What's the Best Way to

DON'T FORGET THE EMISSIONS PRICE

Promote Green Power?

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Right now, the only thing that competes in the news cycle besides the war in Iraq and the upcoming election is green power, in all its forms. Consumers are buying compact fluorescent light bulbs, utilities are promoting their latest options, and the "experts" are claiming that their favorite source should prevail. And renewable energy sources—including geothermal, solar, wind, tide and hydropower—are a major component of most strategies for addressing global climate change. As it turns out, not all policies that promote renewables are created equal; our research shows that broad-based policies like emission fees are substantially more cost effective than more targeted approaches, such as research and development subsidies, if the goal is to reduce greenhouse emissions in the near and medium terms.

Many nations have proposed targets for renewable energy production that can only be described as ambitious, given the current levels and the short time frames involved. Proposals in the United States aim to increase renewable electricity production to 15 percent by 2020, a significant amount, given that hydropower capacity is extremely unlikely to expand. The targets set by the European Union are higher still, to produce 22 percent of electricity and 12 percent of gross national energy consumption from renewable energy sources by 2010.

The feasibility of achieving these goals depends importantly on technological innovation that will lower the cost of these non-emitting energy sources. Toward these ends, Organisation for Economic Co-operation and Development (OECD) countries have implemented a wide range of policies to reduce greenhouse gas emissions and stimulate innovation in cleaner technologies. Policies implemented in OECD countries include the following.

- A carbon dioxide (CO_2) emissions price—via either an emissions tax or a tradable emissions permit system—provides incentives to reduce CO_2 intensity (that is, CO_2 emissions per unit of economic output) and makes fossil-fueled sources more expensive than renewables. Several Scandinavian countries and the Canadian province of British Columbia have implemented CO_2 taxes, and, in 2005, the European Union launched a program of tradable CO_2 emissions permits.

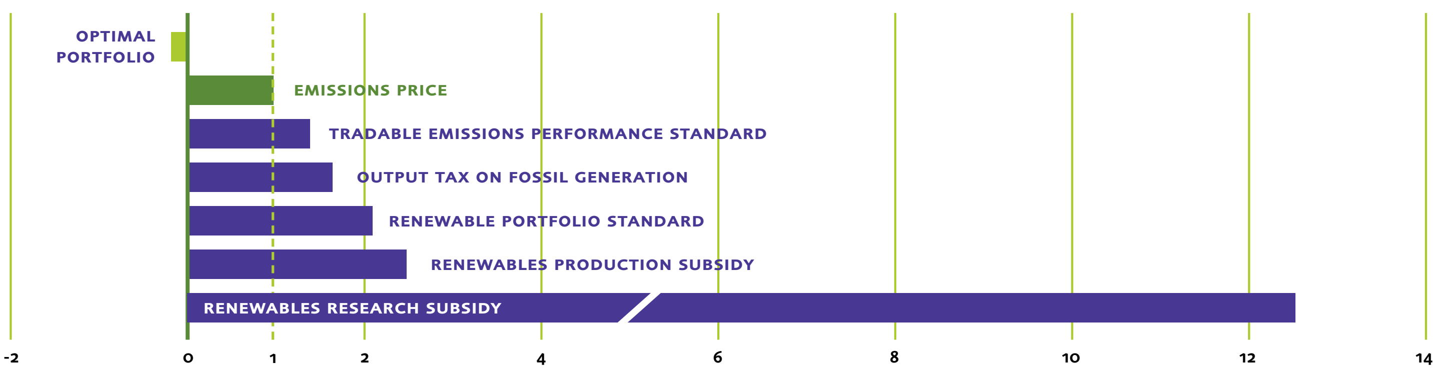
- A tax on fossil-fueled energy raises the price received by renewables through higher consumer prices for energy, favoring renewables over fossil-fueled sources. The United Kingdom, Germany, Sweden, and the Netherlands tax fossil-fueled sources, in most cases by exempting renewable sources from an energy tax.

- A tradable emissions performance standard, or generation performance standard, mandates that the average emissions intensity per unit of output (for fossil-fueled and renewables generation combined) not exceed a standard. Such policies are considered for energy-intensive industries, such as certain sectors in the United Kingdom's Climate Change Levy.

- Renewable energy portfolio standards—also called market share requirements or green certificates—may require either producers or users to derive a certain percentage of their energy or electricity from renewable sources. Such programs have been planned or established in Italy, Denmark, Belgium, Australia, Austria, Sweden, and the United Kingdom, as well as in several states and provinces in the United States and Canada.

- A production subsidy for renewable energy boosts the price received by renewables and lowers their effective marginal cost relative to other sources, improving the competitiveness of these sources vis-à-vis fossil fuels. The United States has the Renewable Energy Production Incentive of 1.9 cents per kWh, and 24 individual states have their own subsidies. Canada has a Market Incentive Program, and several European countries and Korea have production subsidies.

Cost of Policy Scenarios Relative to Emissions Price



The use of a renewables R&D subsidy alone results in both very large R&D investments and forgoing near-term cost-effective abatement opportunities. Because cost-effective early emissions reductions are not pursued, all emissions reductions must be gained in later years by making renewables less expensive than fossil fuels without any emissions reduction or conservation incentives. This would require the cost of renewables to fall by a sizable 25 percent.

An emissions price alone is the most efficient single policy for reducing emissions because it simultaneously gives incentives for fossil energy producers to reduce emissions intensity, for consumers to conserve, and for renewable energy producers to expand production and to invest in knowledge to reduce their costs. The other policies offer different combinations of these incentives with correspondingly different consequences for the distribution and the overall size of the burden of meeting an emissions reduction target.

An optimal policy combines an emissions price with policies to capture spillovers in the market for knowledge, namely a proportional R&D subsidy and a small subsidy for renewable production. These corrective policies provide positive benefits, and allow the emissions price to fall by one-third to meet the same target.

- Subsidies for R&D investment in renewable energy, including government-sponsored research programs, grants, and tax incentives, are used to encourage near-term and long-term innovations through targeted research. Major programs exist in the United States, the United Kingdom, Denmark, Ireland, Germany, Japan, and the Netherlands.

Economists typically argue that a direct price for CO_2 (a tax or tradable emissions permit system) would provide the most efficient incentives for development and use of cleaner technologies. In practice, a number of issues are at play and therefore numerous policies are being pursued. Some of these issues extend beyond economic efficiency, such as political acceptability and distributional questions. Others emerge directly from economic efficiency considerations; for example, spillovers in R&D markets reduce incentives for firms to innovate because a portion of the returns on their investments will be captured by others. Similarly, the innovation process may occur not only through R&D investments, but also through firms "learning" from the production and use of new technologies.

Most prior studies have focused on the effectiveness of emissions pricing policies, such as emissions taxes and emissions permits, for stimulating innovation in green technologies. The broader, more pragmatic set of policies, such as those using performance standards and supporting renewable energy, have generally been neglected.

To shed some light, we developed a modeling framework for the electricity sector that incorporates both a knowledge accumulation stage, when R&D and learning occur, and a knowledge application stage, when the cost-reducing benefits are realized. Using this consistent framework, we evaluated the six aforementioned policy options for their relative performance according to different metrics: emissions reduction, renewable energy production, R&D, and economic surplus. To better understand both the magnitude of the efficiency and cost differences among the policies, we applied our approach to a numerical model of the U.S. electricity sector.

We set an emissions price of $7 per ton of CO_2 (or about $25 per ton of carbon) throughout the model and used the resulting emissions as a target for the other scenarios, allowing for an apples-to-apples comparison. For the portfolio standard and the emissions performance standard, we held the price of credits constant across our two time stages, while meeting the implied emissions target. The resulting renewables portfolio standard rises from 6.0 percent in the first stage of the model to 9.6 percent in the second stage, which is close to a recent proposal for a national renewables portfolio standard that would rise from 5 percent by 2012 to 10 percent by 2020.

Our results indicate that the emissions price is indeed the most efficient means of achieving a given emissions target, leading to the least cost in terms of surplus and requiring the least investment in renewable energy R&D. Conversely, the renewables research subsidy is by far the most costly single policy for reducing emissions.

The figure on page 12 displays the relative costs of the policies as a ratio to the cost of the emissions price. An optimal combination of policies performs best and actually leads to a small cost savings with this modest emissions target due to induced innovation benefits. The renewable portfolio standard is roughly twice as costly as the emissions price, with the performance standard and the output tax lying in between. The renewables production subsidy is two-and-a-half times as costly, while relying on the R&D subsidy alone is a whopping 12 times more costly than utilizing a price on emissions.

When the ultimate goal is to reduce emissions, policies that also create incentives for fossil-fueled energy generators to reduce emissions intensity and for consumers to conserve energy perform better than those that rely solely on incentives for renewable energy producers. For the modest emissions targets we examined, a renewable energy R&D subsidy turns out to be a particularly inefficient means of emissions reduction—when used alone—because it postpones most of the effort to displace fossil-fueled generation until after the costs of renewables are reduced.

Although climate change is a long-term problem, our results for mid-term strategies emphasize the important role of policies that encourage abatement across all forms of energy generation and time frames, as well as the limitations of narrowly targeted policies.

Nonetheless, no single policy can simultaneously correct more than one market failure—in this case the failures associated with the emissions externality and the knowledge spillovers from learning and R&D. Each policy poses different trade-offs. In the presence of knowledge spillovers, an optimal portfolio of policies—an emissions price combined with optimal learning and R&D subsidies—can achieve emissions reductions at significantly lower cost than any single policy alone. (Yet the emissions reductions continue to be attributable primarily to the emissions price and the learning subsidy is small.)

If even a modest emissions price is not politically feasible, an R&D subsidy by itself is not the next best policy, and the costs of that political constraint are likely to be quite large and increasing with restrictions on the remaining policy options. It should be kept in mind, however, that we chose to focus on reductions over the near- to mid-term and incremental improvement of existing technology, rather than the development of breakthrough technologies that might achieve deep reductions. R&D policies probably have greater salience in the latter context, but that should not diminish the role of emissions pricing to improve the competitiveness of all green alternatives in the market. ■

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