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Title: Should We Subsidized Residential Solar Power and if so at what Level?
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Abstract: In determining a government solar subsidy level, it is important to integrate the technical with the social science. Such a framework integrates the technical environment, health, employment, and electricity accessibility benefits with consumers' prosocial behavior. Prosocial consumers may adopt solar power without any subsidy because it increases their reputation as environmentalists. A solar subsidy may reduce this prosocial behavior resulting in lower than expected adoption, called a rebound effect. Considering this effect reduces the optimal subsidy based on external costs. Estimates of the optimal solar subsidy is approximately $0.02 per kilowatt-hour when not considering prosocial behavior. This optimal subsidy is in line with many current state subsidies, which may represent the upper bound when not considering social science in policy analysis.

Why Government Subsidies for Solar Power?

Consumers do not pay the full cost of their residential power consumption. There are environmental external costs to providing residential power generation, which consumers do not pay. Specifically, there are greenhouse gas emissions and local air pollution from current coal power generation. In addition to these environmental effects, there may be "green" and high-tech job opportunities flowing from the solar industry to rural areas. Augmenting current power generation with solar will contribute toward mitigating these external costs and may provide rural areas with job growth. When properly designed, government subsidies supporting a solar industry can reduce these external costs of power generation.

What are the Subsidies for Solar Power?

In the past decade, an array of government policies, programs, and financial assistance have supported solar power. In terms of percentage growth, solar power is the fastest rising renewable power technology. Solar power generation expanded from 1.5 GW in 2000 to just over 100 GW in 2012. A range of government programs drives this expansion of residential-renewable energy systems. At the federal level, homeowners may claim a 30% personal tax credit for residential solar systems and installation costs. State and municipal authorities also employ various supporting policies in the form of cash rebates, net metering, renewable-portfolio standards, solar set-asides, and solar renewable-energy credits. Recently, states have enacted feed-in-tariff systems (California, Hawaii, Oregon, Vermont, and Rhode Island). When considering cumulative subsidies and electricity generation, from 1947 to 1999, solar energy received subsidies worth $0.51/kWh (in 1999 dollars). In 2007 the global total subsidy for solar was $0.64/kWh (in 2007 dollars). The direct federal financial interventions and subsidies in U.S. solar energy markets grew from $179 million in 2007 to $1134 million in 2010 (2010 dollars).

Problem: Solar Adoption is lower than Expectations

Despite economic returns from the adoption of many energy-efficient technologies and a wide array of government policies to foster adoption, uptake rates are slow and not aligned with policymakers' expectations. This “efficiency paradox” indicates an assortment of factors beyond simple cost-benefit economics influence adoption decisions. For the case of residential solar power, there are a number of motivations and energy use behaviors associated with adoption.

Providing government incentives for individuals taking a certain action can have perverse effects, when considering their social reputations. The classic illustration is paying for human blood could actually reduce supply. Individual prosocial behavior is the intrinsic motivation to take actions, which are in the community's best interest. In accordance with motivational-crowding theory, external motivation in the form of government incentives can result in a loss (crowding out or rebound effect) of intrinsic motivation. A subsidy for solar adoption could mitigate, crowd out, intrinsic prosocial behavior of adoption. Households' reputation for being environmentalists may not be as strong with a solar subsidy.

Economics as a Bridge

The optimal solar subsidy not only depends on the technical relation of how external costs respond to a subsidy and the subsidy cost but also on the impact the subsidy has on consumers’ prosocial behavior. If a subsidy yields a large motivational-crowding effect, then the subsidy is inefficient. Identifying the responsiveness of prosocial valuation to a solar subsidy is just as important as the natural sciences in determining the magnitudes of external costs. For policy analysis, economics provides the bridge linking these two sciences.

Application

Unfortunately, information on the magnitude of this prosocial valuation effect are missing. If the effect is significant at a high magnitude, then the optimal-subsidy calculations without consideration of this effect represent an upper bound. One would then discount the subsidy depending on any current subjective valuation of a solar-subsidy motivational crowding. The optimal solar subsidy accounts for the benefits society receives from consumers adopting solar power, which consumers do not consider when making their private adoption decisions. These benefits are a reduction in the external costs of greenhouse gas emissions and local air pollution from current coal power generation along with possible rural development benefits. The estimates of these benefits for a median income household is 7.69 cents/kWh with associated external costs of 7.87 cents/kWh. If excluding the external effect of employment, the optimal solar subsidy for a median income household reduces to 2.24 cents/kWh with associated external cost of 2.23 cents/kWh. These results provide the natural science side of solar government policies. Without consideration of prosocial behavior in a social-technical approach, this only represents at best an upper bound. These values reflect just one possible scenario. Alternative subsidy levels will occur for different regions with modifications to these values.

Implications

Understanding household's responses to subsidies will enable policymakers to determine subsidy levels that effectively 'internalize' the societal benefits that investors do not directly realize. With this knowledge, policymakers will have an improved understanding, based on sound economic theory, of how households will likely respond to policymakers' choices. This alone provides new insights into our understanding of how to move forward toward renewable energies.

Prosocial behavior and the motivational-crowding effect directly influence the optimal solar subsidy. Policymakers in determining the optimal subsidy may want to consider prosocial behavior and the effect their policies have on crowding out this behavior. It is of value to policymakers to consider the relative responsiveness of solar adoption and fossil fuel use to a subsidy. Policymakers may want to consider the degree of motivational crowding when setting a solar subsidy. Realizing a large motivational-crowding effect can lead to inefficiency of any positive subsidy.

The implications transcend determining the optimal solar subsidy. Enriched policy results when the whole spectrum of science is applied. Economics can integrate prosocial behavior with the natural sciences for assessing environmental impacts associated with the adoption of renewable resources. Such integration, socio-technical approach, reveals the true assessment of the solar-policy or in general renewable policy impacts on deriving optimal government policies.

The value of prosocial behavior to policymakers increases greatly then mated with natural science in an economic framework. This is congruent with natural science providing measures of environmental effects for economic analysis. What hampers a socio-technical approach is the lack of bending or shifting science efforts toward integration.

With economic theory providing a bridge linking the prosocial valuation with the natural science of assessing environment costs, future empirical efforts will have theory as a basis for their models instead of ad-hoc modelling. With this framework, sound energy policies based on a comprehensive science approach will emerge.

Source

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