

Table 6.3 (Continued)

Product	Energy, OE (MJ)*	Carbon, CO <sub>2</sub> equivalent (kg)
<b>Power sources, unit as specified</b>		
Li-Ion batteries for laptops, per kg	900–935	74–100
Ni-MH batteries for laptops, per kg	933	57
Lead-acid batteries for cars (39 Wh per kg), per kg	19	1
Li-Ion battery, scooters, cars (99 Wh per kg), per kg	324	8
Alkaline AA cell battery, per unit	1	0.1
Li-Ion AA cell battery, per unit	3	0.2
Ni-Cd AA battery, per unit	3	0.2
Ni-Cd C-cell battery, per unit	5	0.4
<b>Materials, unit as specified</b>		
Single crystalline silicon, electronics, per kg	4,966	251
Single crystalline silicon, photovoltaics, per kg	2,239	103
Mono-crystal-Si wafer, electronics, per m <sup>2</sup>	6,017	305
Mono-crystal-Si wafer, photovoltaics, per m <sup>2</sup>	2,804	129
Poly-silicon wafer, per m <sup>2</sup>	2,000	90
Solder, Sn/Ag4/Cu 0.5	234	20

\*Data from IDEMAT (2009), Knapp and Jester (2000), MEEUP report (2005), and Hammond and Jones (2009)

### Embodied energies of structure and enclosure

**Example:** The structure of a steel-framed building requires, per square meter of floor area, 625 kg of standard concrete (foundation) and 86 kg of steel (100% recycled). The enclosure, per m<sup>2</sup> of floor, requires 0.2 m<sup>3</sup> of fiberglass insulation and 6.6 m<sup>2</sup> of ¾-inch (19 mm) plywood. What, approximately, is the embodied energy of structure plus enclosure?

**Answer:** Drawing data from Table 6.4, we find the embodied energy of the structure is

$$625 \times 1.14 + 86 \times 7.3 = 1,340 \text{ MJ} = 1.34 \text{ GJ}$$

That for ¾-inch plywood is

$$0.019 \times 5,720 = 109 \text{ MJ/m}^2$$