

Education for the global energy challenge

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Energy is the lifeblood of the modern world. According to the Energy Information Administration, global energy consumption is expected to grow by about 70% in the coming 25 years.¹ Much of that growth is driven by developing countries, whose inhabitants seek a standard of living that more closely resembles that of the developed world. Petroleum provides about 40% of the worldwide energy,¹ and although estimates vary, oil production is expected to peak in the relatively near future. The combination of increased energy demand and declining petroleum supply can be a threat to political stability and is likely to lead to a shift toward coal and nonconventional oil, such as tar sands and oil shale. That shift will further increase carbon dioxide emissions and thus accelerate global warming and life-altering regional climate changes. The challenges posed by the growth in demand were described in the April 2002 special issue of PHYSICS TODAY in the articles by Stephen Benka (page 38) and by Ernest Moniz and Melanie Kenderdine (page 40).

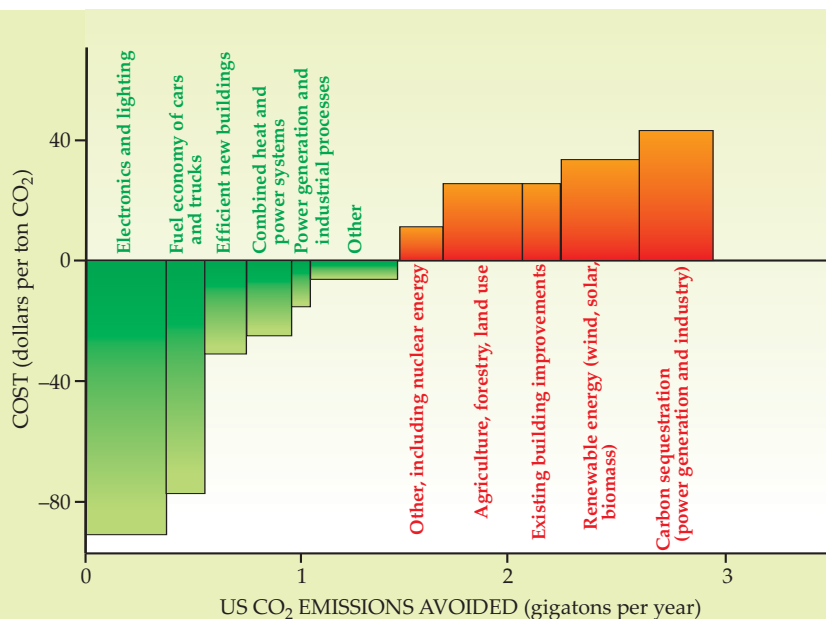
Many actions can be taken now to begin to reduce energy demand, diversify our energy portfolio, lower the costs of energy supplies, and reduce greenhouse gas emissions. Those actions will not occur, however, without a plan and the willingness to implement it. Public engagement and education in dealing with the pressing challenges and opportunities are the keys to getting started now. A recent study has shown that the public largely believes a number of myths regarding our energy use.² Those wrongly held notions include the ideas that today's energy crisis is a hype, that efficiency improvements have reached their potential, that renewable power systems cannot make a significant contribution to our energy supply, that present worldwide power systems are economically and environmentally optimal, and that climate pol-

icy will bankrupt the US economy. Those beliefs impede the acceptance of technical and societal changes that could yield a more sustainable energy supply.

To help dispel the notion that reducing CO₂ emissions will wreck the US economy, we show in the figure the cost versus avoided US CO₂ emissions for a variety of different actions.³ Each bar in the graph stands for a set of actions that help reduce CO₂ emissions; its width gives the amount of avoided CO₂ emissions in units of gigatons per year, and its height depicts the associated cost. The figure shows that about 1.4 gigatons per year of CO₂ emissions can be avoided *at negative cost*, that is, at reduced cost compared with taking no action! Those avoided emissions represent about 20% of the current CO₂ emissions of the US. Measures that have a

negative cost include efficient lighting systems and electronics, fuel-economy packages for cars and light trucks, improved insulation for new buildings, and combined heat and power industrial systems. The negative cost implies that money and energy resources can be saved by adopting those technologies. Many of the measures proposed to reduce CO₂ emissions serve the additional purpose of reducing energy demand by increasing energy efficiency or by switching to renewable energy.

Some of the negative-cost actions for avoiding CO₂ emissions have impediments to their implementation. Capital investment precedes the financial returns from some actions, such as using combined heat and power systems for commercial buildings or better insulation in new residences. For other steps, such as making more efficient cars and



Cost of avoided carbon dioxide emissions per ton (vertical axis) versus annual avoidable US CO₂ emissions (horizontal axis) in gigatons of CO₂ per year. Total US CO₂ emissions are about 7 gigatons of CO₂ per year. (Adapted from ref. 3.)

light trucks, society must change its preference for large and heavy vehicles in favor of low-weight, fuel-efficient ones. Financial incentives and regulation can help accelerate the implementation of such energy-saving steps, and education can make the financial incentives and regulation politically more acceptable. Research can help lower the price for the positive-cost items in the figure—for example, by developing cheaper and more efficient photovoltaic systems or applying nanotechnology to gas separation for carbon capture and sequestration. Financial support for demonstration projects serves the goals of testing and scaling up new technology and creating societal acceptance of that technology. Providing balanced information to the public helps foster a mindset that is open to the technological and social innovations needed for a stable and environmentally responsible energy infrastructure.

How can physicists help to establish a more sustainable energy supply? Some of us are doing research that helps develop renewable energy sources or might lead to increasingly efficient use of nonrenewable sources. Many colleges and universities now offer energy courses. Such courses are useful but tend to attract students who are already convinced of the need to change our energy system. Physics teachers can create a greater awareness of the energy challenge by infusing their classes on thermodynamics, electrodynamics, quantum mechanics, and mechanics with examples that help students understand energy and climate-related issues. The presidents of colleges and universities can sign the American College and University Presidents Climate Commitment,⁴ and invest in creating an environmentally friendly campus. Faculty members can do their part by encouraging their presidents to join the initiative.

As part of the outreach and education activities of the Global Climate and Energy Project at Stanford University, we have developed a public lecture, "The Global Energy Challenge," for students from high schools, community colleges, and universities, and for a general audience. The PowerPoint presentation is freely available⁵ and aims to be broadly appealing and understandable. Accompanying comment boxes give ideas for a narrative. The presentation outlines the tension among increased energy demand, peak oil, the associated challenge in curbing climate change, and actions that we can take toward a sustainable energy system.

When lecturing about energy, it is important to avoid sketching doomsday scenarios, which tend to generate denial that blocks further communication. The energy challenge offers new opportunities that need to be conveyed so that people are empowered to take action. It is helpful to give ideas for positive action that teachers, students, business people, consumers, and citizens can take and to explain that the challenges related to our energy supply come with career opportunities, a point that is especially appealing to a young audience. Our lecture offers material for such a discussion.

Our talks at community colleges have been well received. Teachers of general science at those colleges often are grateful for material relevant to societal concerns that fits into their classes. We have also used our presentation in high schools. Service clubs such as the Rotary or Kiwanis are keen to host engaging speakers; online club locators make it easy to establish contact with such clubs.⁶ Local churches, libraries, and community centers provide other opportunities to present a public lecture.

We encourage you to help raise awareness of the energy challenge that we face and of the opportunities associated with developing and implementing new energy systems. It has been easy for us to engage audiences on the topic. Physicists can make a difference by participating in energy outreach and education—for example, through use of a variant of our lecture. We have consistently received positive responses and have felt rewarded. We invite you to make a similar contribution.

References

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