

# **ECONOMICS DEPARTMENT**

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Tax Policy for Financing Alternative Energy Equipment

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**Abstract**

European countries have taken the lead in investing in renewable energy electricity generating capital. While the EU-15 countries had less than half the installed capacity of the United States in 1990, they currently have more than double the capacity. This study investigates differences in the policy environment between Europe and the United States and identifies key policy differences that impact renewable electricity investment.

The review of the European and US experience provides a number of lessons to guide future renewables policy in the United States. First, the European experiment with feed-in tariffs and renewable portfolio standards suggests that feed-in tariffs may dominate RPS systems as effective policy tools to encourage investment. Second, the US preference for tax incentives has clearly not had the same stimulative investment impact as have feed-in tariffs. Third, a modest feed-in tariff for wind and biomass would make these technologies cost competitive with natural gas. Fourth, it is clear that considerable research and technological development will be required before solar electricity can compete in the market place regardless of the pricing support policy in place.

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## I. Introduction

Rising energy costs along with energy security and climate concerns have increased national interest in and attention to renewable electricity generation. While the United States has made great strides in renewable electricity investment, it has been far outstripped by many European countries. The purpose of this analysis is to glean lessons from the European experience and make recommendations for future policy in the United States.

## II. International Comparisons

The major focus of this study is to identify policies to encourage investment in renewable electricity capital that may be more effective than current U.S. policies. I begin with a comparative analysis of a number of key developed countries. The United States lags sharply in its growth rate for renewable capacity (see Table 1).

<b>Year</b>	<b>US</b>	<b>EU-15</b>	<b>Denmark</b>	<b>Germany</b>	<b>Neth</b>	<b>Spain</b>	<b>UK</b>
<b>1990-1995</b>	2.3%	10.1%	17.4%	20.7%	17.2%	15.3%	31.5%
<b>1995-2000</b>	0.8%	20.0%	25.3%	27.0%	12.1%	53.0%	18.4%
<b>2000-2004</b>	5.2%	16.4%	7.5%	18.9%	16.6%	30.1%	10.7%
<b>1990-2004</b>	2.9%	16.6%	17.8%	23.9%	16.5%	34.5%	21.5%

Source: IEA and author's calculations

The United States had an annualized growth rate between 1990 and 2004 of just under 3 percent while the EU-15 as a group exhibited a growth rate of over 16 percent. The US growth rate has increased in the first half of this decade, but it is still far below that of the EU-15 or any of the high growth countries within the EU. Germany and Spain are

particularly noteworthy with annual growth rates of 19 and 30 percent respectively since 2000.

The next three figures provide information about the share of renewable energy in generation for three key renewable sources.

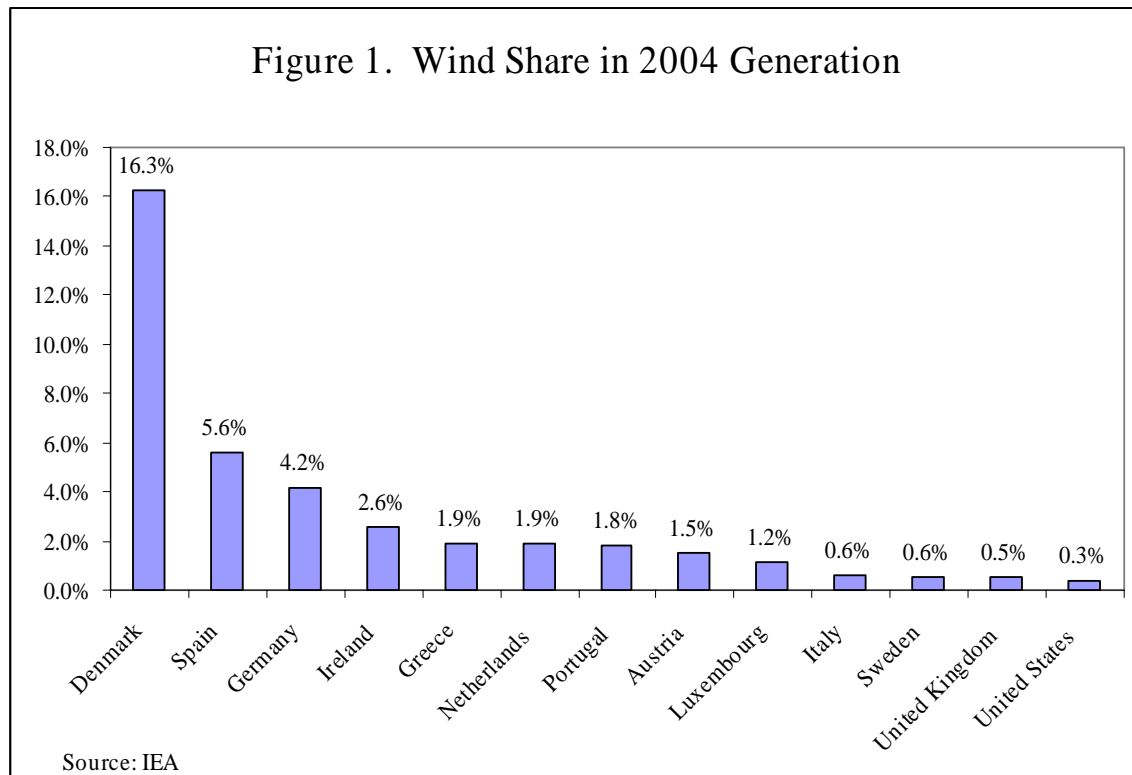
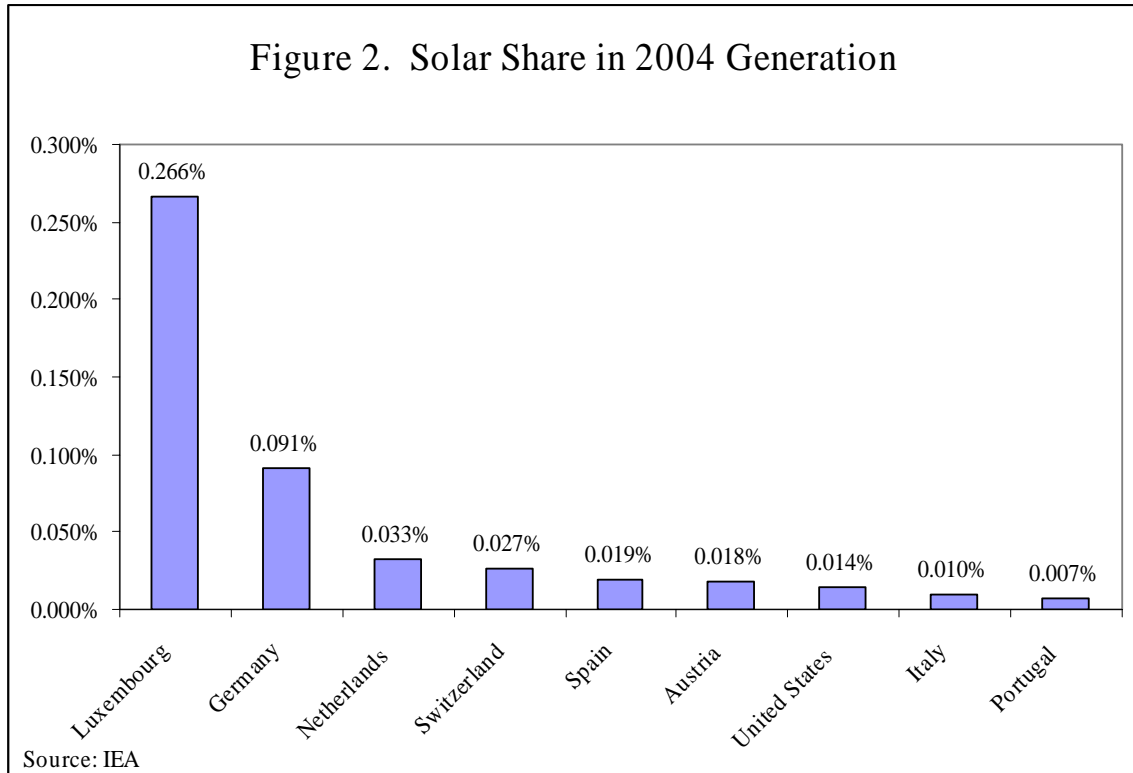


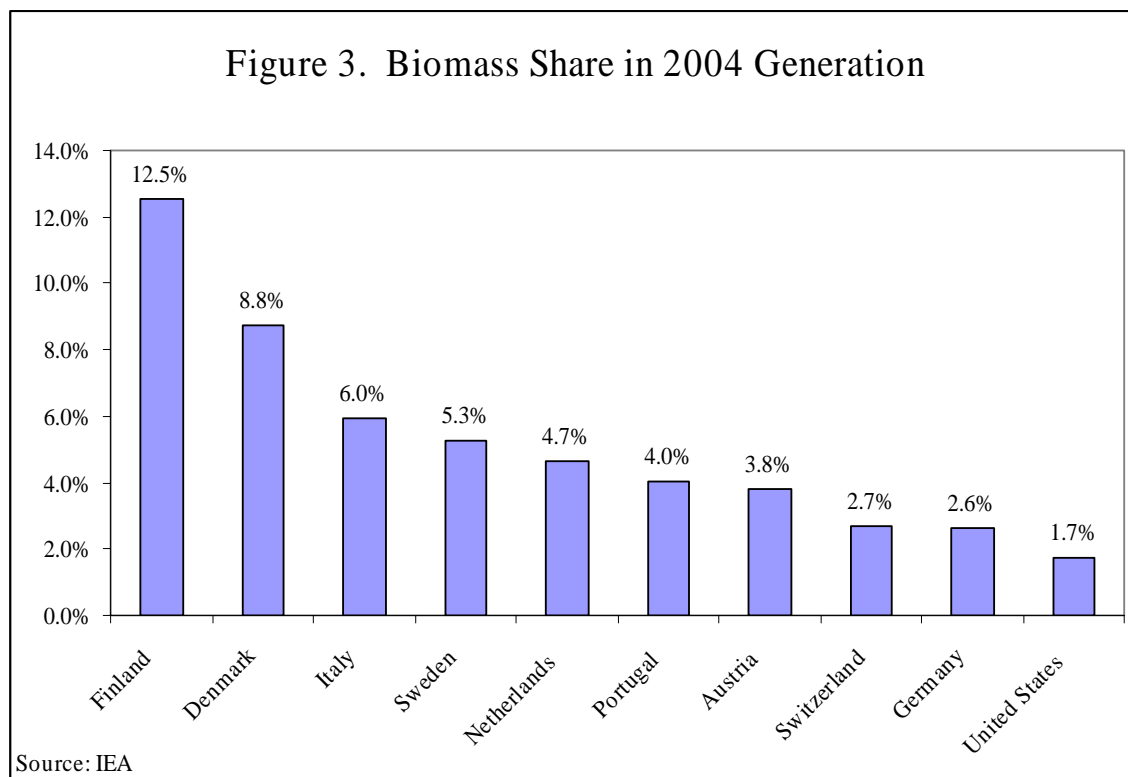
Figure 1 shows the share of wind in renewables for the leading EU countries. Denmark, Spain, and Germany are the European leaders. The United States lags far behind many of these countries. The United States does a bit better relative to other EU countries in solar power (Figure 2) though solar has not made much of an inroad in any of these countries.<sup>2</sup>

<sup>2</sup> Looking beyond the EU, Japan is the world leader in solar capacity with 1,132 MW installed as of 2004. This is in contrast to 753 MW installed in the United States.



The United States also lags behind many EU countries in biomass generation as a share of its total generation (Figure 3). Finland is the world leader in biomass followed by Denmark and Italy.

These data suggest important policy differences between the United States and Europe.



### III. Policy Review

In this section I describe various policies used to support renewable electricity generation investment in the United States and other developed countries. The United States has historically supported renewable capacity investment through the federal tax code and through state level renewable portfolio standard (RPS) programs. Europe, in contrast, has relied heavily on feed-in tariffs. These three instruments have in common that they increase the revenue received by sellers of renewable electricity, the first through tax credits and the latter two through payments from electricity purchasers (grid operator or distributor).<sup>3</sup> A key difference among the programs is the source of funds for the subsidy. For tax credits, the subsidy is paid for by the taxpayer while for the feed-in tariff and RPS programs, it is paid for by rate-payers. As I'll discuss below, this has

<sup>3</sup> For RPS this assumes permits are required of grid operators or distributors.

major implications for the political support shown for the various programs. In addition to these three support mechanisms, I will briefly mention a fourth support structure that has been used but which is being supplanted by these other mechanisms.

A. *Feed-In Tariffs*

Feed-in tariffs are policies that require electricity suppliers to purchase power from renewable electricity sources at given prices for a set number of years. The price is either a fixed tariff or a fixed premium above market prices. Feed-in tariffs subsidize renewable electricity production through the electricity rate base rather than the tax base and thus are generally more stable over the long-run than tax credits. As discussed below, they also differ in that the value of the subsidy is not related to the profitability of the energy supplying company.

As of late 2006, eighteen of the twenty-five countries in the EU had some sort of feed-in tariff for renewable electricity.<sup>4</sup> Feed-in tariffs offer either a set price for electricity generated by the facility over a given number of years or a premium over the market price. In general suppliers are required to purchase electricity offered under the fixed tariff scheme but are not so obligated under the premium system. Rates are typically set so that the total payment under the premium system (the market price plus premium) exceeds the fixed tariff payment. One of the attractions of the feed-in tariff is that the rate set under the fixed tariff is generally based on the *retail* rather than the delivery price for electricity.

B. *Renewable Portfolio Standards*

Renewable portfolio standards are policy measures with two components. First, quotas for electricity produced from renewable sources are set, generally as a percentage

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<sup>4</sup> Source: Klein et al. (2006).

of electricity production. The quotas must be met at a designated level, either by suppliers of electricity or by distributors. Second, generators of renewable electricity typically obtain renewable electricity certificates (RECs) that are marketable. Trading in RECs occurs with the group that is required to provide evidence that they have achieved their renewable quota doing so by submitting RECs to the monitoring agency. The market price for RECs provides a subsidy to renewable electricity generators that combined with the market price received for selling electricity offsets their higher generating costs.

In Europe, RPS programs exist in Belgium, Italy, Sweden, the United Kingdom, and Poland. To date, it does not appear that the RPS systems in Europe have been particularly effective. Belgium allows a penalty for non-compliance with the target of €2 per MWh in the Walloon region and €10 per MWh in Flanders. Given the limits in place, it is more advantageous to pay the penalty than purchase certificates (European Commission (2007a)). Italy and Poland's quotas appear to be poorly regulated.

The United States has enthusiastically embraced RPS programs at the state level. Currently, thirty programs run by states, local government, or utilities operate in twenty-six states.<sup>5</sup> Of these, twenty-one states and the District of Columbia run mandatory RPS programs covering roughly 40 percent of the nation's electrical load (Wiser et al. (2007)). Wiser et al. (2007) in their assessment of state level programs conclude that

experience with these policies remain somewhat limited; few of the states have more than five years of experience with their programs, and some of the policies have been established but have not yet taken effect.

Wiser, et al. (2007), p. 12.

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<sup>5</sup> Source: DSIRE (2007). This list is current as of May 2007.

### C. *Tax Incentives*

In Europe, only Finland and Malta rely entirely on tax incentives to encourage the production of renewable energy.<sup>6</sup> Finland subsidizes electricity produced from renewable sources at different rates according to the fuel and provides investment tax credits up to 30 percent for renewable capital (40 percent for wind).<sup>7</sup>

Other countries use tax incentives to supplement other policies, most notably the feed-in tariffs. The United Kingdom, for example supplements its green renewables and quota instrument with a Climate Change levy, currently set at £4.30 per MWh with an exemption for generation from new renewable capacity.

The United States relies extensively on tax incentives to support renewable electricity. Here follows a very brief summary of current incentives.<sup>8</sup>

- *Depreciation:* renewable electricity capital using wind or solar is allowed a five year accelerated depreciation tax life.
- *Production Tax Credits:* Most renewable electricity (except solar) is allowed a 1.9¢ per kWh production tax credit. This is subject to biennial reauthorization and the current credit expires at the end of 2008.<sup>9</sup>
- *Investment Tax Credits:* Solar and fuel cell powered electricity installations are allowed a 30 percent investment tax credit.

Of these three incentives, the production tax credits (PTCs) have received the most attention both for its effectiveness at stimulating investment as well as the negative impacts of uncertainty over reauthorization at different times.<sup>10</sup> Wisner (2007) notes that it “is difficult to overstate the importance of the PTC to the wind industry over this timeframe, as well as the negative consequences of PTC expiration for the industry in

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<sup>6</sup> Malta does allow a fixed feed-in tariff for small solar (below 3.7 kWp). Source: European Commission (2007c).

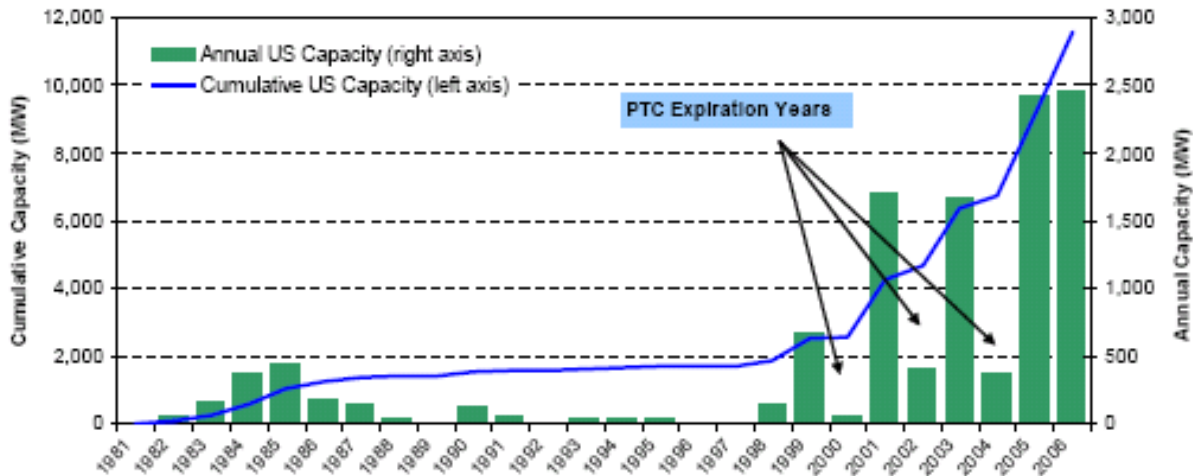
<sup>7</sup> Source: European Commission (2007b).

<sup>8</sup> See Metcalf (2007) for greater detail and analysis of U.S. energy tax policy.

<sup>9</sup> The Senate Finance Committee has proposed a five-year extension as part of deliberations over the current energy legislation in Congress.

<sup>10</sup> Production tax credits operate in a similar fashion as premium feed-in tariffs. A key difference is the source of funding for the tax credits and the political nature of their funding process.

2000, 2002, and 2004.” (p. 5). He provides a graphic illustration of the boom and bust nature of the PTC and its impact on wind capacity investments.



Wiser (2007)

The Production Tax Credit expired first in June 1999 and was not extended until December 1999. Wind capacity additions fell by over 90 percent between 1999 and 2000. Two years later, the PTC lapsed in December 2001 and was extended in February 2002. Again, capacity additions fell from 1,696 MW in 2001 to 410 MW in 2002. The PTC next expired in December 2003 and was extended again the following October and capacity additions in 2004 fell by three-quarters from the previous year. Finally, it is worth noting that 2005 was the first year that the PTC was extended prior to its expiration and capacity additions actually rose in 2006 from the 2005 levels.

#### D. Tender Programs

Ireland and France have had tender programs in which the state publishes tender offers for the supply of renewable electricity. Firms then supply the electricity and are paid by the state. France has shifted from a tender to a feed-in tariff and Ireland has recently announced plans also to shift (European Commission (2005)).

*E. Policy Summary and Analysis*

Feed-in tariffs have been a popular policy instrument to encourage investment in renewable electricity generation in Europe. As of late 2006, eighteen countries had some form of a feed-in tariff in place. The use of feed-in tariffs in Europe stands in sharp contrast to the use of quotas and green certificates in the United States in RPS programs. The view in Europe is that feed-in tariffs have been very successful at stimulating renewable investment. To quote from a recent EU study,

"...all countries with an effectiveness higher than the EU average [for wind] use feed-in tariffs. This type of system currently has the best performance for wind energy."

European Commission (2005), p.6

The report finds that Germany, Spain, and Denmark have the most effective renewable support systems for wind – all of these being feed-in tariffs. Feed-in tariffs have also been successful for biomass, especially in Denmark. The EU study notes, however, that the wide variety of biomass sources and the heterogeneity of the industry make the superiority of the tariffs less clear-cut.

**IV. Financing Analysis**

The review of policies in the United States and Europe suggest that renewable capital investment can be encouraged in a number of ways. The United States relies primarily on tax incentives, including accelerated depreciation and production or investment tax credits. Europe, in contrast, has found feed-in tariffs to be very successful in encouraging investment. In this section, I measure the value of current incentives in the United States and compare to alternative policies. In particular, I consider two alternative policies: investment expensing and feed-in tariffs. The approach I use to compare investment subsidies is a levelized cost analysis.

The levelized cost analysis measures what price must be received for electricity sold by a generator to cover fixed and variable costs of providing the electricity including the required return for equity owners.<sup>11</sup> This approach has been used in a variety of studies of electric power generation (e.g. Deutch and Moniz (2003), Tolley and Jones (2004), and Sekar et al. (2005)). My methodology and parameter choices are fully described in Metcalf (2007).

I estimate the levelized cost for the following electricity generation sources: natural gas combined cycle, biomass, wind, solar thermal, and solar photovoltaics. I include natural gas as renewables are often viewed as a potential substitute for gas. Column 1 of Table 2 reports levelized costs of electricity in cents per kWh (year 2004 dollars). I assume that the plant will be placed in service after Jan. 1, 2006 so that solar power is not eligible for a production tax credit but does obtain the more generous 30 percent section 48 investment tax credit.<sup>12</sup>

The first column reports the levelized costs for the different generating sources under current policy. With existing tax policy, wind and biomass are cost competitive with natural gas. The two forms of solar electricity are considerably more expensive.<sup>13</sup>

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<sup>11</sup> The price is a constant real price received over the life of the plant to cover lifetime fixed and variable costs.

<sup>12</sup> I have not assumed any limitations on credits from the Alternative Minimum Tax in Table 9.

<sup>13</sup> If solar power is installed as distributed capacity, then the appropriate comparison rate is the retail rate. Residential customers pay the highest rates and paid an average rate of 9.45¢ in 2005 according to the Energy Information Administration. Even with this higher comparison rate, solar electricity is not cost competitive without further incentives.

	<b>Current Policy</b>	<b>Expensing Only</b>	<b>FIT 25%</b>	<b>FIT 50%</b>	<b>FIT 75%</b>
	(1)	(2)	(3)	(4)	(5)
<b>Natural Gas</b>	5.47	5.47	5.47	5.47	5.47
<b>Biomass</b>	5.34	4.99	5.10	4.24	3.27
<b>Wind</b>	5.04	4.89	4.79	3.94	2.96
<b>Solar Thermal</b>	10.89	13.66	14.27	13.42	12.45
<b>Solar PV</b>	19.93	25.82	27.76	26.91	25.94
Source: Author's calculations.					

The rest of table 2 discusses alternative policies to the current production and investment tax credits. The first policy option is to eliminate the production and investment tax credits and allow investors to expense their investments. This policy change favors biomass and wind. It adversely affects solar generated electricity raising the cost of solar electricity by roughly one-third.

Another option is to replace the various tax incentives with a renewable portfolio standard. For solar power to become cost-competitive, an RPS policy would have to require enough solar power to drive the price of green certificates for solar over 9¢ for solar thermal and 23¢ for solar PV. It appears that minimal to no limits would be required for wind and biomass to continue to be cost competitive with gas.<sup>14</sup>

A third option to take the place of production and/or investment tax credits is a European style feed-in tariff. I model a ten-year fixed tariff that is set in nominal terms. Electricity prices exhibit volatility and a trend in nominal terms so that the feed-in tariff

<sup>14</sup> This assumes that gas is the marginal fuel source displaced by wind and biomass. An analysis by Energy Information Administration (2007a) suggests that large-scale expansion of wind would replace coal over time. If prospective investors are choosing between coal and renewable projects then positive green certificate prices would be required to get the desired expansion in wind.

becomes less valuable over time.<sup>15</sup> The expected present discounted value of the revenue stream from the feed-in tariff lowers the levelized cost of the project. I show three policy scenarios in Table 2 above. They differ in the amount that the rate guarantee exceeds current electricity prices. The first feed-in tariff scenario sets the rate guarantee at 25 percent above current prices. At the 2005 average generation price of 5.4¢ per kWh, this would be a guarantee of 6.8¢ per kWh. Even at a rate guarantee that only exceeds current prices by 25 percent, wind and biomass producers would be better off than with the current production tax credits. Solar generation is disadvantaged by this policy change.

We can compute the break-even rate guarantees for the different renewable electricity sources that make generators indifferent between the production or investment tax credits and the feed-in tariff.<sup>16</sup> The break-even guarantee for biomass is 7 percent over current prices and 17 percent over current prices for wind. For an electricity price of 5.4¢, this translates to a fixed tariff rate of 5.8¢ for biomass and 6.3¢ for wind. The break-even rate for solar thermal is 119 percent or 11.8¢ given an electricity price of 5.4¢. Solar PV requires a rate guarantee that is 237 percent greater than existing prices or 18.2¢ in order to obtain the same benefits as they receive with the investment tax credit.

Summing up, it appears that a modest feed-in tariff would be sufficient to provide at least the same level of support for wind and biomass as are obtained under the current production tax credit program. An additional benefit not modeled here is the stability of

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<sup>15</sup> I model electricity prices as having no expected trend in real terms based on assumptions in Energy Information Administration (2007b). I assume that the log of price has a standard deviation of 5 percent. The value of feed-in tariffs is not appreciably affected by the volatility of prices over reasonable ranges. I calculate the value of the feed-in tariff as the expected present discounted value of the subsidy paid to generators using an 8 percent nominal discount rate. Expected values are computed using Monte Carlo methods with 5,000 replications.

<sup>16</sup> It is important to stress that this modeling assumes that firms receive the full benefit of the tax credits. As noted above, this does not occur for all firms. They would, however, receive the full benefit of the feed-in tariff regardless of tax status.

total price received by investors relative to a production tax credit or a premium based feed-in tariff. Evidence from Europe suggests that this stability provides additional value to investors.

## **V. Conclusion**

The analysis in this paper provides a number of lessons to guide future renewables policy in the United States. First, it is clear Europe has been extraordinarily successful in spurring renewable electricity capital investment. Second, the European experiment with feed-in tariffs and renewable portfolio standards suggests that feed-in tariffs may dominate RPS systems as effective policy tools to encourage investment.

Third, the US preference for tax incentives has clearly not had the same stimulative investment impact as have feed-in tariffs. Partly this is due to the on-again off-again nature of production tax credits with a two-year authorization cycle in Congress. But it is also likely due to the inability for many firms, especially start-up firms, to take full advantage of the tax incentives.

Fourth, a modest feed-in tariff for wind and biomass would make these technologies cost competitive with natural gas. Moreover the tariff responds to market conditions in a way that production tax credits do not. The feed-in tariff responds automatically to market conditions with the subsidy increasing if purchase prices fall and phasing out as purchase prices rise.

Fifth, it is clear that considerable research and technological development will be required before solar electricity can compete in the market place regardless of the pricing support policy in place. The very high costs of solar suggest that a two-tiered approach for renewables support might be sensible. Wind, biomass, and geothermal would likely

benefit from a shift away from production tax credits to a fixed feed-in tariff system.

Solar, on the contrary, would likely benefit from continuing with the 30 percent investment tax credit put in place in the Energy Policy Act of 2005.

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