Stuff: Lifecycle Assessment (LCA)

Physics and Mathematics of Sustainable Energy

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Material	Energy	Carbon
Stainless Steel	56.7	6.15
Steel	20.1	1.37
Polyurethane insulation (rigid foam)	101.5	3.48
Aluminum (general & incl 33% recycled)	155	8.24
Plywood	15	1.07
PVC	77.2	2.41
Iron	25	1.91
Glass	15	0.85

Table 18.1: Embodied energies and carbon for different materials. Energies are in units of MJ/kg. Carbon is in units of kg of CO_2 per kg. From the Circular ecology database, http://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html, cited on https://en.wikipedia.org/wiki/Embodied_energy.

Figure 1: Embodied energy and carbon for a few materials.

1. Calculate the embodied energy and CO_2 of a 15 gram aluminum can.
2. Calculate the embodied energy and CO_2 of a 192 gram glass bottle.
3. A 2MW turbine requires around 80 tons of steel.
   (a) How much energy would such a turbine produce every month?
   (b) How much CO_2 is saved by the turbine, assuming that its electricity displaces electricity generated from natural gas, which has a carbon intensity of around 470 g/kWh? (The carbon intensity of electricity from wind is around 12 g/kWh.)
   (c) What is the embodied emissions in the steel in the turbine?
   (d) What is its carbon payback time?
   (e) Suppose that turbine is made in Aarhus, Denmark and then travels via container ship to New York City. How much CO_2 is emitted by the boat that transports the turbine. Use an emissions rate of 25 g per ton-km, which is a typical[1] value for a modern freight ship.
   (f) How do the emissions associated with making the steel compare with the emissions associated with transporting it?

[1] http://timeforchange.org/co2-emissions-for-shipping-of-goods/