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Comparing Carbon Fees with Existing Financial Incentives for Solar Electricity

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Abstract

This paper compares a policy of pricing carbon dioxide emissions with existing incentives for renewable energy, in effect juxtaposing disincentives for dirty electricity with existing, but varied, incentives for clean electricity. Among existing policies, the recently renewed investment tax credit (ITC) and accelerated depreciation are most important. The analysis here examines how high a carbon fee would be required to maintain profitability in the absence of the ITC.

The comparison is based on pro-forma financial projections of investors' returns for solar power generation in a typical setting, calculating the carbon fees needed to match existing incentives. Results offer perspective on how best to encourage clean energy with the application of carbon fees.

Keywords: *Financial incentives, solar electricity, carbon fees, tax credits, climate change, external costs*

1. Introduction

The recent extension of the 30 per cent investment tax credit (ITC) in the U. S. has probably saved the solar and wind industries from a severe downturn. With this incentive now in place for a few more years, a careful evaluation of long-term policies for clean energy is timely and appropriate.

U. S. energy policy has focused mostly on positive financial incentives for investment in renewable electricity. A more balanced energy set of incentives would discourage equally all sources of greenhouse gas pollution, not just encourage investments in clean electricity. Economic theory described by Pigou (1920) and Turvey (1963) suggests that the cost of damages to third parties be added to the price of a transaction between a buyer and seller, for example to discourage the use of dirty fuel. Thus, internalizing fossil fuel's damage or external costs could simplify existing complex incentives for clean energy, and cover all sources of carbon dioxide emissions.

Carbon fees have been applied with limited success as disincentives for carbon dioxide pollution, mostly outside the U. S. Legislative proposals within the U. S. have been made at local and federal levels. A key question is what should be the level of carbon fees.

2. Damages from Carbon Dioxide Emissions are Costly

Renewable energy sources are presently at a financial disadvantage because they are more expensive to build, and because cheap fossil fuels do not pay for the damage they do to the environment. Damages are calculated in dollars per tonne of carbon dioxide, which is used the indicator for all harmful emissions.

Damages from greenhouse gas emissions are now recognized as extensive: sea level rise, more violent storms, hotter and drier weather at some times in some locations, cooler and wetter weather in others, decreased agricultural production, international insecurity and migration, wider geographic ranges for

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diseases, loss of species, and ocean acidification, to list a few. Climate change appears to be accelerating now at a rate that requires a more robust response than is possible with existing policies.

Dollar estimates of damages from greenhouse gases vary widely. Epstein, et. al. (2011) report that damages from coal-fired electricity range from $75 to $216 per tonne of carbon dioxide, with an average of $143. Sumner, et. al. (2009) suggest a range of $29 to $221 per tonne. These ranges are too wide to be useful, except to note that they are higher than values closer to zero that are inherent in current pricing.

Ideally, more precise damage estimates would form a basis for public policy, but practical political considerations have in the past and will in the future probably limit adoption of such policy. In any case, the analysis here ignores such logic in making policy, and only considers the effect of carbon prices on the profitability of solar electricity investments.

3. Carbon Fees Better than Cap and Trade

Two types of public policy have been implemented to make fossil fuels more expensive: cap and trade, and carbon fees. Variations of cap and trade are universally complicated and have resulted in prices too low (around $12 per tonne) to make a difference to fuel users (roughly 9 or 10 cents per gallon for gasoline) or to renewable electricity bidders (less than a penny per kWh in electricity). A major shortcoming in cap and trade as it has been implemented is the variety of allowances given to politically influential major polluters. Another shortcoming, which follows from the first, is a lack of certainty in prices that renewable energy investors can anticipate when they compete with polluters.

A simpler policy than cap and trade is to charge a predictable fee for all fossil carbon as it enters the economy, based on the tonnage of carbon dioxide produced when it is burned. Variations have been implemented in Europe, but the best example is in the Canadian Province of British Columbia, reported by Porter (2016). A rising carbon fee has turned out to be effective and politically popular since implementation in 2008. What made it successful was returning all revenue to citizens and companies in tax reductions. Fossil fuel use in the province declined by 17 per cent. The fee is capped at CD$30 (about US$23) per tonne.

Cap and trade policies and carbon fee policies generally cover all or most sources of carbon dioxide pollution (fossil fuel heating and transportation, for example) and do not just support solar and wind as the ITC does. Covering all sources is important, to avoid the economic distortions in the hodge-podge collection of current incentives.

4. Investors Seek Adequate Return and Predictability

In evaluating prospective investments in renewable energy, prospective investors use pro-forma projections of their initial expenditures and future cash flows to determine whether a project is financially profitable. If the return on investment, or the discount rate for which those cash flows yield a zero net present value, on these cash flows is sufficient, then the investment is attractive. If the return is too low or too uncertain, the investor will reject it. A carbon fee will raise the revenue earned from electricity sales and an investor’s return on investment.

Issues in determining these pro-forma cash flows for solar (and wind) electric generation include:

- The initial investment, which depends on the cost per kW and system capacity;
- Revenue earned from electricity sales, which depends on the plant’s capacity factor and the sales price per kWh;
- Operating costs, including maintenance, insurance and property taxes; and
- Income tax, which depends on tax rates, allowable depreciation, and tax credits.

5. Investors’ Returns with Existing ITC

Examples here are based on average California conditions, where the dominant source of greenhouse gas for electricity generation is natural gas. California’s generation mix is efficient, and its solar resource is excellent. Other electricity sources include nuclear, hydro, and renewables, which emit no carbon dioxide. Natural gas prices below three dollars per million Btu in recent years make renewable electricity sources less financially attractive than they were before fracking. Results will be different in states where coal is still a major part of the mix, or where the solar resource is less favorable.

The first example is a typical leased California residential rooftop PV system, based on data from Bolinger and Seel (2015). A pro-forma cash flow is illustrated in Table 1, based on assumptions of 10 kW, $3.00 per watt, 24 percent capacity factor, a 30 percent ITC, 5-year accelerated depreciation with third quarter in service, all equity financing, 20-year life, and 10 percent salvage. California data are taken from Energy Information Administration (2016), which provides 2014 information on electricity sales, revenues, generation, and emissions. Other varied incentives beyond the ITC and accelerated depreciation are not considered.

Revenue is calculated as the reduction in the homeowner's utility bill at 16.2 cents per kWh. The next-to-last row in Table 1 is the cash flow that establishes return on investment, which turns out to be 11.7 percent. Obviously the return would be more attractive with higher revenue, less attractive with higher installation cost, and less attractive with lower capacity factor. Thus, results will differ in other states.

Table 1: Pro Forma Cash Flow Statement for Leased California Rooftop PV,

Existing 2016 Incentives, First Six Years of Twenty Years

Year	0	1	2	3	4	5	6-20
Sales (kWh)		21,024	21,024	21,024	21,024	21,024	21,024
Revenues		3,416	3,416	3,416	3,416	3,416	3,416
Initial investment	30,000						
O and M Plus Insurance	350	350	350	350	350	350	350
Cash Flow Excluding Taxes	-30,350	3,066	3,066	3,066	3,066	3,066	3,066
Depreciation	3,150	7,140	4,284	2,570	2,373	1,483	0
Investment Tax Credit (ITC)	9,000						
Taxable Income	-3,500	-4,074	-1,218	496	693	1,584	3,066
Tax Effects	-10,225	-1,426	-426	174	243	554	1,073
Cash Flow With Tax Effects	-20,125	4,492	3,493	2,893	2,824	2,512	1,993
Return On Investment	11.7%						

Tax issues dominate investors' returns. The ITC and tax deductions like depreciation are only useful to an owner with a tax liability. As a result the legal owners of leased systems are likely to be high-income entities.

Return on investment will be lower without the ITC, so the question addressed here is whether carbon fees could offset that loss. The effect of carbon fee will vary across locations and utilities, depending on the carbon content of its fuel mix and other factors. Therefore these results serve as examples and not as specific numbers for any given location or utility; but what is valid over all conditions is how important both the ITC and revenue with a carbon fee are for profitability.

Calculations of investors' returns, using the pro forma approach and the same California data, are summarized in Fig. 1, using the following examples:

Ex. 1. Rooftop PV leased to homeowner, 30% ITC, with depreciation (Table 1);

Ex. 2. Homeowner's rooftop PV, 30% ITC, no depreciation;

Ex. 3. Rooftop PV, leased to homeowner, no ITC, with depreciation;

Ex. 4. Homeowner's rooftop PV, no ITC, no depreciation.

Treasury bond rates as a fully secure investment are shown for comparison.

If the homeowner owns his system rather than leasing it, Ex. 2, he earns a 13.1 percent return. It exceeds the investor's return because the homeowner pays no tax on the savings in his electric bill. Because it's not classified as a business investment there are no tax consequences, and depreciation as a deduction is irrelevant.

Without the ITC, Ex. 3 and Ex. 4 show rates of return, 7.1 and 7.9 percent, which are enough less attractive that investors would probably reject them, especially for leased ownership. This illustrates why the uncertain, on-again, off-again incentives from the past were so harmful to renewable energy and why the 2015 ITC extension has been crucial for the solar and wind industries.

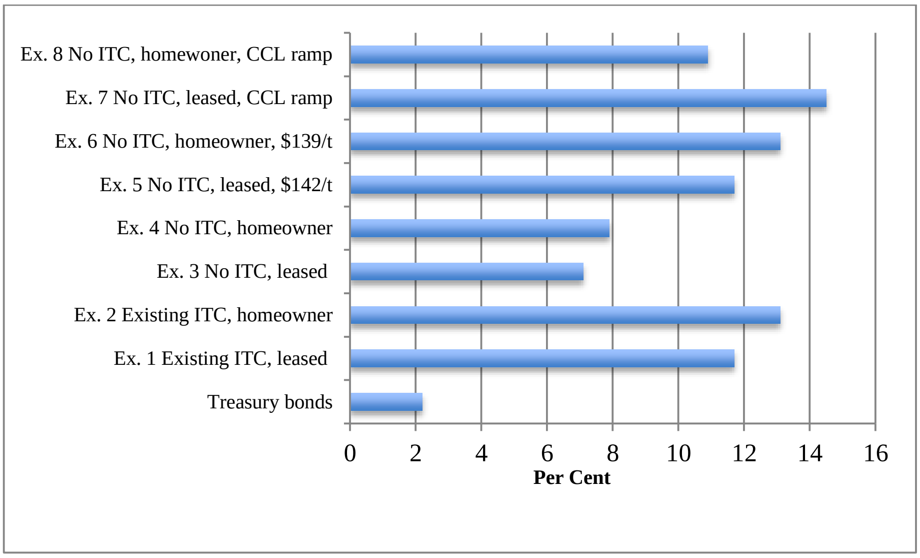

Fig. 1 PV Investors' Returns With ITC and Carbon Fees

6. Without the ITC, a High Carbon Fee Can Restore Investors' Returns

Building on the unattractive investment in Ex. 3 and Ex. 4 without the ITC, carbon fees can restore the return to investors and make those investments acceptable again. Carbon fees to offset loss of the current ITC are illustrated in Ex. 5 and Ex. 6, where the carbon fee is calculated as that which raises each investor's return to the same levels as in Ex.1 and Ex. 2.

An investor's return in Ex. 5 is same 11.7 percent as in Ex. 1, if revenue that the lessor earns incorporates a fee (on the carbon-burning utility) of $142 per tonne of carbon dioxide, thus raising its cost per kWh. Similarly, a homeowner's return in Ex. 6 is the same 13.1 percent as in Ex. 2, if revenue he earns incorporates a (utility's) fee of $139 per tonne.

An immediate increase in the carbon fee from zero to $142 could be politically challenging. Ramping it up from a lower value is probably more palatable, and existing legislative proposals do start low and ramp up. The carbon fee in British Columbia began at a lower (CD$5) level and ramped up to its current value of CD$30 per tonne. Unfortunately it is capped at that level.

7. Without the ITC, Carbon Fee and Dividend Can Also Restore Investors' Returns

In the U. S. one proposal to ramp fees up is termed "carbon fee and dividend" by a San Diego-based non-profit, Citizens' Climate Lobby (CCL). All revenue would be returned directly to U. S. residents with a monthly check. Returning revenue to residents is logical because it is the residents, after all, who are most harmed by climate change. The challenge will be convincing legislators that citizens should benefit with the dividend, instead of the government which may view the fee as a source of tax revenue.

Opponents may claim it's really a tax increase in disguise. Refuting that view, former Republican Cabinet Secretary George Schultz explains in Schultz and Becker (2013) his support for a revenue-neutral carbon tax. It's not a tax if all revenues are returned. Dr. Schultz is a member of CCL's Advisory Board.

Simplicity and ease of explanation are two virtues. Every ton of coal, barrel of petroleum or cubic foot of natural gas extracted from the ground or imported would require a payment to the U. S. Treasury, based on the carbon dioxide it will produce when burned. The Treasury would then return those funds to U. S. families, about $280 per month per family of four after ten years. It would pay residents the way the Alaska Permanent Fund does. It would be a direct and practical application of Pigouvian economic theory, relying on markets rather than governments for investment choices.

CCL proposes a $15 per tonne fee in the first year, followed by increases of $10 per tonne per year. Collecting the fee would be straightforward because most fossil fuel is extracted in the U. S. by fewer than a thousand companies. Carbon fee and dividend (CFAD) would therefore cover all sectors of the economy and all sources of carbon dioxide, not just electricity. It eliminates distortions inherent in existing policies and provides a predictable, steadily rising revenue stream for all clean energy investors. Similarly, it discourages fossil fuel usage.

With CFAD in Ex. 7 the lessor-owner would earn a 14.5 percent return and the homeowner, Ex. 8, would earn a 10.9 percent return. Thus, CFAD as proposed more than matches the incentive that the current ITC provides for a lessor-owner. The homeowner's return is a bit less, but he'll also have revenue refunded to him in his family rebate dividend.

In ten years the gasoline price would rise by about a dollar. But CFAD plus expanded efforts in renewable energy and conservation provide additional benefits for the economy. Nystrom and Zaidi (2014) found that after ten years gross domestic product would rise by $84 billion, employment would increase by 2.1 million, and carbon dioxide pollution would decrease by 33 percent. With cleaner air, early deaths would decrease by about 13 thousand per year.

8. Implementing Carbon Fees Won't be Easy

With approximately 30,000 members in the U. S. and overseas, CCL has been educating citizens and legislators about carbon fees since 2008. These efforts have met with some success; Davenport and Connelly (2015) report that a survey by Stanford University and Resources for the Future found that when citizens understand it, most would support a carbon fee that returns all revenue to citizens.

CCL is under no illusion that the transition to carbon fee and dividend will be easy, especially in the current political climate. Several bills incorporating carbon fees have been introduced in the Congress but none includes all of CCL's proposed features, and none has even had congressional hearings.

The ideal situation would be federal legislation and a uniform carbon fee across the country (or indeed across the world, because damages are worldwide), but a messier option might be a variety of state level carbon fees. In fact, the closest proposal to actual implementation is Washington State's initiative (I-732) starting at $15 per ton, on the ballot for 2016. CFAD could be implemented in other states to meet EPA's Clean Power Plan, which only addresses coal. Indeed, a robust carbon fee and dividend policy would exceed its requirements and cover all sources of carbon dioxide.

9. Conclusion

Data from California suggest that replacing the ITC with carbon fees could be as attractive to clean electricity investors as the current ITC incentives, with fees are as high as $142 per tonne of carbon dioxide or with CCL's carbon fee and dividend. Carbon fees will be difficult to implement in the current political climate, but results here could be helpful in establishing future policy.

Carbon fees will place all fossil fuel emissions on an equal footing, thereby eliminating distortions in the current hodge-podge of incentives.

In the long term, prices with some carbon fee proposals are too low to maintain investor profitability, absent the ITC. To be effective, future proposals should include higher fees than those suggested heretofore, and certainly higher than those resulting from cap and trade. A steadily rising carbon fee and dividend as proposed by Citizens' Climate Lobby or in Washington State's I-732 ballot proposal could restore investors' profitability and might be used to offset future declines in the ITC.

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