

Issue 60

Energy Conversion: Developing Countries

In the farming areas of developing countries, human muscle power is often the most practical source of energy for producing electricity. For operating radios and televisions, battery packs and solar cells are prohibitively expensive, and small gasoline engines driving generators are unreliable and hard to maintain. But a person pedaling a bicycle can easily generate 35 watts, or about 0.05 horsepower ($746 \text{ W} = 1 \text{ hp}$), and a dynamo driven by someone pedaling a stationary bicycle is fairly easy for untrained people to repair.

If your input from food is 2400 kilocalories per day or 100 kilocalories per hour, your input from food, averaged over the day, is 420,000 joules per hour, which is 117 joules per second or 117 watts. Hence, your efficiency at pedaling a simple electric generator is

$$\frac{\text{output}}{\text{input}} = \frac{35 \text{ W}}{117 \text{ W}} = 0.30 \text{ or } 30\%$$

which is better than a gasoline engine for the length of time that you or a farmer can keep pedaling—presumably for hours.

The same pedal-power applied to a stationary bicycle can be rigged to pump water out of a well or to drag a plow across a field with a winch or to operate winnowing or grinding machines.

Sending powerful labor-saving machinery to developed countries may seem like a good idea, but it usually is not. The 18,000 tractors once shipped to Pakistan increased no crop yields there but simply put thousands of people out of work. Considerations like these guide the development of what is called “appropriate technology” for helping people in developing countries that have little or no access to Western technology but have a large under-used labor force.

People from developed countries working overseas use elementary physics in a similar way:

- to improve pumps for getting clean water from deep underground,
- for building small cement plants and brick-making plants,
- for designing simple metal-working machinery, and
- for inventing more efficient windmills and more effective farming tools.

All use locally available materials. Each developing country has different needs and different solutions—different appropriate technology.

Suppose it takes 10,000 laborers two years to build an earthen dam in India using shovels and wheelbarrows. Suppose also six American bulldozers could do the same job in three months. If you had to make the decision (and some person has to), would you send the bulldozers to India as part of our ongoing foreign aid? If not, why not? Is your answer an argument against giving American technical aid to developing countries? What about sending bicycles instead of gasoline-driven vehicles?

Perhaps you will become interested in using your knowledge of science in this practical way abroad.



"Oh, good—heavy boxes. They'll hold down the thatch on our roof in those torrential winds."