Table 5. Off-farm energy inputs/outputs of soybean biodiesel and corn grain ethanol production and co-product energy credit.

	Production energy (MJ/L)			
	Corn grain ethanol		Soybean biodiesel	
	Input	Output	Input	Output
Crop and biofuel transportation *	1.07		1.17	
Conversion of crop to biofuel †	12.73		8.08	
Production facility capital	0.04		0.06	
Non-farm household energy use	0.15		1.08	
Energy in biofuel ‡		21.26		32.93
Co-product credit §		4.31		21.94

* Energy use to transport corn from the farm to ethanol plants and to transport ethanol from the plants to end users is an average of five studies (2-6). For soybean biodiesel production, we used reported energy input values for transporting soybeans from farm to crushing facility, soybean oil from crushing facility to soybean oil conversion facility, and biodiesel from the soybean oil conversion facility to the point of use (14).

† Dry-mill ethanol production energy use is an average of estimates from three studies (2-4), excluding the study that assumes wet-milling (5) and that which includes in this value energy to produce an ethanol plant (6), which we calculate separately. For soybean biodiesel, we use current steam and electricity production efficiencies to estimate the energy required to produce oil and meal from seed at a crushing plant, and convert the oil to biodiesel and glycerol at a conversion facility (26). At the crushing plant, 0.260 kg of steam and 0.027 kWh of electricity are required per kg of soybeans for seed preparation, oil extraction, and meal production. At the conversion facility, 0.395 kg of steam and 0.024 kWh of electricity are needed per kg of soybean oil for degumming and transesterification. Energy inputs for steam and electricity are 2.44 MJ/kg and 3.60 MJ/kWh. We include production energy of solvents and reagents used in processing (*i.e.*, hexane, methanol, sodium hydroxide, hydrochloric acid, and sodium methoxide) (14).

‡ The combustible energy of corn grain ethanol and soybean biodiesel are assumed to be 21.26 MJ/L (2-6) and 32.93 MJ/L (14), respectively.

§ *Co-product credit for DDGS*: Enough DDGS is produced per L of ethanol to displace 0.78 kg of corn and 0.59 kg of soybean meal (31). As it takes 2.04 MJ and 4.60 MJ to produce 1 kg of corn and 1 kg soybean meal, respectively, 4.31 MJ are credited per L of ethanol. *Co-product credit for soybean meal*: With a soybean oil content of 18%, the soybean meal co-product credit is 18.43 MJ per L of biodiesel, which is 82% of the energy used to grow soybeans, transport them to a crushing facility, extract their oil, and prepare the meal (14). Energy inputs for soybean oil transportation and conversion, and biodiesel distribution are not allocated as these steps are specific to biodiesel production from soybean oil. *Co-product credit for glycerol:* 0.071 kg of glycerol is produced per liter of soybean biodiesel. It takes 49.5 MJ/kg to produce synthetic glycerol (32). Therefore, the co-product credit of glycerol per liter of biodiesel is 3.51 MJ. Because synthetic glycerol is of a higher purity than raw glycerol, however, this co-product credit overestimates the displacement energy.