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State Clean Energy Policies Analysis (SCEPA) Project: An Analysis of Renewable Energy Feed-in Tariffs in the United States

Technical Report
NREL/TP-6A2-45551
Revised June 2009

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E3 Analytics

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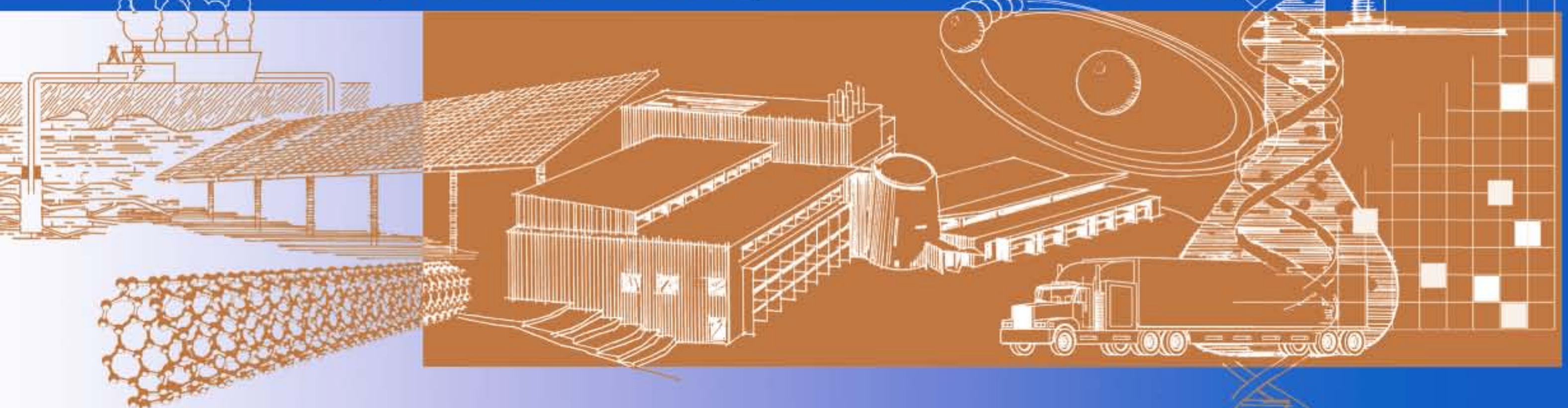

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The following corrections were made to this report:

Section 2.7, Page 16 – In the first paragraph, New Jersey is now eliminated from the list.

Section 7.0, Page 31 – In the first paragraph (second sentence), New Jersey is now eliminated from the list.

Acknowledgments

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List of Acronyms

ARRA	American Recovery and Reinvestment Act of 2009
CEC	California Energy Commission
CPUC	California Public Utilities Commission
CVPS	Central Vermont Public Service Corporation
DOE	U.S. Department of Energy
DSIRE	Database of State Incentives for Renewables and Efficiency
EWEB	Eugene Water and Electric Board
FIT	Feed-in tariff
GPP	Green power program
GRU	Gainesville Regional Utilities
GWh	Gigawatt hour
HB	House Bill
IEPR	Integrated Energy Policy Report
IOU	Investor-owned utility
ITC	Investment Tax Credit
kW	Kilowatt
kWh	Kilowatt hour
LMP	Locational marginal pricing
MGE	Madison Gas & Electric
MPR	Market price referent
MW	Megawatt
MWh	Megawatt hour
NREL	National Renewable Energy Laboratory
PBI	Production-based incentive
PG&E	Pacific Gas and Electric Company
PPA	Power purchase agreement
PTC	Production Tax Credit
PURPA	Public Utilities Regulatory Policies Act
PV	Photovoltaic
RE	Renewable energy
REC	Renewable energy certificate
RES	Renewable Energy Sources
RPS	Renewable portfolio standard
SCE	Southern California Edison
SCEPA	State Clean Energy Policies Analysis
SOC	Standard Offer Contract
TWh	Terawatt hour

Executive Summary

The use of feed-in tariffs (FIT) is gaining popularity in the United States as a policy option for encouraging renewable energy (RE) development. A number of states have recently implemented FITs and several utilities have launched utility-specific FIT policies to help meet their renewable portfolio standards (RPS) (Rickerson et al. 2007). Experience around the world suggests that FITs could be used effectively to meet a number of U.S. state policy goals, including job creation, economic development, and meeting state RE targets.

FIT policies offer a long-term guarantee of payments to RE developers for the electricity they produce. These payments can encompass both electricity sales and payments for renewable energy certificates (REC). This guarantee of payments is often coupled with the assurance of access to the grid, which is generally extended to all interested parties, including but not limited to homeowners, business owners, utilities, and non-government organizations (Rickerson et al. 2008).

Well-designed FIT policies offer a cost-efficient method for fostering rapid development of RE resources, thereby benefiting ratepayers, RE developers, and society at large. FIT policies offer a stable investment environment featuring long-term certainty of payment terms. Transparent contracts help minimize the administrative and regulatory barriers to RE development, which can help accelerate the overall pace of RE deployment. Moreover, FITs can be fine-tuned to encourage particular project attributes with respect to technology type or project size and they can be flexibly adapted to match different electricity market structures. On the other hand, FIT policies have a few disadvantages, including the fact that they do not directly address the challenges posed by the high initial costs of RE development (Lantz 2009) and that they may result in less-than-optimal project siting (Klein et al. 2008).

Following best practices can help to ensure the success, cost efficiency, and overall performance of FIT policies. Importantly, most successful FIT policies base the prices offered to suppliers on the levelized cost of RE generation to ensure a reasonable rate of return. Other best practices include offering long-term, must-take contracts; differentiating FIT prices by technology type, project size, and resource quality; tariff degression, a design feature that incorporates an incremental decrease in the FIT prices over time to encourage innovation and accelerate the pace of deployment; incorporating the costs of the policy into the electricity rate base; and minimizing transaction costs by providing streamlined administrative procedures.

FIT policies can be implemented to support all renewable technologies including wind, solar photovoltaic (PV), solar thermal, geothermal, biogas, biomass, fuel cells, and tidal and wave power. Provided the payment levels are differentiated appropriately, FIT policies can increase development in a number of different technology types over a wide geographic area while contributing to local job creation and increased clean energy development in a variety of different technology sectors. The success of FIT policies

around the world, notably in Europe, suggests that they will continue to grow in importance in the United States as evidence mounts that they provide an effective framework for the promotion of RE development and job creation.

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SCEPA Project Background

The State Clean Energy Policies Analysis (SCEPA) project is supported by the Weatherization and Intergovernmental Program within the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy. This project seeks to quantify the impacts of existing state policies, and to identify crucial policy attributes and their potential applicability to other states. The goal is to help states determine which clean energy policies or policy portfolios will best accomplish their environmental, economic, and security goals. Experts from the National Renewable Energy Laboratory (NREL) are implementing this work, with state officials and policy experts providing input and review. This report analyzes renewable energy (RE) feed-in tariff (FIT) policies, their impacts on RE development, and their current status within the United States.

For more information on the SCEPA project, access NREL's Applying Technologies Web site at http://www.nrel.gov/applying_technologies/scepa.html.

1.0 Introduction

Renewable energy (RE) feed-in tariffs (FIT) are a policy option that is currently growing in popularity throughout the United States. A number of states have recently begun implementing FITs and a few utilities have launched utility-specific FIT policies to help meet their renewable portfolio standards (RPS) (Rickerson et al. 2007). Experience around the world suggests that FIT policies could be effectively used to meet a number of U.S. state policy goals, including job creation, economic development, and meeting state RE targets.

This analysis begins by defining FITs, including a brief description of the advantages of FIT policies. Section 2 explores the different FIT policies currently implemented in the United States, with a discussion of a few proposed policies. Section 3 discusses a few of the best practices in FIT policy design, while Section 4 examines how FITs can be used to target state policy goals. Section 5 deals with current and potential future interactions between FITs and other state and federal energy policies. Section 6 provides an overview of the impacts FIT policies have in terms of RE deployment, job creation, and economic development while also touching on ratepayer impacts based on data from a few leading European countries. The paper concludes with a brief discussion of the future of FIT policies in the United States while highlighting a few areas where greater research is required.

1.1 What is a Feed-in Tariff

A feed-in tariff (FIT)[1] is an energy supply policy that offers a guarantee of payments to RE developers[2] for the electricity they produce. Payments can be comprised of electricity alone or of electricity bundled with renewable energy certificates (REC)[3]. These payments are generally awarded as long-term contracts set over a period of 15-20 years. FIT policies can be understood as an advanced form of production-based incentive (PBI), where a payment is awarded for the actual electricity produced ($/kWh). PBIs are distinguished from capacity-based incentives like rebates, where a payment is awarded on the basis of how much capacity is installed ($/watt).

As an advanced form of PBI, FIT payments can be determined in three ways: 1) **based on the actual levelized cost of RE generation**. This is the most common choice for FIT policies around the world because it awards a payment level sufficient to ensure the profitability of RE investments; 2) **based on the utility's avoided costs**,[4] either in real time, according to a locational marginal pricing[5] (LMP) formula, or based on utility projections of long-run fossil fuel prices, as under the Public Utilities Regulatory Policies Act (PURPA); or 3) **offered as a fixed-price incentive** that is established arbitrarily and without regard to avoided costs or to levelized RE project costs. The three FIT payment calculation methodologies are shown in Table 1.

Table 1. Feed-in Tariff Price Calculation Methodology

Methodology	Description
1: FIT payments based on levelized RE project costs	Where the FIT payment is **methodologically based on the levelized cost of RE generation**, plus a target rate of return (e.g., Gainesville, FL)
2: FIT payments based on utility avoided costs	Where the FIT payment is **based on utilities' avoided cost** (e.g., CA, Central Vermont Public Service Corporation in VT, Xcel in WI)
3: Fixed-price incentives	Where the FIT is awarded as **a fixed-price incentive**, without regard to avoided cost, or the cost of RE generation (e.g., WE Energies' solar buy-back, WA)

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[1] FIT policies are known variously as renewable energy payments, fixed-price policies, production-based incentives, feed laws, and standard offer contracts. Their more sophisticated forms are known as advanced renewable tariffs.

[2] "Developers" can include citizens, local governments, municipalities, farmers, businesses, utilities, corporations, non-profits, etc. Unless specified otherwise, FIT payments are generally available to all interested parties.

[3] RECs represent the environmental attributes of renewable energy generation.

[4] "Avoided costs" refers to the estimated cost of supplying electricity if it were done by means of other supply sources. Interpretations of what constitutes avoided costs differ widely from one jurisdiction to the other. It is meant to represent the value of new generation to the utility.

[5] LMP is a strategy put forward by the Federal Energy Regulatory Commission to improve the efficiency of wholesale power markets. It assigns different prices to the value of electricity produced at various nodes of the electricity network on the assumption that the price signals will influence the overall balance of supply and demand in the transmission system. LMP reflects the market cost of delivering new supply to a given area of the grid based on transmission and generation constraints. See http://www.iso-ne.com/nwsiss/grid_mkts/how_mkts_wrk/lmp/index.html.

The first option—FIT payments based on levelized RE project costs—has been and continues to be the most successful FIT option in terms of driving rapid RE deployment, largely because it provides investors with a price adequate to ensure a reasonable return on investment. It is also the most common FIT design used in Europe. In contrast, the avoided cost and fixed-price incentive options are more common in the United States, and have experienced more limited success.

In addition to the FIT payment calculation methodology, a decision must be made as to how the basic structure of the FIT payment will be determined. There are two basic ways to structure a FIT payment: 1) the fixed-price model where fixed prices are established independent from prevailing electricity prices. This is the model most commonly used in Europe (Klein et al. 2008, Ragwitz et al. 2007, Mendonça 2007); 2) the premium price model where a technology-specific premium or bonus is offered above the spot market price (Held et al. 2007, Klein et al. 2008). Both of these approaches have different implications for investment risks.

FIT payments can be differentiated in a variety of ways to account for the type of technology, project size, quality of the resource, and the RE project location. In most cases, the payment level is adjusted to reflect the cost of generating electricity from the type of project while allowing for a modest profit.

In addition to offering a guarantee of payments, FIT policies typically guarantee grid access, allowing both small and large projects to connect to the grid according to uniform interconnection standards (Klein et al. 2008). FIT payments can therefore be understood as an open form of power purchase agreement (PPA) similar to those found in conventional electricity supply contracts. In contrast to PPAs, however, FIT policies tend to be designed specifically for RE technologies and generally provide non-discriminatory access to supply electricity to the grid through a standard contract.

1.2 Advantages of FIT policies

Well-designed FIT policies have several advantages over other RE policies such as upfront rebates, net metering, and quota-based policies like renewable portfolio standards (RPS). First, a growing body of evidence from Europe demonstrates that FIT policies have on average fostered more rapid RE project development than these other policy mechanisms (see Section 6.0) (Fouquet 2007, Mendonça 2007, Held et al. 2007, Klein 2008, Ragwitz et al. 2007, Stern 2006). Additionally, they have been found to be more cost-efficient in terms of the average cost-per-kWh paid for RE generation than policies like RPSs that make use of competitive solicitations (de Jager and Rathmann 2008, Fouquet, 2007, Ragwitz et al. 2007). This suggests that their implementation could help secure the benefits of RE development at lower cost to society, and to ratepayers.

Initial evidence suggests that there are two primary reasons FIT policies are more cost-efficient than other policies. First, policies that make use of competitive solicitations like RPSs involve a higher degree of risk for the developer, putting upward pressure on the required returns (de Jager and Rathmann 2008, Ernst & Young 2008, Dinica 2006). The reduction of these investment-level risks under FIT policies can also help reduce capital costs, ultimately reducing the cost of renewable electricity (de Jager and Rathmann 2008, Ernst & Young 2008). Second, projects vying under the competitive solicitation processes tend to be financed by larger institutional or corporate investors who provide equity as opposed to debt financing. Since equity is more expensive than debt, leading to a higher weighted average cost of capital, further upward pressure is placed on the levelized costs of energy (Cory et al. 2009a).

Successful FIT policies are generally designed to allow for an adequate recovery of project costs plus a reasonable rate of return, thereby increasing investor security. Furthermore, by offering transparent payment levels and uniform contract terms at the outset, FIT policies help create a framework with low administrative and regulatory barriers for promoting RE deployment (de Jager and Rathmann 2008).

A further advantage of FIT policies is that because average citizens and business owners can participate, they tend to reduce the social opposition to RE development. This may prove to be particularly important in the years ahead, and may become an important condition for the broader expansion of RE technologies (Mendonça et al. 2009).

Overall, FIT policies also help provide flexibility. When differentiated according to technology type, they can be designed to encourage any RE technology, as well as a particular subset of technologies depending on local resource availability. By differentiating the payment levels according to different project variables, including project size, FIT policies allow RE investments to be profitable for citizens, small business owners, and large commercial-scale developers. This flexibility, ensured by the differentiated payment levels, helps leverage capital investment toward renewables and drives rapid RE deployment in a number of different technology classes.

1.3 FIT Policy Challenges

Despite their advantages, there are a few central challenges of FIT policies. These can be broken down into five basic categories.

The first challenge is that FIT policies do not address the barrier posed by the high up-front costs of RE systems, in contrast to rebate programs and other up-front "capacity-based" incentives. FIT policies are designed to offer stable revenue streams through long-term purchase contracts, requiring that the high up-front costs be amortized over a long period of time. It is generally assumed that the guaranteed terms offered by FIT policies will help developers and investors overcome the high up-front costs by financing a larger portion of the project with debt financing. However, FIT policies do little to address up-front costs directly. Despite this challenge, experience from both Europe and North America indicates that up-front incentives may not be as effective at spurring broad market adoption or at driving innovation and technological cost reductions (Lantz 2009, Jacbosson and Lauber 2005, Nielsen 2005).

Second, FIT policies can put near-term, upward pressure on electricity rates, particularly if high-cost technologies like solar photovoltaics (PV) are included in large amounts (i.e., thousands of MW). The risk of cost impacts grows in proportion to the rate and scale of deployment of these costlier technologies. One way to resolve this issue is to cap the total annual capacity of high-cost RE resources. Additionally, experience in Europe has shown that the large-scale deployment of wind power, for instance, has actually helped *lower* electricity rates (see Section 6.3; also de Miera et al. 2008, Morthorst 2006). Also, it is important to weigh the broader social and economic benefits of the rapid RE development generated under successful FIT policies against any near-term pressure on rates. Analysis in Germany has found the tradeoff between higher near-term rates and industry development, economic growth, environmental costs, etc. has been positive (see Section 6.3) (BMU 2008b).

Third, well-designed FIT policies require a significant up-front administrative commitment to design the policy and to establish FIT payments based on the levelized cost of RE generation. Detailed analyses on technology cost and resource quality are needed to ensure FIT payments are adequate to guarantee cost recovery without leading to windfall profits.

Fourth, FIT policies designed to include guaranteed grid interconnection, regardless of location on the grid, could lead to less-than-optimal project siting. Accordingly, if projects are sited far from load centers or transmission or distribution lines, interconnection costs increase, putting upward pressure on policy costs. However, this challenge can be largely overcome if FIT policies encourage siting projects near load centers by creating an incentive (either a bonus or a higher price based on higher spot-market prices), or if the policies require developers to bear a portion, if not the entirety, of the costs of connecting projects to the grid. Both of these financially-based solutions create incentives and could encourage more efficient, less costly project siting (Klein et al. 2008). However, requiring the developer to cover all costs related to interconnection, including grid upgrades, may make certain projects where significant resource potential exists uneconomic when considered in isolation. If utilities are required to share the costs of interconnection and grid infrastructure upgrades, it is likely that higher levels of RE penetration will occur as more of a region's RE potential will be harnessed.

Finally, due to changes in technology costs and market prices over time, FIT policies must be adjusted periodically to account for these changes. Accounting for changes in technology costs accurately remains a challenge. Changing payment levels too often can be undesirable as well, as it creates investor uncertainty and increases overall market risk. Some jurisdictions such as Germany choose to adjust their policies via tariff degression, where FIT payments decline by a pre-established percentage every year, coupled with periodic policy adjustments that occur every three or four years (BMU 2008). Others such as Spain choose to adjust FIT policies annually by updating the entire suite of FIT premium payments to track observed changes in technology and operational costs (RD 661/2007). Despite these short-term adjustments, both Germany and Spain retain long-term commitments to the policy (see Section 6.3). To be successful, these adjustments require a detailed methodology to track market changes effectively from year to year. Ultimately, the challenge is to provide a flexible policy framework without jeopardizing investor confidence (Klein et al. 2008).

Due to the potential near-term impact that rapid deployment of RE technologies could have on electricity rates and overall policy costs, caution should be taken when including costlier RE technologies in FIT policies. For instance, some jurisdictions may choose to put caps on costlier renewable resources like solar PV, while technological advancement gradually reduces technology costs over time. As RE technologies become more cost-competitive, or as carbon pricing and/or market changes put upward pressure on the costs of fossil fuels sources, these caps can be progressively raised or removed. For more cost-competitive RE resources like wind power, it may be advantageous not to include caps to better capitalize on the hedge benefits of lower-cost RE resources.

As with any policy, benefits and challenges surround FIT policies. However, many of the challenges can be resolved with careful policy design and proper cost-benefit analysis. Additionally, because of the intrinsic benefits created by FIT policies in terms of RE development, policymakers may accept a tradeoff between the positive economic effects and any near-term impacts on electricity prices.

1.4. Feed-in Tariff Policy Design in Europe

Since FIT policies have had the most success in European countries like Germany and Spain, it is worth examining the design features that have led to their success. Typically, FIT policies in Europe offer payments that are based on the actual cost of generation from RE sources, while allowing for a reasonable profit. They also guarantee connection to the grid, while giving priority to RE sources (Klein et al. 2008).

Further design features that account for the success of FIT policies in Europe are the long-term contracts they provide, along with the streamlined procedures for project approval. They also design their FIT policies to allow for a high degree of price differentiation, allowing RE investments to be profitable in a wide variety of technology types, at a wide range of different sites, as well as in a wide spectrum of different project sizes. These various differentiations make European FIT policies more sophisticated than their North American counterparts. This has led some analysts to distinguish them as "advanced renewable tariffs" (Gipe 2009).

FIT policies in Europe also have fewer caps on project and program size, and where such caps exist, they impose less restrictive limits on how much RE deployment can occur, leaving greater room for development while increasing overall investor confidence.

2.0 FIT Policies Currently Enacted in the United States

FIT policies are being experimented with in the United States, though at a smaller scale and less comprehensively than in a number of European countries. To date, several utilities in California, Florida, Oregon, Vermont, Washington, and Wisconsin have implemented different variations of FIT policies. This section briefly explains the structure of the various state-level FIT policies currently enacted in the United States.

It is important to distinguish between utility-based and state-level FIT policies. The United States has a number of utility-based FIT policies which differ considerably in design and effectiveness. They are generally put forth by utilities to help meet utility-specific goals, which may range from meeting RPS targets to encouraging distributed generation. Wisconsin and Oregon are examples of this as both states have utilities that offer fixed-price FIT payments for RE sources. State-wide FIT policies, in contrast, are mandated at the state level and require utilities operating within their jurisdiction to purchase electricity generated from RE sources. Note that this obligation can apply only to investor-owned utilities (IOU) or to all utilities within the state. Two examples of state level FIT policies include California and Washington.

Figure 1 provides an overview of the current status of FIT policies in the United States,[6] most of which are best characterized as 'avoided cost' based FIT policies or fixed-price incentives rather than full-fledged FITs based on the cost of RE generation (Rickerson and Grace 2007). To date, the only FIT policy in the United States based on the cost of RE generation has been adopted by Gainesville Regional Utilities (GRU) in Florida, designed for solar PV. It is important to note, however, that as of April 2009, no U.S. state has implemented a FIT policy based on the cost of RE generation.

There are substantive differences between the FIT policies found in the United States and those currently implemented in Europe. A brief discussion is included at the end of each state analysis, highlighting the ways each of these U.S. state FIT policies differ from those found elsewhere in the world.

[6] On June 26, 2008, Congressman Jay Inslee (D) submitted the Renewable Energy Jobs & Security Act, H.R.6401, a federal FIT proposal, to the United States Congress. This bill outlines a FIT policy that includes 20-year contracts for all RE technologies, including solar, wind, geothermal, biomass, and biogas facilities, with fixed payment levels set nationwide to encourage the development of the top 30th percentile of the country's renewable resources. The Inslee Bill (H.R. 6401) would have the FIT policy financed by a nationwide, non-bypassable system benefit charge.

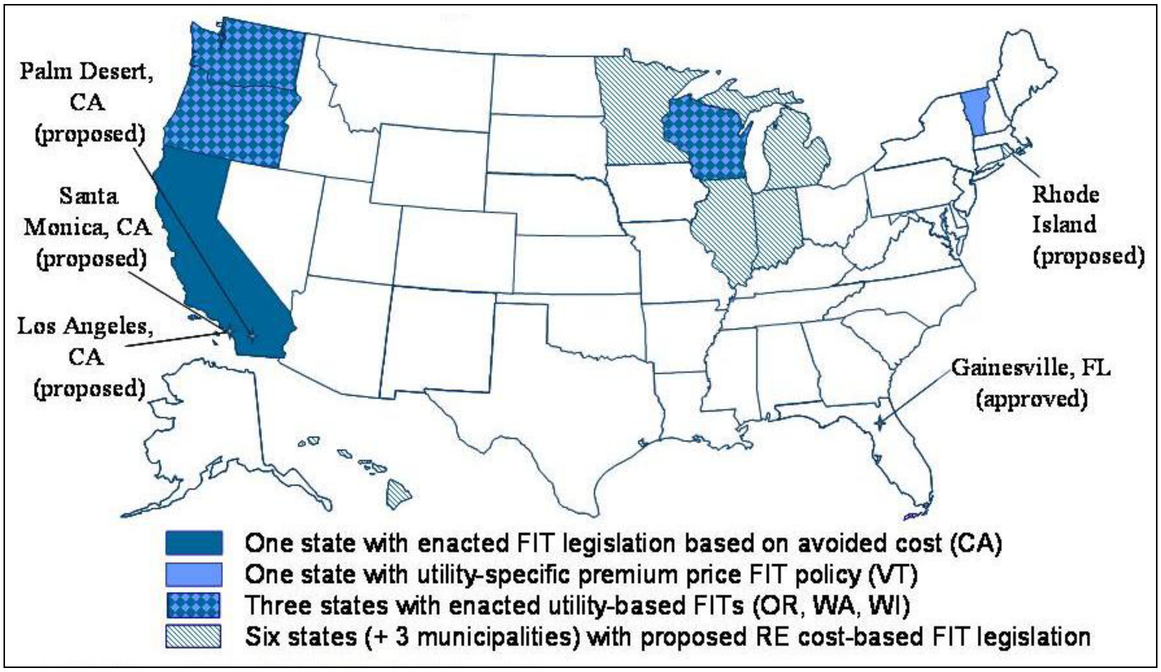

Figure 1. Feed-in tariff policy implementation within the United States
Source: www.wind-works.org.

2.1 Gainesville, Florida

On February 5, 2009, the board of directors at the Gainesville City Commission approved Gainesville Regional Utilities' (GRU) proposal for a FIT policy tailored to solar PV (GRU 2009a). This particular policy is unique in the United States as it is the first FIT to be based on the levelized cost of generating electricity from RE sources, with an estimated rate of return, thereby making it close in design to FIT policies in Europe. GRU expects that smaller developers will be able to obtain roughly a 5% rate of return on their investment, which is expected to make solar PV a financially viable investment (GRU 2009a).

The GRU FIT policy was implemented at the municipal utility rather than the state level and was available March 1, 2009. It is designed to help developers make use of existing state and federal incentives (GRU 2009a). Included in the contract terms is the stipulation that GRU retains any RECs generated, as well as any "carbon rights" that may accrue in the future.

The GRU FIT policy will enable residents served by GRU to install solar PV systems and sell their electricity directly to GRU for a fixed price contract of $0.32/kWh for systems smaller than 25 kW, and $0.26/kWh for free-standing systems larger than 25 kW. FIT payments will be awarded for a period of 20 years. The payments will decrease by approximately 5% beginning in 2010, such that projects installed in 2011, for instance, will receive $0.30/kWh (<25 kW) and $0.25/kWh (>25 kW) (GRU 2009b). This payment decrease is known as tariff degression (Klein et al. 2008). Additionally, the program includes an annual program cap so that no more than 4 MW of new installed solar capacity will be installed in any one year (DSIRE 2009b, GRU 2009b).

2.1.1 Comparison to European FIT Policies

Gainesville's FIT policy degression is one of three features the tariff has in common with Europe for fixed-price FIT design. This degression means that the annual payment awarded to solar developers for the electricity generated declines by a certain percentage (in this case, 5%) every year. This is done to both track and encourage cost reductions in the technology while fostering greater efficiencies and innovation.

The second similarity is that FIT payments are differentiated by project size. A higher tariff rate is offered for projects less than 25 kW than the rate offered to projects greater than 25 kW. This is an important feature of successful and cost-efficient FIT policies as it helps projects of various sizes to be profitably developed without awarding windfall profits to larger systems that benefit from economies of scale. The primary function of project size differentiation is to factor these economies of scale into the contracted FIT payment.

The third similarity is that the contract length is structured over 20 years, providing a reliable horizon for investors. While the guarantee of stable revenue streams over 20 years is a feature commonly used in Europe, it is far less common in the United States.

The GRU FIT policy differs somewhat from most in Europe as it is designed solely for solar PV rather than being extended to a wider variety of RE technologies. It also involves a fairly small annual program size cap; although, the cap may be appropriate to a small municipal utility such as GRU, whose peak capacity is 632 MW (GRU 2008).

2.2 Wisconsin

While the state of Wisconsin does not have a FIT policy, a number of utilities operating in the state have chosen to implement their own. Therefore, Wisconsin's FIT policies are utility-based and include all three kinds of FITs: fixed-price incentives, avoided cost FITs, and one loosely based on RE project costs.

As of October 2005, WE Energies offers a fixed-price incentive for solar PV projects through a pilot project program. Currently, the contracts are structured over 10 years and offer a payment of $0.225/kWh for systems ranging from 1.5 kW to 100 kW in capacity (DSIRE 2009c). A cap is also included on the total program size of 1 MW. WE Energies purchases both the electricity and RECs, and project developers receive a check once the net amount accumulated exceeds $100. Projects are also connected via a separate, supply oriented meter, distinguishing the policy from net metering (DSIRE 2009c). The policy is valid until September 30, 2011; however, enrollment has been discontinued due to full subscription.

WE Energies also offers a FIT payment for biogas systems that is based on the utilities' avoided cost (DSIRE 2009d). The payment varies from $0.155/kWh for on-peak production to $0.04/kWh for off-peak production, roughly reflecting the utility's cost of generation during these times. The policy is available for projects up to 1 MW in size, for a total program size of 10 MW. FIT payments are structured according to a 15-year contract with WE Energies; the policy is will expire on December 31, 2009, or when the 10 MW cap is reached, whichever comes first (DSIRE 2009d).

Another Wisconsin utility, Madison Gas & Electric (MGE), started offering a similar fixed-price incentive for solar PV systems between 1 kW and 10 kW in size in March 2007 (DSIRE 2009e); there is a 300 kW cap on program size. The policy is only available to customers serviced by MGE who have opted into its Green Power Tomorrow program, which includes an additional $0.01/kWh surcharge on the utility retail rate. The contract period is 10 years; all electricity sold is bundled with the RECs which are then transferred to MGE (DSIRE 2009e). Additionally, MGE has a fixed-price incentive that states the amount of energy consumed by the owner via the green power program (GPP) must be larger than the total AC output of the system.

Finally, as of January 1, 2008, Xcel Energy offers a FIT payment for wind power of $0.066/kWh and biomass and biogas electricity of $0.073/kWh (DSIRE, 2009f). Other technologies are technically eligible for a fixed-price incentive as well, though the actual payment is negotiated on a case-by-case basis. Contracts are based on a 10-year period, ranging from a minimum project size of 20 kW to a maximum of 800 kW for biomass and biogas projects. A cap is also included on the total program size at 0.25% of retail sales over the previous year (Donovan 2009).[7]

The FIT payment levels offered are based on Xcel's approximations of RE project costs, derived from their own internal modeling (Donovan 2009). Although Xcel calculated its FIT payments with the intention of basing them on the costs of RE generation, the prices have been set too low and have been insufficient to drive significant RE development (Donovan 2009). This example underscores the importance of setting the FIT payment levels accurately to ensure they are adequate to cover project costs; policies that fail to do so are unlikely to be successful unless other supplementary incentives are in place.

2.2.1 Comparison to European FIT Policies

There are a few key differences between FIT policies in Wisconsin and those currently implemented in Europe. First, Wisconsin's FIT policies have not been accurately based on the levelized cost of RE generation. Because they are utility-based FIT policies, utilities are not allowed to participate. Also, because the programs include a number of caps on the individual project size, as well as on the total program size, these FIT policies are limited in their ability to drive large-scale RE deployment.

2.3 California

Although FITs are widely understood to be a European policy, they originated in the Unites States under the Public Utilities Regulatory Policies Act (PURPA) of 1978 (Rickerson & Grace 2007). In the early 1980s, California was the state to most

[7] Based on Xcel's 2005 Wisconsin retail sales of just over 6,000 TWh, this works out to just over 15 GWh.

aggressively implement PURPA. In fact, Standard Offer Contract (SOC)[8] No. 4 helped encourage the development of almost 1,200 MW of wind power in California between 1984 and 1994 (Gipe 1995). However, PURPA was based on the notion of utility "avoided costs," and contracts in California were locked in based on projections of the long-run price of natural gas.[9] When actual natural gas prices dropped well below the projections, SOCs payments kept rising and proved costly to the ratepayer, giving PURPA a negative connotation that persists in the United States. (Guey-Lee 1999).

In July of 2007, the California FIT policy was passed into law by Assembly Bill 1969 (CPUC 2008a), requiring utilities to file tariffs for the purchase of renewable electricity from a number of eligible facilities, including water and waste-water facilities. The total program size was capped at 478.4 MW (CPUC 2006). The tariff payment level was determined according to the market price referent (MPR) at the time of commercial operation of the plant; it is fixed at this level over a period of 10, 15, or 20 years (AB 1969).

The MPR, used primarily for implementing California's RPS, is the anticipated average annual cost of generation from the power plant that would otherwise be supplying the load in that area (CPUC 2008a), making it a slightly more nuanced form of the avoided cost payments previously awarded under California's SOC No. 4. The MPR in California is currently determined by the market price of natural gas (Grace et al. 2008a). The California Public Utilities Commission (CPUC) specifies that the tariffs are to be: adjusted according to the time of delivery; differentiated as either peak, shoulder, or off-peak; and are to differ depending on whether the electricity is supplied in the summer or winter, and by which utility (CPUC 2008a). There is also a limit on individual project size of 1.5 MW. Although Resolution 4137 extended the FIT policy to apply to all IOUs, most only offer FIT payments to water and waste-water facilities. Pacific Gas and Electric Company (PG&E) and Southern California Edison (SCE), however, do extend the payments to other RE technologies (CPUC 2008a).

This MPR approach means that California's FIT policy is based on avoided-costs, as opposed to one based on the levelized cost of RE generation. It is important to note that it is different from PURPA in that it is updated annually, and it is also more closely tied to *current* utility avoided cost, unlike California's SOC No. 4, which was pre-determined at the beginning of the contract, based on projections of the long-run avoided cost.

The FIT policy has had little impact in California so far. This is largely due to the fact that the suite of rebates and up-front subsidies[10] is not available to certain technologies

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[8] "Standard Offer Contract (SOC)" has sometimes been used interchangeably with "feed-in tariff". It is important to distinguish modern cost-based FIT policies, which are often highly differentiated in their design and overall payment structure, from previous SOCs born of the PURPA policy, which were based on varying interpretations of the notion of avoided cost.
[9] Avoided costs are estimated by location and depend on the marginal electricity resources for that location. In some states, this could have been based on natural gas, oil, or nuclear.
[10] These up-front subsidies range from $1.55/watt to $2.30/watt as of October 2008 (CPUC 2008b). Note that these up-front payments differ from one utility to the next.

under the FIT policy (CPUC 2008b). Because the payment levels offered remain too low to drive development in most RE technologies, the California FIT is not viable as a stand-alone policy. Approximately 97% of developers and residents opt for the high up-front rebates available under the program instead of the FIT payment due to the higher rate of return they ensure (CPUC 2008b).

There are a number of other initiatives in California that could advance FIT policies in the state. The California Energy Commission (CEC) recently recommended moving toward a cost-based FIT policy and held a series of workshops on potential designs (Grace et al. 2008a, b, c). California's 2008 Integrated Energy Policy Report (IEPR) also directs the CPUC to immediately implement a FIT policy for projects under 20 MW, stating explicitly that FIT payments should be based on RE project costs rather than tied to the MPR (IEPR 2008). It also directs the CPUC to consider FIT policies for projects above 20 MW. All of this activity in California, combined with the realization that the state is falling behind schedule for meeting its RPS targets (Grace et al. 2008a), means it is likely that a more comprehensive FIT policy could be implemented in the state in the near future.

2.3.1 Comparison to European FIT Policies

There are three primary differences between California's current FIT policies and those commonly found elsewhere in the world: 1) California's payment levels are determined according to avoided costs rather than the cost of generation; 2) for most utilities in the state, the FIT payments are only available to water and waste-water facilities, significantly limiting potential growth in RE deployment; 3) California has a cap on both project and program size, hindering the developers' ability to harness economies of scale. These size caps also limit the ability of the FIT to drive large-scale RE deployment in the state of California.

2.4 Vermont

Two IOUs offer FIT programs in Vermont. As of July 30, 2004, the Central Vermont Public Service Corporation (CVPS), the largest utility in Vermont, offeres a FIT based on their utility avoided cost for farm-based projects generating electricity from anaerobic digesters (DSIRE 2009g). The incentive payment is based on 95% of the LMP, plus an incentive of \$0.04/kWh.

CVPS purchases both electricity and RECs and it sells the RECs to participants of the utility's GPP (DSIRE 2009g). The contract period for the purchases is five years, and the project must operate under a separate supply oriented meter. Since this policy effectively offers a bonus, or premium, above the average avoided cost price, it can be considered a premium-price FIT policy (Klein et al. 2008). The tie to the market price, via the LMP formula, arguably makes the policy riskier from a developer's standpoint due to the loss of price certainty. Also, the total allowable capacity under the program is limited by the participants in CVPS's GPP (DSIRE 2009g), limiting the scale of the RE development in the state.

In addition to CVPS, Green Mountain Power (a Vermont IOU) offers a fixed price incentive for net metered solar PV systems (DSIRE 2009h). Owners of the system receive \$0.06/kWh for the electricity they produce. A cap is included on the individual project size of 250 kW, and a second meter must be installed to track the total production of the system. No capacity limit or time duration is included, and under this policy, owners also retain the solar RECs for the electricity they produce.

2.4.1 Comparison to European FIT Policies

Vermont's FIT production incentives differ in a number of respects from those common in Europe. First, they are targeted at specific technologies (anaerobic digesters and solar PV, in particular), rather than being designed for a wide variety of RE technologies. Also, neither FIT is based on the actual cost of RE generation. CVPS's FIT program also involves a comparatively short contract period, significantly reducing the investment certainty. CVPS's program is integrated into the utility's GPP, effectively capping the total program size and limiting the potential for broader market growth. The fact that GMP's program does not include a cap on the total program size is a feature that it shares with certain European FIT polices.

2.5 Washington

In 2005, the state of Washington successfully passed a fixed-price incentive targeted at residential, commercial, and local government projects (SB 5101, DSIRE 2009i). Under the policy, solar PV, solar thermal, wind, and anaerobic digester systems are all eligible and are offered at a range of \$.12/kWh to \$.54/kWh, depending on the technology type and whether or not the project uses in-state manufactured components (DSIRE 2009i). However, a maximum FIT payment amount per project, per year is set at \$2,000, significantly limiting the eligible project size.

In addition, utilities in Washington are not obligated to participate; rather, they have the choice of offering the policy or not (Nelson 2008). The policy is financed through the utilities' in-state tax liability and can be offset annually by means of the \$2,000 per-project payments (Nelson 2008). The only direct costs incurred by the utilities are transaction costs (Nelson 2008). To minimize the transaction costs, the utility only verifies the meter once a year and pays out the corresponding amount on a yearly rather than monthly basis. The tariff amount is paid on all kWh generated, effectively distinguishing it from net metering policies. Washington's production incentive could therefore be understood as a form of "gross metering," where a payment is offered for all electricity produced, regardless of whether it is consumed onsite or not (Rose et al. 2008).

Note that for projects that qualify under Washington's FIT production incentive, the payments are only available through June 30, 2014, no matter when the project starts (DSIRE 2009i). This means there is a relatively short contract period over which the payments are offered, significantly reducing the likelihood that the revenue streams generated will be adequate to make RE projects profitable.

As mentioned above, preferential rates are offered to projects purchasing in-state components to help boost the local RE industry. For instance, solar PV projects are offered a base price of $.15/kWh. This base price is then modified according to two multipliers: 1) if the inverter is purchased from in-state manufacturers, a 1.2 multiplier is factored in; 2) if the solar panels are purchased from in-state manufacturers, a multiplier of 2.4 is factored in:

($.15/kWh x 1.2) + ($.15/kWh x 2.4) = $.54/kWh

2.5.1 Comparison to European FIT Policies

There are a few key differences between Washington's FIT policy and those found in Europe. First, Washington has no purchase obligation whereas Europe does. Also, the state's period payments are available for five years or less (instead of the 15-20 common in Europe). The policy is funded through utility tax liabilities rather than through the rate base, and an implicit cap on project size is imposed by capping the total allowable payment per project per year. Additionally, the state gives preferential treatment to locally manufactured RE technology components.

2.6 Oregon

In early 2007, the Eugene Water and Electric Board (EWEB), the largest publicly owned utility in Oregon, initiated a pilot project for solar PV, offering a production incentive of $0.15/kWh where the fixed-price incentive payment is based on the utility's avoided cost (Morehouse 2009). After the initial pilot program met EWEB's expectations, the program was expanded (Morehouse 2009). However, on January 25, 2008, EWEB dropped the actual FIT payment amount from $0.15/kWh to $0.12/kWh (DSIRE 2009j).

EWEB offers the fixed-price incentive for electricity produced from solar PV systems larger than 10 kW, with no upper limit on eligible project size. All electricity produced is fed into the grid via a separate supply oriented meter, and generators are paid based on their total production. This FIT payment is available for a contracted period of 10 years and all RECs generated by the system are transferred to EWEB.

2.6.1 Comparison to European FIT Policies

Several differences exist between EWEB's FIT production incentive and those common in Europe. First, EWEB's FIT payment is only available to solar PV projects and the contract period is somewhat shorter than those found in Europe. However, the most crucial difference is that the payment level is not based on the cost of RE generation, but on the utility's avoided cost.

Table 2 provides an overview of FIT policy design in the United States as of April 2009.

Table 2. U.S. Feed-in Tariff Policy Design

State	Utility	FIT Type(i)	Tech Eligible	Price (c/kWh)	Contract Duration	Project Size Caps	Program Size Caps
CA	IOUs only	Avoided-cost Based	Most(ii)	6 to about 20	10, 15, or 20 years	1.5 MW	478 MW
FL	Gainesville Regional Utilities (GRU)	Based on the Cost of Generation (Solar)	Solar	32	20 years	None	4 MW per year
OR	Eugene Water & Electric Board	Fixed-price Incentive	Solar	12	10 years	Only projects >10 kW	None
VT	Central Vermont Public Service	Avoided-cost Based	Biogas	95% of LMP + 4-6	5 years	None	Tied to GPP
	Green Mountain Power	Fixed-price Incentive	Solar	6	Unspecified	250 kW	None
WA	Almost all (60+)	Fixed-price Incentive	Solar	15-54	Until 06/30/2014	N/A(iii)	N/A (iv)
			Wind	12-18	Until 06/30/2014	N/A(iii)	N/A(iv)
			Biogas	15	Until 06/30/2014	N/A(iii)	N/A(iv)
WI	Xcel Energy	Loosely Based on Cost of Generation	Wind	6.6	10 years	20 kW-1 MW	0.25% of retail sales
			Biomass/ Biogas	7.3	10 years	20 kW-800 kW	
	WE Energies	Fixed-price Incentive	Solar	22.5	10 years	1.5 kW-100 kW	1 MW
		Avoided-cost Based	Biogas	4-15.5 (peak)	15 years	1 MW	10 MW
	Madison Gas & Electric	Fixed-price Incentive	Solar	25	10 years	1-10 kW	300 kW

(i) See Table 1 for a definition of FIT type.
(ii) FIT policies are only available to technologies other than water and waste-water facilities in PG&E and SCE's service area.
(iii) The maximum annual payment is $2,000 per system, effectively capping the eligible project size.
(iv) Utilities offset the FIT purchases through their in-state tax liabilities, implicitly capping the total program size to the extent of the utilities' tax liabilities.

2.7 FIT Policies Currently Proposed in the United States

As of March 2009, state representatives have proposed FIT policies in a wide range of U.S. states, including Arkansas, California, Florida, Hawaii, Illinois, Indiana, Michigan, Minnesota, New York, Oregon, Rhode Island, Vermont, Washington, and Wisconsin.[11] California and Washington are examining the possibility of expanding their existing FIT policies (IEPR 2008 and HB 1086, respectively) and Hawaii saw a number of solar FIT proposals in its legislature in 2007. Throughout this flurry of legislative activity, a trend toward designing FIT policies similarly to those found in Europe can be seen. Many jurisdictions that already have either state- or utility-based FIT policies are exploring ways of improving them, and this could help increase the success of FIT policies in the United States in the future.

In addition to state legislative proposals, governors are also proposing FIT policies. Hawaii, for example, has included a more comprehensive FIT policy within its most recent energy plan (FIT-Hawaii 2009). As part of the Hawaii Clean Energy Initiative, Hawaii identifies reaching 40% of the state's electricity from renewable sources by 2030 as one if its objectives, with the long-term goal of supplying 70% of the state's energy needs with clean energy sources (FIT-Hawaii 2009).

State energy offices are also proposing FIT policies. Florida, Ohio, and Maine are considering FIT policies at the state-level (Gipe 2009b), and California recently held hearings at the CEC to examine different policy options for an expanded FIT policy, with the aim of replicating the success of its European counterparts by improving the policy design (CEC 2008).

Finally, the municipalities of Palm Desert, Santa Monica, and Los Angeles in California have also recently proposed FIT policies; however, none were implemented as of April 2009 (Gipe 2009b; Ferguson 2009).

[11] For a full list of current U.S. state FIT proposals, see Gipe 2009b.

3.0 Key Elements of FIT Policy Success

FIT policies can be implemented in any jurisdiction and can support all renewable technologies including wind, solar PV, solar thermal, geothermal, biogas, biomass, fuel cells, and tidal and wave power. These policies can increase the development of a number of different technology types over a wide geographic area based on local resource availability, so long as the payment levels are differentiated appropriately. As with any policy, there are a number of best practices that can help ensure policy success and improve overall policy performance and cost-efficiency. This section examines the key elements that contribute to FIT policy implementation success.

Since Europe has a high concentration of FIT policies and the longest experience in policy implementation (see Section 6.0), this section draws on that experience to identify key FIT policy design elements. These lessons provide a useful framework for identifying best-practices, and could help promote better FIT policy design in the United States.

The key elements of a successful FIT policy, as identified by leading European research (Klein et al. 2008, Ragwitz et al. 2007, Langniss 2008), include:

1. **Offer a stable FIT policy**. The promise of a policy being in place for at least five years (preferably more) provides certainty that the policy will exist, even if it takes several years to develop a renewable power project. While the actual payment levels can be adjusted moderately, the promise of policy stability is critical. This security creates project financing certainty. It also helps attract manufacturers and supports other job-creating industries. Policy stability communicates a clear, long-term commitment to RE development.

2. **Offer long-term (15-20 years) contracts to provide investment security**. Longer contract terms lower the levelized cost of the project, which can help reduce the overall rate impact of RE development. The longer the contract term, the longer the period during which investment costs can be recovered, resulting in a lower levelized cost (likewise, the shorter the contract term, the higher the levelized cost).

3. **Base payment levels on the levelized cost of RE generation to ensure a modest profit for developers and investors**. An adequate FIT price to cover costs, plus a reasonable return, provides investors with the certainty that they have a high likelihood of making a decent return on the RE investment. This can significantly reduce the complexity and the risks of RE project financing. Further, due to the stability and predictability of the revenue streams, investors can often obtain a larger proportion of debt financing, lowering overall financing costs.

4. **Introduce incremental payment decreases (annual tariff degression)**. Some technologies are expected to experience innovation and economies of scale, resulting in significant cost reductions. For these technologies, it is important to reduce the payment level each year for projects installed in subsequent years, in a transparent and pre-determined manner. In other words, the schedule of annually decreasing payments is determined and established for multiple years, it is published, and it is not adjusted during the multi-year timeframe. This helps reduce the costs of the policy over time and creates an incentive for rapid deployment, further cost-reductions, and improved efficiencies in the future. This creates added competition between manufacturers, stimulating innovation.

5. **Differentiate payment levels by technology type, project size, and resource quality to offer project-appropriate FIT payments**. Technology differentiation can promote supply diversity and higher levels of RE penetration. Differentiating FIT payments by project size allows projects to be scaled to the particular site and interconnection point, while lowering payments for larger projects to account for economies of scale. It can also promote distributed generation. Finally, differentiating FIT payments by resource quality can improve siting flexibility, reducing the chance of overpayment at the best sites (e.g., the windiest sites).

6. **Incorporate the added costs of a FIT policy into the electricity rate base**. The certainty of the FIT payment being tied back to ratepayers provides certainty that investors will receive payments, no matter the state of the economy. This also allows costs to be distributed through electricity rates equitably. Marginal costs may be integrated into the rate base, either incrementally or by means of a system benefit charge.

7. **Streamline approval processes to reduce administrative barriers and transaction costs**. This can help improve the economics of smaller projects while allowing citizens, farmers, and other groups to become active participants in RE generation, thereby ensuring broader economic benefits for the state.

4.0 FITs: A Tool for Achieving State Goals

There are several major drivers that motivate states to consider implementing FIT policies. In particular, FIT policies have been known to help states ramp up the deployment of RE sources, drive economic development and job creation, and other significant economic and social benefits. This section examines some common goals states have and briefly assesses how well-designed FIT policies can meet those goals.

A common reason for introducing a FIT policy at the state level is to help states ramp up the deployment of RE sources (Grace et al. 2008a, HB 5812, HB 5855, Minnesota 216B.1601). In states where these targets are aggressive, they require policies that will create sustained growth in the industry and will lead to rapid RE deployment. Research is beginning to show that a FIT policy can be used in conjunction with an RPS as an alternative procurement mechanism to help utilities meet RPS mandates (Rickerson et al. 2007, Grace et al. 2008c, Cory et al. 2009b).

One of the major goals for states nationwide is to drive economic development and job creation in the green energy sector. FIT bills proposed in Michigan, Illinois, Minnesota, and Indiana cite this as a leading reason for implementing a FIT policy (Gipe 2009b). Indeed, data from countries like Germany and Spain demonstrate that well-designed FIT policies can positively impact job creation and economic growth, opening up the prospects for significant expansions of future export opportunities (see Section 6.2 *Jobs, Manufacturing, and RE Industry Impacts*) (EEG 2007, López 2006). FIT policies, particularly in Europe, are often specifically designed to encourage a number of different technology types to stimulate job creation in a variety of RE technology industries.

FIT policies can also be used to help increase a jurisdiction's energy security by reducing the dependence on imported fuels or electricity. In particular, they can help reduce dependence on natural gas while helping promote long-term rate stability.

Significant economic and social benefits can also be yielded by FIT policies. For example, peak shaving can be encouraged by differentiating FIT payments according to their time of delivery, or by offering bonus payments for dispatchable technologies (Klein et al. 2008). This may be particularly important in jurisdictions where peak electricity is generated by single-cycle natural gas turbines, which are highly exposed to price spikes and volatility (Carley 2009). Dispatchable RE resources like biogas and biomass can help reduce the use of natural gas for peak generation, benefiting industry as well as residential electricity customers either through softening regional natural gas prices or by providing lower cost supply in times of high demand. A FIT policy's long-term contract also provides an added price stability benefit (de Miera et al. 2008).

If they are designed to target distributed supply, FIT policies can also help alleviate congestion in areas where transmission is limited, providing valuable benefits for the electricity system while diminishing the scale of brownouts and blackouts (Bouffard and

Kirschen 2008). More distributed supply sources can also help reduce line losses while deferring the need for grid upgrades (Bouffard et al. 2008).

Table 3 outlines various policy goals that a FIT policy could help a state achieve.

Table 3. State Policy Drivers

State Policy Drivers	Specific State Policy Objectives	FIT Policy Impacts	Notes
Economic Objectives	Job creation	High	• Due to the guaranteed terms and low barriers to entry offered by FIT policies, they have been highly successful at driving economic development and job creation • Fixed prices for renewable energy sources can also help stabilize electricity rates
	Economic development	High	
	Economic transformation	High	
	Stabilize electricity prices	Moderate	
	Lower long-term electricity prices[12]	Low/Moderate	
	Grow the state economy	High	
	Revitalize rural areas	High	
	Attract new investment	High	
	Develop community ownership[13]	High	
	Develop future export opportunities	High	
Environmental Objectives	Clean air benefits (Mercury, particulates, etc.)	Moderate	• The rapid RE development seen in jurisdictions with FIT policies has helped reduce the environmental impacts of electricity generation, while providing valuable air quality and other environmental benefits. • Differentiating FIT payments by resource type can also target various biomass waste streams.
	Greenhouse gas emissions reduction	Moderate	
	Preserve environmentally sensitive areas	Low	
	Minimize human impacts of energy development	Moderate	
	Manage waste streams (biogas, landfill gas, biomass, agricultural wastes, forestry wastes, etc.)	High	
	Reduce exposure to carbon legislation	Moderate	
Energy Security Objectives	Secure abundant future energy supply	High	• Well-designed FIT policies can improve overall energy security by helping diversify energy supply and helping domestic energy resources be more widely harnessed.
	Reduce long-term price volatility	High	
	Reduce dependence on natural gas[14]	Low/Moderate	
	Promote a more resilient electricity system[15]	Moderate	
Renewable Energy Objectives	Rapid RE deployment	High	• By creating favorable conditions for RE market growth, FIT policies can help jurisdictions meet RE targets. • FIT policies have also helped countries move toward a green energy economy.
	Technological innovation	High	
	Drive RE cost reductions	High	
	Meet RPS targets	High	
	Reduce fossil fuel consumption	Moderate	
	Provide base-load generation	Low/Moderate	
	Stimulate green energy economy	Low/Moderate	
	Reduce barriers to RE development	Moderate/High	

[12] Cost reduction is more likely to be ensured if lower cost RE resources like wind and biogas are included.
[13] Community ownership will depend on how high the payment levels are set, and whether or not communities are able to participate.
[14] Dependence on natural gas will be reduced primarily in areas where natural gas is the marginal supply.
[15] Greater grid resilience will be fostered if more distributed resources are encouraged, and particularly if they are sited in highly congested areas.

The extent to which a FIT policy will help achieve these goals depends primarily on the design options incorporated into policy. It may also depend on a number of factors that are external to the policy design. However, experience has consistently shown that well-designed FIT policies can help reach these and other economic, environmental, and energy-related goals by leveraging significant amounts of capital toward the RE sector (see Section 6.0 Quantifying the Impacts of FITs) (EEG 2007, Mendonça 2007, Klein et al. 2008, Rickerson et al. 2007, Grace et al. 2008c). Therefore, when designing a new policy, it is important to consider the ways that policy will interact with other policies, and how those interactions could work synergistically or detrimentally with the existing policy environment. Section 5.0 Interaction Between FITs and other State and Federal Policies explores how FIT policies may interact with existing policies in the United States.

5.0 Interaction Between FITs and other State and Federal Policies

Interactions between existing state and federal policies can influence the way a FIT policy is implemented, and may even limit the specific policy design options available for implementation in the United States. This section explores the potential interactions between FIT policies and other current state and federal policies that relate to RE. Interactions with state RPSs, net metering, as well as the interactions with the federal Production Tax Credit (PTC) and Investment Tax Credit (ITC) are also examined.

5.1 RPSs and FIT Policies

Although it has been argued that FIT policies are not compatible with an RPS framework, recent analysis has shown that this is not the case (Rickerson et al. 2007, Grace et al. 2008b, IEPR 2008). In fact, FIT policies can be used as tools to help meet and promote pre-existing state RPS objectives. Strictly speaking, an RPS is a mandated target, representing a minimum amount of either capacity or generation to be supplied from RE sources by a certain date. This target acts as a minimum amount of renewable electricity that must be delivered to customers (otherwise, a penalty or alternative compliance payment is typically paid).

The relevant question when considering FIT-RPS policy interactions is which implementation mechanism should be chosen to help meet the renewable mandate. The mechanism most commonly used to meet the RPS mandates in the United States is competitive solicitations,[16] where project developers are required to put forward competitive bids to obtain contracts (Wiser et al. 2008). European countries, in contrast, have overwhelmingly opted for the FIT policy as their implementation mechanism of choice to meet their RE goals (Ragwitz et al. 2007).

5.1.1 Potential Interactions

A recent series of analyses conducted for the state of California outlines a number of different ways a FIT policy could act in concert with an RPS policy (Grace et al. 2008a). First, the FIT could be an alternative to the current method for awarding contracts, which is based on competitive solicitations. Alternatively, a FIT could provide opportunities to ensure that RE development continues *between* competitive solicitation cycles (Grace et al. 2008c).

A third option would be to have the two policies acting in parallel, with FITs targeting specific technology types, ownership models, or project sizes. For example, FIT policies could be offered to smaller scale projects while leaving the basic competitive solicitation mechanism for utility-scale projects. This is the approach currently employed in states like California, Washington, and Oregon. Due in part to Federal Power Act provisions that treat projects larger than 20 MW differently, a 20 MW cap on project sizes is

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[16] Also known as "tendering".

beginning to emerge (Grace et al. 2008c). Another possibility is that FIT policies could be designed to allow those who do not have the requisite tax liabilities to participate in RE development.[17] This would not take anything away from existing RPS solicitation processes, while providing an alternative procurement mechanism for parties that do not have access to the financial and technical resources required to put forward bids in the competitive solicitation process.

Finally, in light of the project failure rate in states like California where developers often underbid to obtain the contracts and are left unable to profitably develop their proposed projects (Wiser et al. 2005), it has been argued that FIT policies could be designed to gradually take the place of existing solicitations policies (Grace et al. 2008c). If payment levels are differentiated to account for economies of scale while still ensuring modest profit margins, RE development of all scales could take place through FIT policies, removing the risk premium and potentially lowering RE costs while allowing a wider diversity of project developers to participate through the guaranteed contract terms and technology-differentiated prices FITs offer.

Regardless of the approach an individual state employs, no immediate conflict exists between FIT and RPS policies; rather, the two policies can be designed to work synergistically with one another.

5.2 Net Metering and FIT Policies

It is important to consider how FIT policies will interact with existing net metering policies. First, there could be confusion over how the two policies are distinguished from one another, so this distinction should be clarified up front. Also, there are several different ways net metering and FIT policies could interact, and with each of those possibilities come specific considerations.

Net metering is a policy that allows customers to generate their own electricity to offset power that would otherwise have been purchased from the grid (Rose et al. 2008). From a utility standpoint, net metering is therefore a demand or load reduction policy. In the event that on-site supply exceeds on-site demand, a credit is typically offered for excess generation which, depending on the state, may be carried over from month to month, or from one year to the next.[18]

FIT policies, on the other hand, require a separate meter to track actual generation, and the owner of the system is awarded payment for the entirety of the electricity produced. This makes FIT policies a supply oriented policy rather than a load-reduction policy. FIT policies also generally differentiate payments by technology type, resource quality, and

[17] Given the reliance of RE developers on either the PTC or the ITC in the United States, this will likely be less of an issue in the near-term in light of the recent changes to the federal tax incentive structures that help developers convert the previously tax-liability-dependent credits into cash grants (Zindler 2009). These new changes could play a significant role in unleashing capital investment toward RE development, if implemented effectively.

[18] For more details of state specific policies, see the Database of State Incentives for Renewables and Efficiency (DSIRE) at www.dsireusa.org.

project size, something net metering does not do. The payments awarded are also not determined by the residential, commercial, or industrial retail rates, as most net metering credits are; rather, they tend to be based on the cost of different types and sizes of RE projects. This creates a more robust incentive for all interested developers,[19] helping overcome what has been a significant barrier to the success of net metering policies in the United States.

5.2.1 Potential Interactions

There are different possibilities for how interactions between net metering and FIT policies can take place. The first approach is gross metering, where a FIT payment is made for all electricity produced, regardless of whether it is consumed onsite or not. This requires that a supply meter be installed to monitor the system output at the inverter. Electricity can then supply on-site loads, or it can be sent to the grid in the event that on-site supply exceeds demand. Washington is currently implementing gross metering for its FIT policy (Nelson 2009).

Another approach is to allow both policies to coexist in parallel with one another, allowing end-users to choose to net meter their systems with the grid (receiving the available credit for their excess) or receive a FIT payment for the entirety of the electricity sold. Customers that chose the FIT policy would need to install a separate meter. Which option end-users would choose would depend largely on the prevailing electricity prices, the size of their system, and the price offered by the FIT policy.

A hybrid approach is being implemented in Germany as of January 2009. It allows qualifying solar PV systems smaller than 30 kW to remain net metered (Klein et al. 2008). These PV systems are compensated at a rate of €.25/kWh for electricity consumed onsite and €.43/kWh for exported energy. The difference (€.18/kWh) represents what the project owner pays for power from their system (Klein et al. 2008). It is important to note that this difference is marginally lower than Germany's average electricity rate; therefore, project owners are encouraged to consume energy produced onsite, reducing overall demand on the electricity system.

Whether existing net metered systems will be grandfathered into a newly implemented FIT policy is also something to consider. If systems have received up-front rebates or other forms of incentives, offering to grandfather them into a FIT program could be considered preferential treatment. Given that one of the goals of a FIT policy is to encourage new RE deployment and not to favor incumbents, grandfathering may not be desirable. This is a decision that will likely have to be taken on a state-by-state basis as FIT legislation is drafted differently in different areas.

5.3 Federal PTC/ITC and FIT Policy Interactions

The primary federal incentives to encourage RE technology development have, until recently, been either PTCs or ITCs. Under the American Recovery and Reinvestment Act

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[19] "Interested developers" includes end-use customers.

of 2009 (ARRA), a new option of direct cash grants has been added. [20] Eligible projects are those that come into service before the end of 2010, or those that begin construction between 2009 and 2010 (Zindler 2009). These cash grants are designed to provide an up-front payment of 30% of the total investment costs; however, this is a temporary option.

5.3.1 Potential Interactions

For those technologies eligible for the PTC, the choice is between annual payments based on production and an up-front 30% incentive (either as a tax credit or cash grant). A recent joint report produced by the Lawrence Berkeley National Laboratory and NREL evaluated this choice, both quantitatively and qualitatively (Bolinger et. al. 2009).

One of the consequences of these federal incentive structures, whether offered as direct grants or as tax incentives, is that they lower the up-front costs of RE projects. This puts downward pressure on the FIT payment required to drive RE investments, leading to marginally lower payments than those required elsewhere to encourage market growth. In other words, FIT policies in the United States may have to be designed to factor in the presence of these federal incentives to reduce the possibility of overpayment. These considerations could be important in jurisdictions where a lot of RE development is anticipated in the next few years, and are likely to be important in designing cost-efficient FIT policies in the United States in the future.

In the design of its FIT policy, for instance, GRU calculated the solar rate based on the assumption that those developing the projects would be able to benefit from the 30% ITC. In other words, its targeted rate of return rests on the assumption that those investing in the projects will be able to obtain this federal incentive, as well as the accelerated depreciation provision (Regan 2009). In this way, FIT policies can be designed to either assume, or account for, the existence of other state and/or federal incentives.

[20] Note that under the ARRA, renewable projects eligible for the PTC have a choice between the PTC and the up-front 30% cash grant. The choice between the two depends on the overall value of the incentives to the project, which differs by technology. The quantitative and qualitative factors that go into this decision are analyzed in Bolinger et al. 2009.

6.0 Quantifying the Impacts of FITs

As comprehensive, advanced FIT policies like those in Germany, France, and Spain have not yet been implemented in the United States, it is difficult to draw comparative conclusions between economic and RE impacts in the United States and Europe. However, experience from Europe demonstrates the impact FIT policies can have on green industry growth and RE deployment (BMU 2008, López 2006). This experience provides lessons that can be useful for future adoption and implementation in the United States.[21]

This section briefly examines the impacts on RE deployment, job creation, and the electricity cost impacts that can be discerned from data available in the United States.[22]

6.1 U.S. FIT-based RE Deployment

Although FIT policies implemented in the United States have their share of limitations, the majority of which are due to issues of policy design, they have not been entirely ineffective. States like California, Washington, and Oregon have put their policies to work and successfully developed a number of RE installations.

As mentioned in Section 2.0 FIT Policies Currently Enacted in the United States, California implemented the first FIT policy under SOC No. 4 in 1984. As a result, California successfully developed more than 1,200 MW of wind power between 1985 and 1992 (Gipe 1995). Over those seven years, SOC No. 4 saw just under 16,000 wind turbines installed, which collectively produced an annual output of roughly 2,750 GWh of electricity, enough to power 450,000 Californian homes (eWPRS 2009). Collectively, California's turbines represented roughly 70% of the total installed wind capacity in the world at the time, effectively launching the commercial wind industry in North America and making California the world leader in wind power generation (Gipe 1995).

Under Washington's FIT policy initiated in 2005, the state has seen the development of more than 760 solar PV projects, eight small-scale wind power projects, and two biomass projects (Nelson 2008). These developments were made possible by the fixed-price incentives that allow small RE projects to obtain financing.

Since launching its FIT policy in 2007, EWEB has contracted approximately 30 solar PV projects—more than 1.5 MW of installed capacity. This includes a few larger (>100 kW) projects as well as a number of smaller commercial and residential systems (Morehouse 2009).

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[21] A more comprehensive analysis of these impacts will be included in an upcoming NREL report analyzing the impacts of FIT policies in countries like Germany and Spain, where rapid RE market growth has led to the creation of several hundreds of thousands of jobs in recent years.
[22] For a more comprehensive look at job and cost impacts in Europe, see BMU 2008a and 2008b; Lopez 2006.

In addition to these examples, Gainesville Regional Utilities in Florida has experienced overwhelming interest in its recent FIT policy (Blake 2009). Although GRU imposes a 4 MW cap on annual installed capacity, GRU has already generated interest for as much as 40 MW of solar development (Regan 2009). This level of interest is likely due to certain elements of GRU's FIT policy design. As mentioned earlier, Gainesville's FIT is the first in the United States to be based on the cost of RE generation, plus an estimated 5-6% rate of return (see Section 2.1 *Gainesville, Florida*). This design element, combined with 20-year contract terms, has made GRU's FIT policy a stable environment for solar investments and helped garner interest from a wide variety of local, regional, and global investors (Regan 2009). The policy has successfully attracted millions of dollars of new investment to Gainesville, creating a valuable local economic boost in the midst of a recession (Blake 2009).

6.2 Jobs, Manufacturing, and RE Industry Impacts

Experience in Europe demonstrates that FIT policies can be a significant driver of domestic job creation, industry development, and innovation (BMU 2008a, López 2008). At the end of 2007, the German RE sector supported 250,000 jobs, spurred by a combination of their FIT policies, strong domestic demand, and the growth of their export capacities in the green technology sector (BMU 2008a).

U.S. data on FIT policy impacts on green jobs, manufacturing, and industry is limited as the policies are only being implemented in a few locations. Also, with the exception of California's SOC No. 4, FIT policies are relatively new, making it difficult to present definitive data on their RE development impacts in the United States. However, a few general observations can be made. The state of California is the focus of this section.

Between 1984 and 1992, under California's SOC No. 4, approximately 1,200 MW of new wind development occurred, fueled by the stable prices offered by the early FIT policy. According to a California database of wind industry information, on average, more than 50% of turbines installed in California over this period were domestically produced there (eWPRS 2009). Slightly less than 16,000 wind turbines were installed at the time, suggesting that nearly 8,000 turbines were manufactured within the state itself.

Although the job creation impacts are fairly modest to date compared to successes in Europe, there is potential for greater impacts in this area as FIT policies become more widely implemented throughout the United States and become more sophisticated in their design.

6.3 Electricity Cost Impacts

This section examines the impact FIT policies could have on electricity rates. First, the upward near-term pressure on rates is examined. Then, some of the potential stabilizing benefits are discussed followed by a brief analysis of various methods used to cap the impact on rates.

Due to the lack of reliable data for ratepayer impacts caused by FIT policies in the United States, it is instructive to examine European data. Since implementing its FIT policy in

1991, and revamping it in its 2000 Renewable Energy Sources (RES) Act, Germany has become the world leader in both total installed wind and solar capacity, developing more than 22,000 MW of wind by the end of 2007, and more than 3,800 MW of solar, for a total of 34,018 MW of new renewable energy capacity (BMU 2008c). Based on analysis conducted by the German Ministry, the average cost of the RES Act on German households for this amount of renewable energy development was $3.82 per household per month in 2007 (BMU 2008b).

Figure 2 represents the breakdown of the various components that contributed to the costs of electricity in Germany in 2007 (BMU 2008b). It reveals that the portion of the total electricity costs attributable to the RES Act was approximately 5% of the total average electricity costs.

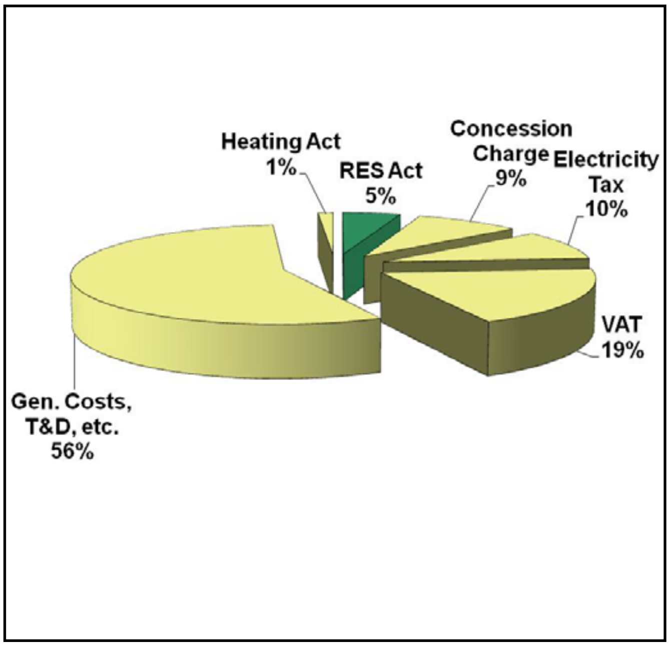

Figure 2. Breakdown of electricity costs in Germany (2007)
Source: Based on BMU 2008b

Due to the marginally higher cost of RE sources, on average, over existing conventional generation, implementing an aggressive FIT policy is likely to put near-term upward pressure on electricity rates, as demonstrated by Figure 2 based on data from Germany.

However, experience in Europe has begun to demonstrate that RE development can also help stabilize electricity rates (BMU 2008b, de Miera et al. 2008, Sensfuss et al. 2007, Morthorst 2006). In order to consider the ways RE development can contribute to stabilizing and even lowering electricity prices, the merit order effect and the impact of wind generation in particular are examined below.

6.3.1 Merit Order Effect

The Fraunhofer Institute for Systems and Innovation Research (the Institute) in Germany recently examined the positive impacts attributable to what is called the "merit order effect" (Sensfuss et al. 2007). The merit order effect is intended to capture the impact of adding new supply into an existing system with an existing supply curve. The effect is most prominent in systems during times of high demand, particularly in systems with tight supply that rely on high-cost generation during those hours. By adding new supply to such systems, there can be an overall demand reduction for the highest cost conventional electricity supply resources, in turn reducing overall electricity prices. This reduction in demand from high-cost conventional supply sources tends to soften market prices, which can provide benefits for electricity ratepayers (Sensfuss et al. 2007).

Based on simulations conducted by the Institute, the reduction in market prices due to the merit-order effect in periods of high demand reached as high as \$46.4/MWh (Sensfuss et al. 2007). When summed up nationally across all electricity purchases, price savings in 2006 were \$6.35 billion (Sensfuss et al. 2007).

6.3.2 Wind Power Generation Impact

Similar to the merit order effect, wind power development has lowered electricity rates in other jurisdictions as well. In the United States, there are a few locations where the cost of wind power development is in the range of \$0.05-0.07/kWh (Bertello 2007). In these areas, wind is already cost competitive with the average wholesale cost of conventional supply[23] (Wiser and Bolinger 2009).

European countries are seeing a similar trend of lowered electricity rates. Recent data from Spain (see Figure 3) show that due to their aggressive wind power development over the past 10 years, electricity prices in 2005, 2006, and the first half of 2007 were 11.7%, 8.6%, and 25.1% lower, respectively, than they would have been without wind power (de Miera et al. 2008). This decrease reflects the difference in electricity prices that would have occurred had that incremental supply been provided by natural gas instead. Danish data suggest a similar trend, where a reduction of 12-14% occurred in 2005 due to wind power alone (Morthorst 2006). Both countries make use of FIT policies to encourage wind power development (Klein et al. 2008).

[23] Assuming that the federal PTC incentive is still in place.

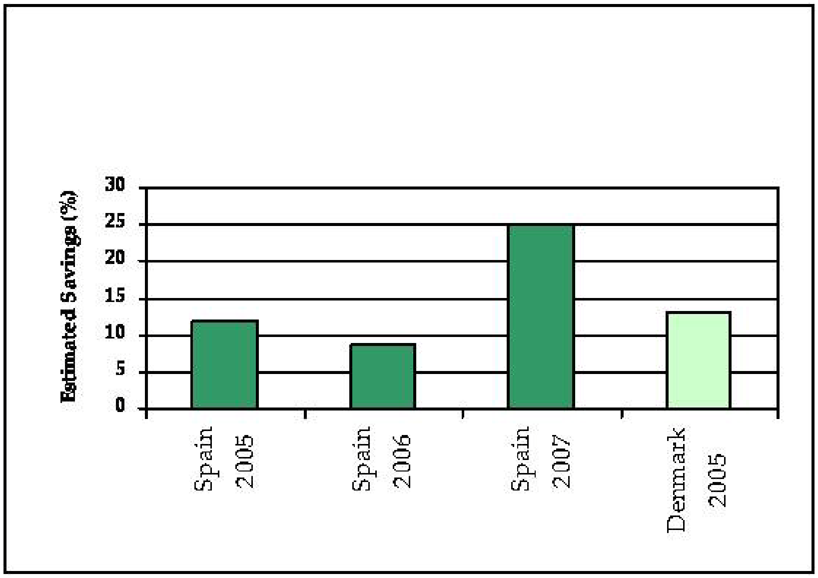

Figure 3. Estimated ratepayer savings in Spain and Denmark due to wind power
Sources: de Miera et al. 2008, Morthorst 2006.

Spanish data suggests that while an aggressive RE policy can increase costs, it can also, under certain circumstances, reduce electricity prices and mitigate volatility while providing a hedge against any upward pressure caused by rising fossil fuel prices (de Miera et al. 2008).

The results of these various analyses suggest that although electricity generated from RE sources is costlier on average than that of conventional generation, other factors play an important role. A more comprehensive analysis of the net costs and benefits reveals that RE development can already lead to net positive benefits for both customers and for society at large (Morthorst 2006, BMU 2008abc, de Miera et al. 2008).

In order to limit cost increases, a number of RPS policies in the United States have included overall cost caps, including New Mexico and Colorado (Cory and Swezey 2007). FIT policies can be designed to include similar cost caps, limiting the overall rate impact of RE development. A similar goal can be achieved by imposing a size cap on the total installed capacity eligible under the policy.

Some European jurisdictions have also begun limiting the rate impacts of FIT policies on specific sectors of the economy (e.g., energy intensive industries) or population (e.g., low income customers). The goal is to better manage any impacts of RE development on electricity rates for key sectors.

7.0 Conclusions

FIT policies are growing in prominence worldwide, and interest appears strong in the United States with more than a dozen states looking at implementing their own FIT policies. In addition to Arkansas, California, Florida, Hawaii, Illinois, Indiana, Maine, Michigan, Minnesota, New York, Oregon, Rhode Island, Vermont, Washington, and Wisconsin, four municipalities in the United States have also either considered or implemented FIT policies as of April 2009 (Gipe 2009).

Among the primary reasons for implementing FIT policies are the stability and certainty they offer to RE project owners. By offering long-term contracts, FIT policies guarantee stable revenue streams, helping reduce the risks of RE investments while reducing the overall costs of RE financing. By offering long-term price security, FIT policies also remove many barriers to rapid RE development, creating conditions conducive to market growth.

In Europe, FIT policies have proven to be a mechanism for stimulating large amounts of investment in the green energy sector, spurring the growth of both smaller energy start-ups and the more established players. Research has shown that FIT policies can also generate a wide variety of social and environmental benefits, while gradually contributing to the transformation of the overall energy supply mix.

FIT policies can be considered an alternative to other RE policy mechanisms such as offering up-front rebates, a mechanism that is common in the United States. Through careful design and by making payment levels approximate RE project costs, the policies can help projects be financed without up-front rebates, partly by making it easier for developers to take out loans structured over longer periods of time.

FIT policies can also be designed to work in conjunction with other U.S. state policies like RPSs and net metering. Federal policies like the PTC and the ITC could help lower the FIT payments needed to drive investment, while their new structure could make project financing easier for a broader number of investors.

Interest in FIT policies in the United States is expected to continue to grow in coming years. In Europe, the policy has successfully helped deploy significant amounts of RE capacity, across a wide variety of technologies, in a relatively short period of time. As this new policy propagates through U.S. states and municipalities, it will be critical for FIT policy makers to follow best design and implementation practices to achieve their goals.

A number of topics need additional research to better understand how FIT policies will operate in the United States. These include treatment of environmental attributes (or RECs), the relationship between FIT policies and the federal PTC and ITC incentive structure, the interaction between FIT policies and existing voluntary green power markets, as well as the role FIT policies can play to create jobs and spur market growth.

Questions also remain about the technical aspects of a high-penetration RE scenario that can result from effective FIT legislation, and how the grid can be improved to better accommodate high levels of incremental and variable supply.

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This report analyzes renewable energy feed-in tariff (FIT) policies and explores the different FIT policies currently implemented in the United States. It also discusses of a few proposed policies, the best practices in FIT policy design, and examines how FITs can be used to target state policy goals. The report covers current and potential future interactions between FITs and other state and federal energy policies while also providing an overview of the impacts FIT policies have in terms of renewable energy deployment, job creation, and economic development.

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