

# CAIRN POLICY BRIEF

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Funded by  
Agriculture & Agri-Food  
Canada

## THE EFFECTS OF GREEN ENERGY POLICIES ON INNOVATION

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### Issue

With ongoing worldwide concern about the effects of climate change and large fluctuations in oil prices, governments are increasingly looking for energy policies and incentives to help curb carbon emissions while maintaining continued economic growth. The current costs of most renewable energy sources (excluding large scale hydro) are significantly more than traditional energy sources (coal, oil and natural gas). Innovation will therefore play a key role in ensuring that renewable energy technologies gradually enter mainstream markets without large government subsidies.

It is generally agreed that private industry on its own under invests in R&D because the private valuation of an innovation is less than the social valuation. The divergence in private and social value occurs because firms cannot capture all of the gains from the

innovation due to knowledge spillovers, which arise because of imperfect property rights. These spillovers benefit competing firms in domestic and international markets, firms in other industries and consumers. When looking at the issue of green energy technology, the pollution externality is also an important reason why firms under invest in R&D. Innovations which reduce pollution and greenhouse gas emissions may have high social value, but low private value. Firms in the green energy sector therefore have a double disincentive to invest at the socially optimal level of R&D.

Over the years countries have implemented many different R&D and renewable energy policies to encourage growth and innovation in green energy markets. Examples of green energy policies include R&D tax credits, R&D grants and feed-in tariffs. Renewable energy policies



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*This policy brief is based on the research contained in Prescott's M.Sc. thesis, which can be downloaded from:*

<http://sites.google.com/site/ryangprescott/RyanPrescottThesis.pdf>

increase the expected returns of renewable energy firms, which results in increased innovation. From a public policy perspective, it is important to know which policies are the most effective at inducing innovation. In particular, accounting for spillovers and market competition, which policies have the highest social benefit to cost ratio?

The analysis of optimal R&D policy is complicated by the desire of most countries to support domestic innovation. Domestic support typically comes at the expense of less efficient innovation and market outcomes. One of the goals of this research is to investigate this so-called home-country bias in green energy policies. Identifying the magnitude of home country bias is important because it will highlight political economy features of green energy markets and it will allow policy makers to identify the policy instruments which are most likely to be associated with a home country bias.

### Research Methods

A two stage theoretical model is constructed to look at the effects of energy policies on innovation and specific reasons for home country bias. In the first stage a pair of renewable energy firms from two different countries each invests in research in order to produce a new green energy

technology. In stage two the firm which is first to innovate wins the patent and uses its new innovation when competing in the global energy market against traditional energy (coal, oil and natural gas) firms. A renewable energy firm will allocate money to research until its marginal expected returns from research equals its marginal cost of research. Energy policies raise the returns for the winning firm which induces each firm to spend more on R&D in an attempt to win the patent race. The theoretical model is used to examine the differential effects of alternative energy policies on the incentives to innovate by domestic and international firms.

The idea that domestic market size has a larger effect on domestic innovation than international innovation is tested empirically. Patent counts are used for measuring innovation. Although not all innovations are patented, the vast majority are as a way of protecting innovations. European patent data from 1990 to 2006 was used to examine the number of wind patents by inventor country and year. Yearly patent counts were regressed as function of domestic output (GWh) and world output (GWh) of electricity. If there was a home-country bias we would expect to see domestic output having a greater effect on patent counts than world output.

Policy makers might also wish to know which policies are most effective at encouraging growth in domestic market size. Changes in domestic wind capacities were regressed as a function of domestic policies (grant to producers, grants to companies, feed-in-tariffs, obligations, targets, green certificates and taxes), GDP per capita and oil prices. If domestic green energy policies are effective at encouraging growth in renewable energy we would expect to see a positive effect of such policies on changes in wind capacities. Large growing economies, increased individual wealth and increases in oil prices should also have positive effects on wind capacities.

### Results

A green energy policy such as a feed-in-tariff was incorporated into the theoretical model in order to examine the differential effects of the policy on the incentive to innovate by domestic and international firms. A policy such as a feed-in-tariff raises the consumption of renewable energy, which results in larger profits and more output for renewable energy firms. The increased profit by the renewable energy firm in the second stage encourages more research in the first stage, which in turn raises the level of innovation. If international firms have higher

costs of supplying renewable energy because of government policies or regulations, then they will have lower second stage profits. These lower profits result in lower incentives to spend money on research, which results in less innovation by foreign firms. As a result a policy such as a feed-in-tariff which increases the use of renewable energy may be subject to a home country bias because the incentive to innovate may be stronger for domestic firms than international firms.

The empirical results showed that domestic size of market had a much larger effect on patent counts than the international size of market. This could be due to barriers to entry for foreign firms. Unfortunately, the question of which economic policies are most effective in increasing market size is not easily determined. A country's economic policies will typically vary from region to region within a country, therefore making it difficult to look at levels of economic policies and the associated strength of such policies. As a result in the empirical analysis the only policy which had a positive impact on changes in wind capacities was green energy consumption obligations, which is the strongest of the various policy types. Others policies may have had an impact on wind capacities, but the inability to determine country

policy levels hindered this analysis.

### **Policy Implications and Conclusions**

Several European countries have been at the forefront of green energy use and, not surprisingly, green energy policies. The specific policies used by countries has varied substantially. Denmark, for example, has targeted growth in wind energy since the early 1980's, implementing policies such capital grants incentives and guaranteed prices. Guaranteed prices or feed-in-tariffs guarantee renewable energy sources a fixed rate per kilowatt hour above what traditional energy receives. Other policies include obligations (mandates) which force power producers to include a certain amount of renewable energy in their energy mix, carbon taxes which tax the use of traditional energy and grants to consumers or producers.

When all necessary information is available, price instruments such as taxes and quantity instruments such as obligations can have similar effects on reducing emissions and increasing renewable energy output. The key difference is that with a tax or feed-in-tariff the exact amount of pollution abated or new renewable energy supplied will not be known ex ante, while in the case of obligations the amount

of renewable energy which is added or pollution abated will be known with relative certainty.

Ultimately most policies have the potential to increase the use of renewable energy and the level of renewable energy innovation given sufficient strength. From this research there is a noticeable home-country bias, whereby domestic size of market encourages domestic innovation more than international innovation. This increased domestic innovation may have political benefits by allowing for the creation of new "green jobs", but this bias may not be maximizing social benefit. If barriers to entry in domestic markets are reduced then worldwide innovation in the green energy sector is likely to increase and this increase could increase domestic welfare. New international innovations would benefit domestic consumers by making renewable energy even more cost competitive with traditional energy, which in turn will result in lower energy subsidies and decreased emissions.