

Comparison of battery types

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Common characteristics

Cell chemistry	Also known as	Electrode		Re-chargeable	Commercialized year	Voltage			Energy density		Specific power W/kg	Cost [†] Wh/\$ (\$/kWh)	Discharge efficiency %	Self-discharge rate %/month	Shelf life years	
		Anode	Cathode			Cutoff V	Nominal V	100% SOC V	by mass MJ/kg (Wh/kg)	by volume MJ/L (Wh/L)						
Lead-acid	SLA VRLA	Lead	Lead dioxide	Yes	1881 ^[1]	1.75 ^[2]	2.1 ^[2]	2.23 –2.32 ^[2]	0.11–0.14 (30–40) ^[2]	0.22–0.27 (60–75) ^[2]	180 ^[2]	6.99–17.98 (56–143) ^[2]	50–92 ^[2]	3–20 ^[2]		
Zinc-carbon	Carbon-zinc	Zinc	Carbon	No	1898 ^[3]	0.75 –0.9 ^[3]	1.5 ^[3]		0.13 (36) ^[3]	0.33 (92) ^[3]	10–27 ^[3]	3.2 (313) ^[3]	50–60 ^[3]	0.32 ^[3]	3–5 ^[4]	
Zinc-air	PR		Oxygen	No	1932 ^[5]	0.9 ^[5]	1.45 –1.65 ^[5]		1.59 (442) ^[5]	6.02 (1,673) ^[5]	100 ^[5]	2.8 (358) ^[5]	60–70 ^[5]	0.17 ^[5]	3 ^[5]	
Mercury oxide-zinc	Mercuric oxide Mercury cell		Mercuric oxide	No	1942– ^[6] 1996 ^[7]	0.9 ^[8]	1.35 ^[8]		0.36–0.44 (99–123) ^[8]	1.1–1.8 (300–500) ^[8]						2 ^[6]
Alkaline	Zn/MnO ₂ LR		Manganese (IV) oxide	No	1949 ^[9]	0.9 ^[10]	1.5 ^[11]	1.6 ^[10]	0.31–0.68 (85–190) ^[12]	0.90–1.56 (250–434) ^[12]	50 ^[12]	0.5 (2003) ^[12]	45–85 ^[12]	0.17 ^[12]	5–10 ^[4]	
Rechargeable alkaline	RAM			Yes	1992 ^[13]	0.9 ^[14]	1.57 ^[14]	1.6 ^[14]							<1 ^[13]	
Silver-oxide	SR		Silver oxide	No	1960 ^[15]	1.2 ^[16]	1.55 ^[16]	1.6 ^[17]	0.47 (130) ^[17]	1.8 (500) ^[17]						
Nickel-zinc	NiZn			Yes	2009 ^[13]	0.9 ^[13]	1.65 ^[13]	1.85 ^[13]							13 ^[13]	
Nickel-iron	NiFe		Iron	Yes	1901 ^[18]	4.5 ^[19]	6 ^[19]	7.2 ^[19]	0.07–0.09 (19–25) ^[20]	0.45 (125) ^[21]	100	4.25–5.67 (176–235) ^[11]		20–30	30– ^[22] 50 ^[23] ^[24]	
Nickel-cadmium	NiCd NiCad	Cadmium	Yes	c. 1960 ^[25]	0.9 –1.05 ^[26]	1.2 ^[27]	1.3 ^[26]	0.11 (30) ^[27]	0.36 (100) ^[27]	150 –200 ^[28]				10 ^[13]		
Nickel-hydrogen	NiH ₂ Ni-H ₂	Hydrogen	Nickel oxide hydroxide	Yes	1975 ^[29]	1.0 ^[30]	1.55 ^[28]		0.16–0.23 (45–65) ^[28]	0.22 (60) ^[31]	150 –200 ^[28]				5 ^[31]	
Nickel-metal hydride	NiMH Ni-MH	Metal hydride		Yes	1990 ^[1]	0.9 –1.05 ^[26]	1.2 ^[11]	1.3 ^[26]	0.36 (100) ^[11]	1.44 (401) ^[32]	250 –1000	3.4 (294) ^[1]		30 ^[33]		
Low self-discharge nickel-metal hydride	LSD NiMH			Yes	2005 ^[34]	0.9 –1.05 ^[26]	1.2	1.3 ^[26]	0.34 (95) ^[35]	1.27 (353) ^[36]	250 –1000			0.42 ^[33]		
Lithium-manganese dioxide	Lithium Li-MnO ₂ CR Li-Mn	Lithium	Manganese dioxide	No	1976 ^[37]	2 ^[38]	3 ^[11]		0.54–1.19 (150–330) ^[39]	1.1–2.6 (300–710) ^[39]	250 –400 ^[39]			1	5-10 ^[39]	

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		Anode	Cathode			Cutoff V	Nominal V	100% SOC V	by mass MJ/kg (Wh/kg)	by volume MJ/L (Wh/L)						
Lithium-carbon monofluoride	Li-(CF) _x BR		Carbon monofluoride	No	1976 ^[37]	2 ^[40]	3 ^[40]		0.94–2.81 (260–780) ^[39]	1.58–5.32 (440–1,478) ^[39]	50–80 ^[39]			0.2–0.3 ^[41]	15 ^[39]	
Lithium-iron disulfide	Li-FeS ₂ FR		Iron disulfide	No	1989 ^[42]	0.9 ^[42]	1.5 ^[42]	1.8 ^[42]	1.07 (297) ^[42]	2.1 (580) ^[43]				0.05 ^[42]	10–20 ^[42]	
Lithium cobalt oxide	LiCoO ₂ ICR LCO Li-cobalt ^[44]	Graphite [‡]	Lithium cobalt oxide	Yes	1991 ^[45]	2.5 ^[46]	3.7 ^[47]	4.2 ^[46]	0.70 (195) ^[47]	2.0 (560) ^[47]		2.83 (353) ^[1]				
Lithium iron phosphate	LiFePO ₄ IFR LFP Li-phosphate ^[44]		Lithium iron phosphate	Yes	1996 ^[48]	2 ^[46]	3.2 ^[47]	3.65 ^[46]	0.32–0.47 (90–130) ^[47]	1.20 (333) ^[47]	200 ^[49]			4.5		
Lithium manganese oxide	LiMn ₂ O ₄ IMR LMO Li-manganese ^[44]		Lithium manganese oxide	Yes	1999 ^[1]	2.5 ^[50]	3.9 ^[47]	4.2 ^[50]	0.54 (150) ^[47]	1.5 (420) ^[47]		2.83 (353) ^[1]				
Lithium nickel cobalt aluminum oxide	LiNiCoAlO ₂ NCA Li-aluminum ^[44]		Lithium nickel cobalt aluminum oxide	Yes	1999	3.0 ^[51]	3.6 ^[47]	4.3 ^[51]	0.79 (220) ^[47]	2.2 (600) ^[47]						
Lithium nickel manganese cobalt oxide	LiNiMnCoO ₂ INR NMC ^[44] NCM ^[47]		Lithium nickel manganese cobalt oxide	Yes	2008 ^[52]	2.5 ^[46]	3.6 ^[47]	4.2 ^[46]	0.74 (205) ^[47]	2.1 (580) ^[47]						

[†] Cost in USD, adjusted for inflation.

[‡] Typical. See Lithium-ion battery § Negative electrode for alternative electrode materials.

Rechargeable characteristics

Cell chemistry	Charge efficiency	Cycle durability
	%	# cycles
Lead-acid	50–92 ^[2]	500 typical, 800 max ^[2]
Rechargeable alkaline		5-100 ^[13]
Nickel-zinc		100 to 50% capacity ^[13]
Nickel-iron	65–80	5000
Nickel-cadmium		500 ^[25]
Nickel-hydrogen		20,000 ^[31]
Nickel-metal hydride	66	300–800 ^[13]
Low self-discharge nickel-metal hydride battery		500-1500 ^[13]
Lithium cobalt oxide		500–1000
Lithium iron phosphate		1000–2000
Lithium manganese oxide		300–700
Lithium nickel cobalt aluminum oxide		1000-1500 ^[53]
Lithium nickel manganese cobalt oxide		5000 ^[53]

Thermal runaway

Under certain conditions, some battery chemistries are at risk of thermal runaway, leading to cell rupture or combustion. As thermal runaway is determined not only by cell chemistry but also cell size, cell design, and charge^[54] only the worst-case values are reflected here.

Cell chemistry	Overcharge	Overheat		
	Onset	Onset	Runaway	Peak
	SOC%	°C	°C	°C/min
Lithium cobalt oxide	150 ^[54]	165 ^[54]	190 ^[54]	440 ^[54]
Lithium iron phosphate	100 ^[54]	220 ^[54]	240 ^[54]	21 ^[54]
Lithium manganese oxide	110 ^[54]	210 ^[54]	240 ^[54]	100+ ^[54]
Lithium nickel cobalt aluminum oxide	125 ^[54]	140 ^[54]	195 ^[54]	260 ^[54]
Lithium nickel manganese cobalt oxide	170 ^[54]	160 ^[54]	230 ^[54]	100+ ^[54]

See also

- List of battery sizes
- List of battery types

- Battery nomenclature
- Experimental rechargeable battery types

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