellent frequency regulation. Also, flywheels are highly cyclable compared to batteries, meaning they maintain the same energy and power after a significant amount of cycles(on the order of 10,000 cycles). Short term use batteries, at a large enough scale of use, can help to flatten the duck curve and prevent generator use fluctuation and can help to maintain voltage profile. However, cost is a major limiting factor for energy storage as each technique is prohibitively expensive to produce at scale and comparatively not energy dense compared to liquid fossil fuels. Finally, another method of aiding in integration is in the use of that have the capability to also store the energy when there is more energy production than consumption. There have been some efforts to mitigate voltage and frequency issues due to increased implementation of DG. Most notably, IEEE 1547 sets the standard for interconnection and interoperability of distributed energy resources. IEEE 1547 sets specific curves signaling when to clear a fault as a function of the time after the disturbance and the magnitude of the voltage irregularity or frequency irregularity. Voltage issues also give legacy equipment the opportunity to perform new operations. Notably, inverters can regulate the voltage output of DGs. Changing inverter impedances can change voltage fluctuations of DG, meaning inverters have the ability to control DG voltage output. To reduce the effect of DG integration on mechanical grid equipment, transformers and load tap changers have the potential to implement specific tap operation vs. voltage operation curves mitigating the effect of voltage irregularities due to

DG. That is, load tap changers respond to voltage fluctuations that last for a longer period than voltage fluctuations created from DG equipment.

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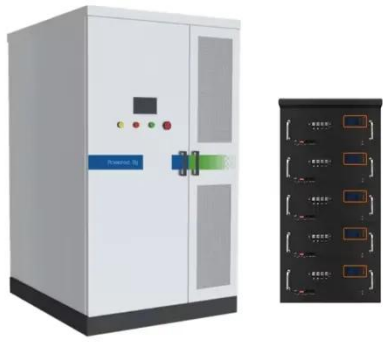

Distributed Energy Resources: Technology for Affordable, Resilient

To help meet the ever-rising demand for energy in the U.S., policymakers, regulators, and utilities should look to distributed energy resources (DERs) as a bigger part of the solution.

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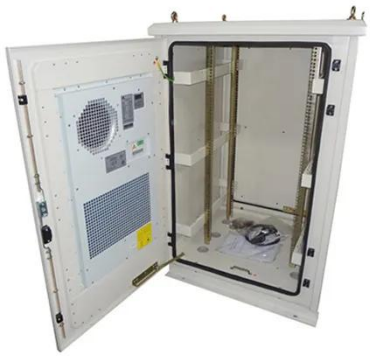

Introduction to Distributed Generation

Distributed Generation, often called Private Generation or Customer-Generated Power, refers to smaller-scale energy systems, such as solar panels, that allow you to generate and even store your own ...

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Distributed Energy Resources

In a shift from the traditional electric power paradigm, utilities and their customers are installing DERs, including distributed generation (DG) facilities that employ small-scale technologies to produce or ...

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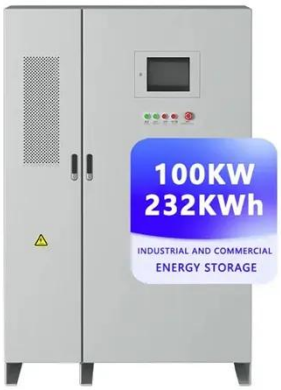

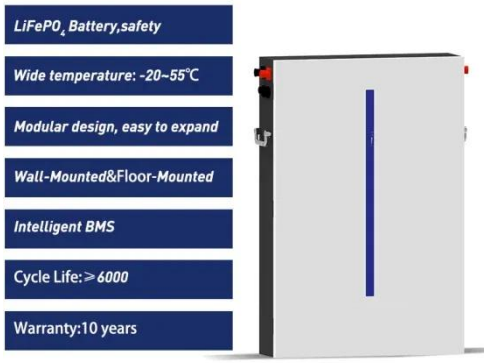

Distributed Energy Resources

DOE is helping policymakers, regulators, utilities, and stakeholders address challenges by coordinating best practices to enable the utilization of distributed energy resources (DERs). All of ...

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How Distributed Energy Resources Are Reshaping Utility Planning ...

Distributed energy resources are changing how utilities plan grid capacity. Learn how DERs can defer infrastructure upgrades and improve resilience at the distribution level.

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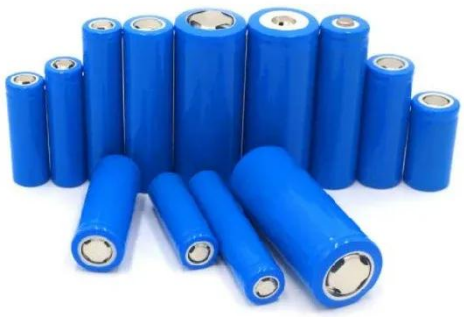

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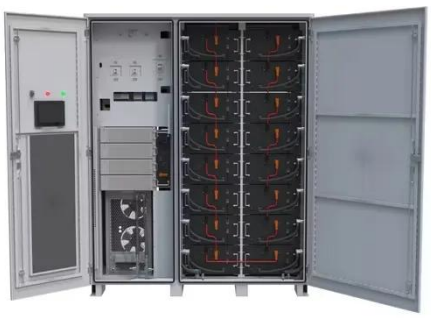
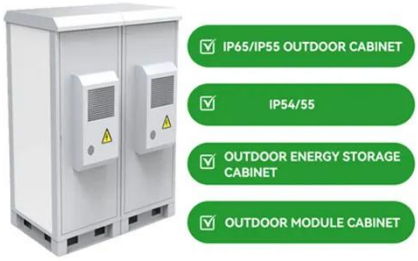


NYSERDA DER Integrated Data System

Distributed Energy Resources, or DERs, are technologies that generate or store electricity either for homes and buildings to manage their energy use, or to serve energy demand directly on the electric ...



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Understanding the Value of Distributed Energy Resources

These energy technologies scattered around the grid are called "Distributed Energy Resources" (DERs). Traditionally, utilities source power from large power plants. DERs, by definition, ...

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What Are Distributed Energy Resources (DER)? , IBM

Distributed energy resources, or DER, are small-scale energy systems that power a nearby location. DER can be

connected to electric grids or isolated, with energy flowing only to specific sites or ...

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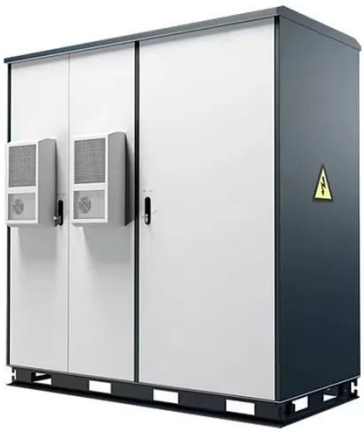

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