

**Table 1**  
**Distributed Generation Technologies**

Energy Source	Description	Typical Size (kW)	Dispatchable ?	Typical Uses	Commercially Available	Emerging Technology
<b>Solar Energy (Photovoltaics)</b>	A cell which converts the solar energy of the sun directly in to electricity	1-100	No	Baseload power source. Off Grid homes, Remote Industrial Applications (e.g. telecommunication), road signage.	√	
<b>Microturbines</b>	A relatively new technology, which is just making the transition to commercial markets. Microturbines can run on a variety of fuels, including natural gas, propane, and fuel oil. They consist of a compressor, combustor, turbine and generator. These very small turbines contain essentially one moving part and use either air or oil for lubrication. Microturbines require little maintenance, but need a major \$10,000 overhaul every four years.	30-300	Yes	Can be used in baseload, peaking or co-generation applications.	√	√
<b>Fuel cells</b>	In fuel cells, hydrogen and oxygen are separated by an electrolyte - inducing an electrochemical potential. This potential is converted into direct current electricity by protons moving through the electrolyte (combining with oxygen to form water) and electrons flowing through a separate electrical circuit.	1-200	Yes	Rural (off-grid) power. Transportation. Appropriate for baseload applications.	√	√

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	<p>Fuel cell types include phosphoric acid, molten carbonate, solid oxide and proton exchange membrane. Only phosphoric acid fuel cells are available commercially. Fuel cells can be fueled by natural gas, hydrogen, biogas or propane. Hydrogen is the most used fuel source.</p> <p>Companies developing products for utilities and electric customers are concentrating on fuel cells that run on natural gas, but the automobile industry is investigating models that would run on gasoline or methanol.</p>					

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<b>Wind Turbines</b>	<p>Wind turbines are packaged systems that include the rotor, generator, turbine blades, and drive or coupling device.</p> <p>The wind turns the blades of a windmill-like machine. The rotating blades turn the shaft to which they are attached. The turning shaft typically either powers a pump or turns a generator which produces electricity.</p> <p>Selection of a suitable site is key to the economics of wind energy. In general, winds exceeding 5 m/s (11 mph) are required for cost-effective application of small grid-connected wind machines, while windfarms require wind speeds of 6 m/s (13 mph).</p>	10 -2,000	No	<p>Homes and farms Process industries Remote communities</p> <p>Could be considered baseload if not for dependency on wind.</p>	√	
<b>Internal combustion engines</b>	Includes diesel engines, natural gas engines.	50 - 5,000	Yes	Well-established, long history as back up or peaking applications.	√	
<b>Reciprocating Engines</b>	Natural gas, diesel, landfill gas, digester gas	5 - 7,000	Yes	<p>High-speed units are derived from automotive or truck engines and operate at 1200-3600 rpm.</p> <p>Medium-speed engines are derived from locomotive and small marine engines, and operate at 275-1000 rpm.</p>	√	

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				Low-speed units are derived from large ship propulsion engines and operate at 58-275 rpm. Low-speed engines are designed to burn low-quality residual fuels.		
<b>Stirling Engines</b>	Natural gas primarily but broad fuel flexibility is possible	<1 - 5	Yes	Space and marine industries, baseload and peaking.		√
<b>Energy Storage/ UPS Systems</b>	Batteries, Flywheels, Superconducting Magnetic Energy Storage (SMES), Supercapacitors, Compressed Air Storage Systems (CAES)	5 - 150,000	Yes	Used to correct voltage sags, flicker, and surges, that occurs when utilities or customers switch suppliers or loads. They may also be used as an uninterruptible power supply (UPS).	√	√
<b>Hybrid Systems</b>	Solid oxide fuel cell combined with a gas turbine or microturbine. Stirling engine combined with a solar dish (see the photograph). Wind turbines with battery storage and diesel backup generators. Engines (and other prime movers) combined with energy storage devices such as flywheels.	5 - 25	Yes	Baseload and peaking.		√
<b>Mini Hydro</b>		100 - 1,000	No	Baseload energy. Serve isolated customer, small factory or connect to grid.	√	√

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<b>Biomass</b>	Biomass is organic matter, such as agricultural wastes and wood chips and bark left over when lumber is produced. Biomass can be burned in an incinerator to heat water to make steam, which turns a turbine to make electricity. It can also be converted into gas, which can be burned to do the same thing.	1,000 - 50,000	Yes	Baseload combined steam and electric power.	√	
<b>Geothermal</b>	A geothermal power plan is a steam power plant. A well is drilled, the steam comes out, goes through a heat exchanger, and spins a turbine generator.	1,000 - 30,000	Yes	Baseload.	√	