

Fig. 7

DER TECHNOLOGY CHARACTERISTICS

Source: NREL, 2014

Characteristic	Internal Combustion Technologies			Fuel Cell Technologies				Storage Technologies		Solar
	Reciprocating Engine	Microturbine	Combustion Gas Turbine	Proton Exchange Membrane (PEMFC)	Phosphoric Acid (PAFC)	Molten Carbonate (MCFC)	Solid Oxide (SOFC)	High Power <i>e.g.</i> , li-ion	High Energy <i>e.g.</i> , NaS	PV
Size	30kW-6+MW	30-400kW	0.5-30+MW	<1kW-500kW	50kW-1MW (250kW module typical)	<1kW-5MW (250kW module typical)	<1kW - 5MW	kWs to MWs	kWs to MWs	0.2 kW per module, could be 000s of MW
Power Density (mW/cm ²)	2,900 - 3,850	3,075 - 7,175	1,750 - 53,800	350-800	140 - 320	100 - 120	150 - 700	N/A	N/A	up to 175
Operating Temperature	450°C (850°F)	980°C (1,800°F)	1,930°C (3,500°F)	50-100°C (122-212°F)	150-200°C (302-392°F)	600-700°C (1,112-1,292°F)	600-1,000°C (1,202-1,832°F)	Ambient	290-350°C	Ambient + ~20°C
Startup Time	10s to 15 mins	Up to 120s	2 - 10 min	15 - 30 min	3-4 hrs	8 - 24 hrs	8 - 24 hrs	ms	ms	ms
Elec. Efficiency (LHV) %	30-42%	14-30%	21-40%	36-50%	37-42%	45-50%	40-60%	93-97%	85-90%	15%
Electric+Thermal (CHP) Efficiency %	80-85%	80-85%	80-90%	50-75%	<85%	<80%	<90%	90-94% AC	78-80% AC	N/A
Installed Cost (\$/kW)	\$700-1,200/kW	\$1,200-1,700/kW	\$400-900/kW	\$3,500/kW	\$4,500 - 9,000/kW	\$4,200 - 7,200/kW	\$3,500 - 8,000/kW	\$1,200-1,800/kW	\$3,500-4,000/kW	\$2,000-5,000/kWp
Fixed O&M Cost	\$500-1,000/kW	\$700-1100/kW	\$500/kW	\$1000/kW	\$400/kW	\$350/kW	\$175/kW	\$8-30/kW	\$15-40/kW	\$10-30/kWp
Variable O&M Cost	\$0.007 - 0.02/kWh	\$0.005 - 0.016/kWh	\$0.004 - 0.01/kWh	\$0.003/kWh	\$0.002/kWh	\$0.004/kWh	\$0.0045-0.0056/kWh	\$0.002-0.004/kWh	\$0.03-0.09/kW	\$10-30/kWp
Maintenance Interval/ Fuel Cell Module Durability	750 - 1,000 hrs: change oil and oil filter 8,000 hrs: rebuild engine head 15,000 hrs: rebuild engine block	5000 - 8000 hrs	4000 - 8000 hrs	20,000 + hrs	40,000 - 80,000 hrs	40,000+ hrs	25,000 - 70,000 hrs	2 yr interval, 10 yr life	2 hr interval, 10 year life	8,000 hrs (annual maintenance for central inverters)