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IS THE FIT RIGHT?
CONSIDERING TECHNOLOGICAL MATURITY IN DESIGNING RENEWABLE ENERGY POLICY

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EXECUTIVE SUMMARY

Recent studies suggest that the United States can greatly expand its deployment of renewable energy resources beyond current levels.[1] This would reduce emissions of harmful pollutants and enhance energy security by diversifying the nation's domestic energy supply. This brief describes a number of policy tools that can be employed to drive investment in renewable energy technologies and discusses which policy options may be the best fit based on the commercial maturity of a targeted technology (see Figure 1). We examine several policy tools to describe where they have been most effective to advance technology progress along the innovation chain. The findings and recommendations presented are based on a study of the literature on technology innovation and policy best practices, as well as on discussions with experts in the field, policymakers, and private sector companies involved in renewable energy projects.

KEY FINDINGS

- **Grants** can be used to fund technologies in their earliest stages—research and development (R&D) and early-stage demonstration. The R&D stage involves significant uncertainty as to whether the concept will ever lead to a viable technology application. Grants help overcome this risk because they provide an important cost share for investment to research and develop the technology further. Technologies in the demonstration stage typically have difficulty accessing commercial investment due to uncertainty on technical performance and the inability to provide performance warranties. It is unclear whether they will eventually be financially profitable, particularly in the near-term. Demonstration grants allow commercial investors time to pilot and evaluate a new technology with appropriate due diligence. This can reduce risk perception and facilitate further investment.
- **Loan guarantee** programs are well suited for technologies in the commercialization and early deployment stages. In these stages, project performance remains uncertain, making it difficult to attract investors. Loan guarantees help attract private investors by sharing the risk of technical failure with a financially secure and credible entity (namely, a government agency).
- **Tax credits and feed-in tariffs (FITs)** can help advance technologies in the later stages of innovation, namely commercialization and early deployment. These policies allow projects to earn more profit for electricity produced so that they earn the revenues needed to offset higher upfront investment costs.
- **Renewable electricity standards (RES)** are most effective for more mature technologies that are in early deployment. An RES creates demand for renewable electricity and allows the market to determine how to most efficiently supply it; thus the market sets the premium paid to renewable resources. RES mandates can allow for open competition among a range of different technologies, or can be tailored with a carve-out to promote specific technologies that are not yet cost competitive with other renewables. The carve-out option can be a good fit for technologies that are still in the commercialization phase.
- **A favorable regulatory environment** is important to ensure that renewable energy technologies do not face inherent disadvantages due to interconnection standards, utility pricing structures, and other legal hurdles.[2] Failing to address regulatory barriers to renewables can increase their cost of deployment and reduce the effectiveness of incentive programs.

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I. INTRODUCTION: PROMOTING RENEWABLE ENERGY INNOVATION WITH THE RIGHT POLICY MIX

As a technology matures, its cost is driven down by technical innovation, improved business practices, and larger-scale production. For more advanced technologies, manufacturing will eventually reach a more efficient scale, supply chains will be built out, and business models will develop to accelerate deployment and drive down costs. The cost reduction that accompanies greater production of the technology can be represented by a "learning curve," which maps the cost of the technology against the total cumulative units produced at a given time (the red curve in Figure 1).[3] This "innovation chain" can be broken up into six stages: basic R&D, applied R&D, demonstration, commercialization, early deployment, and widespread deployment.[4]

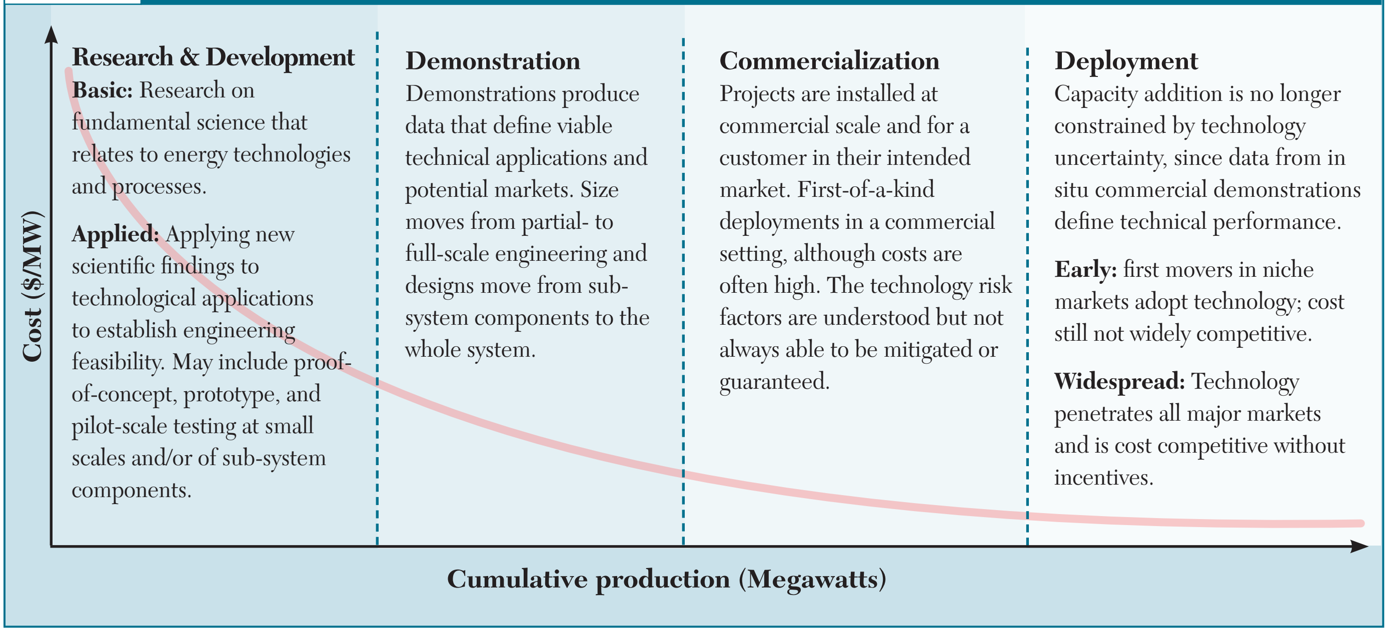
Basic R&D is the laboratory research on fundamental science pertinent to energy, including fields such as materials science, physics, chemistry, and computational research.[5] Since basic research is far removed from a potential commercial product and may never yield a profit, the private sector faces the highest risk with these investments. Therefore, the U.S. Government has traditionally played a substantial role in driving investment through cost share programs in this phase. Typically, 80 percent of the funding is public and only 20 percent is private.[6]

Applied R&D occurs when new scientific findings are incorporated into technological applications to establish engineering feasibility. This stage includes proof-of-concept, prototype, and pilot-scale testing at small scales and/or of sub-system components. Like basic R&D, the main barrier is the uncertainty of eventually creating profitable technology, and so private sector capital tends to be limited. Therefore, the U.S. Government has traditionally continued cost sharing at this stage at an 80:20 public to private financing ratio.

Demonstration projects can range from partial- to full-scale engineering of the technology and generate data on its viable technical applications and potential markets. In the demonstration phase, piloting moves from testing system components to whole system demonstrations. It is difficult to obtain affordable financing at this stage due to high risk and uncertainty about eventual market size. Therefore, these projects frequently require public funding, with a cost share of 50:50 (public versus private funding) fairly standard in the United States.[7]

Commercialization occurs when full size installations are made for a customer in their intended market. These "first-of-a-kind" deployments have relatively high costs since manufacturing has not reached a large scale. Technology risk is better understood but guarantees or warranties may not be available, so financing is scarce and expensive. Capital is needed so that companies can show customers that their product performs, line up a sales pipeline, and scale up manufacturing.

Figure 1 The Learning Curve and the Technology Innovation Chain[8]



Research & Development

Basic: Research on fundamental science that relates to energy technologies and processes.

Applied: Applying new scientific findings to technological applications to establish engineering feasibility. May include proof-of-concept, prototype, and pilot-scale testing at small scales and/or of sub-system components.

Demonstration

Demonstrations produce data that define viable technical applications and potential markets. Size moves from partial- to full-scale engineering and designs move from sub-system components to the whole system.

Commercialization

Projects are installed at commercial scale and for a customer in their intended market. First-of-a-kind deployments in a commercial setting, although costs are often high. The technology risk factors are understood but not always able to be mitigated or guaranteed.

Deployment

Capacity addition is no longer constrained by technology uncertainty, since data from in situ commercial demonstrations define technical performance.

Early: first movers in niche markets adopt technology; cost still not widely competitive.

Widespread: Technology penetrates all major markets and is cost competitive without incentives.

Early deployment begins when sales are no longer constrained by technology uncertainty, because data from commercial demonstrations have clearly defined technical performance. Costs at this point are not yet competitive in all markets.

Widespread deployment refers to the stage when a technology has penetrated all of its major markets and is not reliant on incentives to compete on a level playing field with "incumbent" technologies. Not all technologies will progress through the entire innovation chain to reach widespread deployment. In fact, many fail before they reach this stage.

The following sections of this paper explore the suitability or "fit" of specific renewable energy policies at each stage of the innovation chain. By targeting policies to address barriers that are common at each stage, government support can have more success moving a technology toward widespread deployment.

II. GRANTS

Policy Basics

Grants are the direct provision of government revenue to a research program or specific project. This public funding can be directed to research at universities, national laboratories, or private entities to help drive high-risk investments that would not otherwise happen. Grants are typically awarded after an open and competitive public process to encourage innovation and efficiency.

Best-Fit Applications

Renewable energy technology concepts in the Basic R&D and Applied R&D stages often have serious technical limitations to their "real-world" application that need to be resolved before the technology can even be piloted. Investments in individual R&D projects are high risk and the private sector's appetite to invest in them is limited because the potential commercial value is uncertain. For this reason, public research funding through grants is crucial at this early stage of the innovation chain, even if it leverages only minimal extra private investment. Historically, the cost share for R&D grants between government and the private sector has been about 80:20.[9]

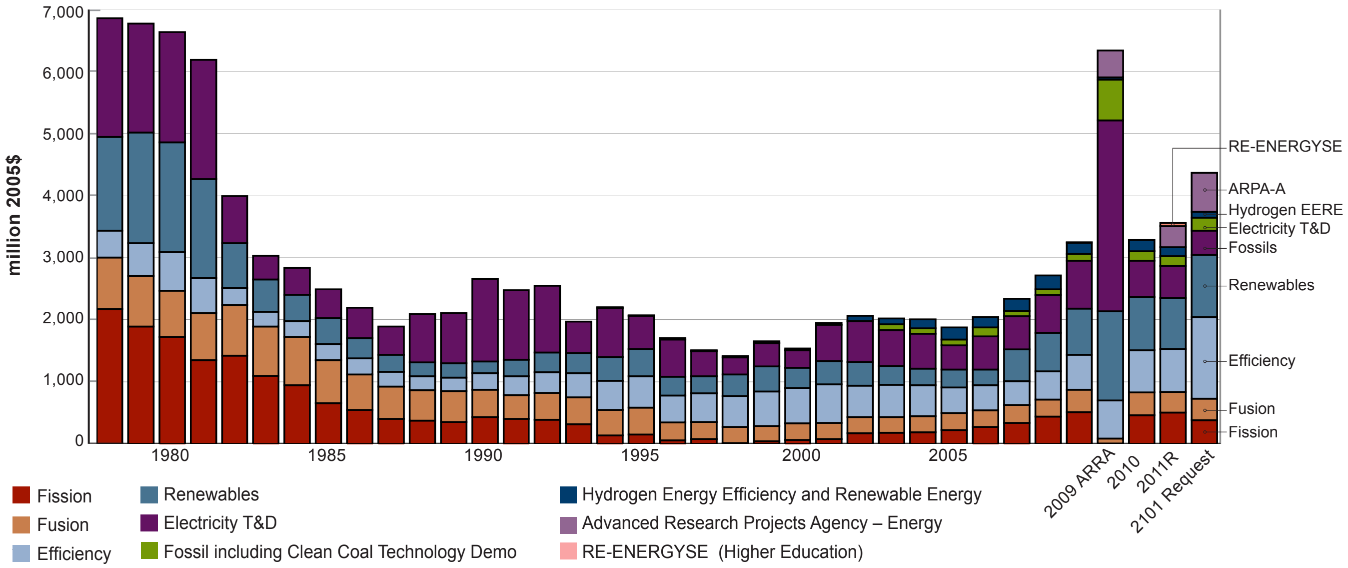
Grants can also be helpful in the demonstration stage. This is when technologies face the proverbial "valley of death" where successfully piloted technologies are especially likely to fail because they are starved for commercial investment.[10] High costs and performance uncertainty may make it difficult for projects to obtain private sector financing. Therefore, demonstration grants are awarded to individual projects to help prove the technology's viability and gather data on its performance characteristics. This data is useful in defining a market for the technology and attracting venture capital investors.

For demonstration grant programs to be most effective, they should ensure that application turnaround times are short and fees for applying do not include high fixed charges, since when fixed fees become a high percentage of the loan amount it prevents smaller, innovative projects from applying. The Massachusetts Commonwealth renewable energy grant program provides a good example of a program with regular outreach and clear procedures, in which the timelines for selection are communicated upfront and competitive applications are selected relatively quickly (two to three months for some technologies).[11]

In the United States, RD&D (research, development, and demonstration) grant programs for renewable energy technologies exist at the federal, state, and local levels. According to the International Energy Agency, the United States was the world leader in renewable energy R&D investment from 1990 to 2006 (in total dollars spent), even though renewable energy R&D spending represented a relatively small percentage of its Gross Domestic Product (GDP; about 0.002 percent).[12] U.S. funding for energy RD&D was increased substantially by the American Recovery and Reinvestment Act (ARRA), almost reaching the peak funding levels of the late 1970s. However, this was a one-time allocation made in 2009 to be disbursed over three years, and regular congressional funding was subsequently reduced in 2010 and in the budget requests for 2011 and 2012 (see Figure 2). The budget request for Fiscal Year (FY) 2011 is approximately two thirds of what the United States invested in 1980, according to data from Harvard University's Belfer Center for Science and International Affairs.[13] Analysis by experts Daniel Kammen and Gregory Nemet shows that the decline in R&D funding since then has been accompanied by a decrease in the number of energy patents granted.[14] Their research finds that for the United States to develop the zero-emissions energy technologies needed to both meet future energy needs and to stabilize carbon dioxide emissions at 560 parts per million, annual federal energy R&D spending would need to be increased five- to ten-fold above 2005 levels.[15]

It may be appropriate to close some of the gap for renewables by reallocating funding among energy types. Fossil fuel technologies that are already relatively mature[16] have demonstrated slower improvements in cost of generation per kilowatt-hour (kWh) as a result of R&D investments, yet they still receive a significant amount of R&D funding. For example,

Figure 2 U.S. Department of Energy (DOE) Energy RD&D Spending (1978 through 2012 budget request)



Source: Gallagher, K.S., and L.D. Anadon, 2011, "DOE Budget Authority for Energy Research, Development, and Demonstration Database," Energy Technology Innovation Policy, John F. Kennedy School of Government, Harvard University, March 3. 2009 ARRA denotes funding appropriated by the American Recovery and Reinvestment Act passed in 2009.

coal R&D (not including carbon capture and sequestration, or CCS) was allocated $231 million in the FY2011 budget request. Some research suggests that R&D investments in more mature fossil fuel technologies have not yielded the same performance improvements (as measured by cost reduction) as other renewable energy technologies despite high historic R&D spending. By contrast, in terms of technology improvement per dollar of R&D investment spent, wind and geothermal energy have shown large performance gains.[17] This suggests that renewable energy technologies are underfunded relative to their expected superior payoff in technical progress and cost savings.[18]

III. LOAN GUARANTEES

Policy Basics

Early-stage renewable energy technologies are often perceived as risky by investors and/or lenders because of technology performance risk and the fact that at times start-up companies do not have strong balance sheets against which they can offer guarantees. This typically results in a premium on loans for a given renewable project. Government agencies with good credit can help reduce this risk premium by offering a loan guarantee. In doing so, the agency agrees to assume all or part of the risk associated with project underperformance. This reduces the repayment risk borne by the bank, thus allowing the bank to provide financing to allow the project to move forward. The loan guarantee can also allow the bank to provide longer loan terms than it might otherwise be comfortable with (up to the useful life of the assets being financed), resulting in lower monthly payments for the developer.

One strength of loan guarantee programs is that by removing some risk they can encourage commercial financing of new, potentially transformative technologies that may otherwise be too risky for commercial investors. However, if these loan guarantee programs have transaction costs that include fixed fees, then smaller projects—which could benefit most from the program—may be dissuaded from applying.

The Department of Energy's (DOE's) Loan Guarantee Program, authorized by the Energy Policy Act of 2005, was established to provide loan guarantees to qualified renewable energy projects in the early stages of commercialization. However, under the American Reinvestment and Recovery Act, the DOE can also make loan guarantees for technologies that are commercially proven but still need financing support. ARRA allocated an additional $4 billion dollars to the program.[19] Despite this influx of funding, the combination of high transaction costs (up to 1 percent of the loan) and fixed fees has dissuaded some smaller projects from applying, since the fixed fee can become a large percentage of the loan value. The DOE Loan

Guarantee Program has issued seven solicitations since 2006 and, as of a 2010 report, has committed only one quarter of the funding.[20] The Government Accountability Office (GAO) has found that developers of larger projects with proven technologies such as nuclear energy face a less cumbersome application process compared to emerging renewable technologies. The administration of these programs, therefore, can impact the mix of technologies that receive the most support.[21]

Loan guarantee programs will be most effective if the application process is straightforward, timely, and transparent, and if they incorporate regular outreach to potential applicants, as new companies are regularly entering the market and may not be aware of these opportunities. Programs with confusing application processes and delayed payments will discourage participation from innovative emerging companies that could bring new technology solutions to market.

Best-Fit Applications

Loan guarantee programs can be most effective at supporting technologies in the commercialization stage, as these programs provide a risk-sharing mechanism that attracts mainstream investors and can provide risk sharing that allows financial institutions to become familiar with innovative technologies more quickly.

IV. TAX CREDITS

Policy Basics

Tax credits have been the predominant tool the U.S. Federal Government has used to deploy renewable energy technologies.[22] Tax credits improve a project's financial position and can drive additional deployment of a technology if the credit is large enough to make it cost competitive. By reducing the price that a project must charge in order to remunerate investors, tax credits can also make it cheaper for utilities to comply with other renewable mandates, such as state renewable electricity standards.

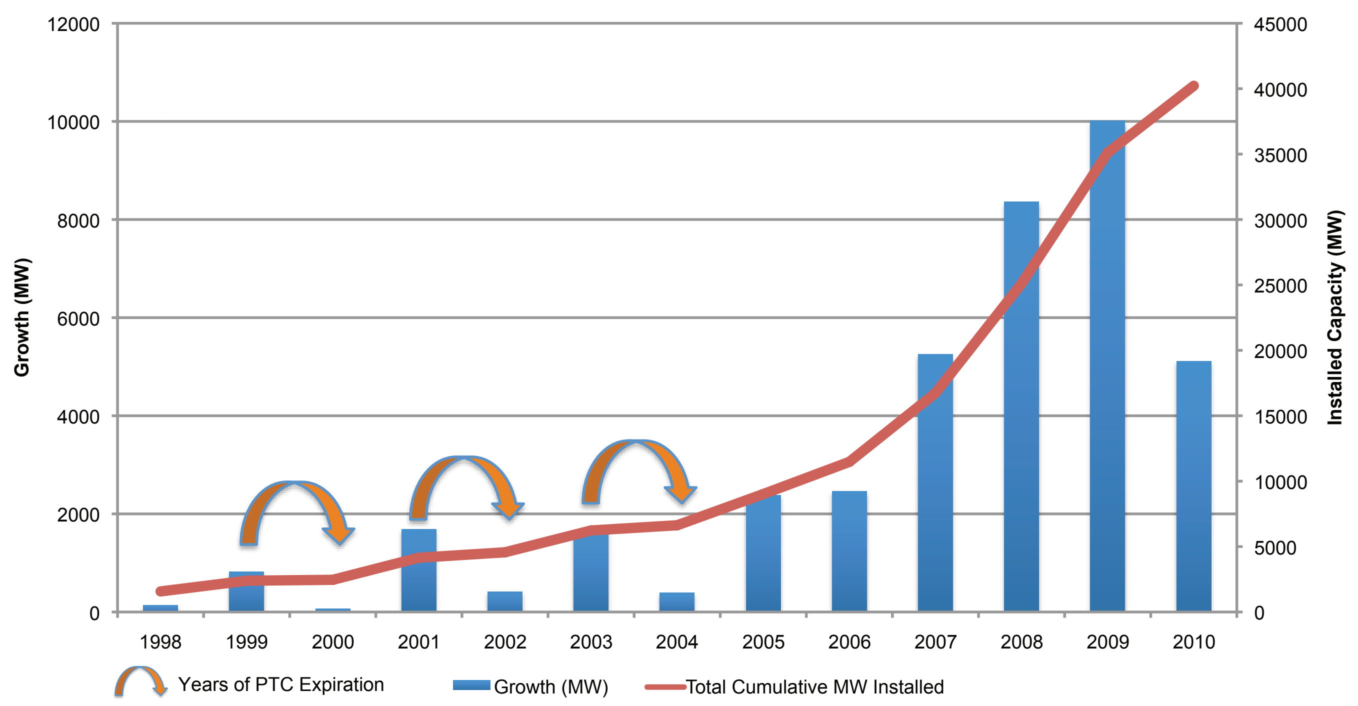
In the United States, federal tax credits have taken two main forms: the investment tax credit (ITC) and the production tax credit (PTC).[23] The ITC reduces federal income taxes for qualified tax-paying owners of renewable energy projects based on the capital investment in a project and what is earned during the first year the plant is placed into service. The ITC works best for projects that require high upfront capital investments. In contrast, the PTC is linked to production: each kilowatt-hour of energy fed into the grid by an eligible facility reduces federal income tax liability. This makes the PTC effective for technologies with lower upfront investment costs and predictable electric output over their lifetime.

At this time, the PTC is provided as a non-refundable tax credit, and thus can only be used to reduce tax obligations but not to receive revenue directly from the federal government in the form of a tax refund. Therefore, for the PTC to provide its full financial benefit, the entity using it must have sufficient tax obligations. For example, a company building a new wind farm might have low tax obligations in the project's early stages, as the project has high investment costs (which are typically deducted from revenue) and no income from the project until it is completed. In the United States, many project developers do not have sufficient tax obligations to take advantage of the ITC or PTC.[24]

To address this issue, U.S. federal tax credits can be allocated by the project developer to other investors that have sufficient tax appetite if those entities take an equity stake in the project. These "tax equity" investors have typically been large investment banks. However, this pattern of investment ultimately pins the success of the renewable energy industry on the tax appetite of external investors. There are 14 financial institutions that provide renewable energy tax equity in the United States, and their supply of tax equity is only about half of what is needed to fund renewable energy investment at 2009 levels.[25] This means that new renewable projects will have greatly diminished capacity to realize the financial benefits of the tax credits unless new players enter the market that have significant tax appetite. Structuring ownership and investment in projects to efficiently use tax credits is complicated and can involve high transaction costs from legal fees. Making the ITC and PTC refundable tax credits would avoid the need to involve institutions that would not otherwise be part of project development, such as large investment banks. This could simplify the process, reduce transaction costs from legal fees, and thus would maximize the financial incentive provided for renewable development.

While periodic reevaluation can be beneficial, volatility in the availability of tax credits is problematic and in the United States has resulted in significant volatility in the installation of wind projects. As Figure 3 demonstrates, when the federal PTC was allowed to expire in 2000, 2002, and 2004, annual installation of U.S. wind capacity decreased by 93 percent, 73 percent, and 77 percent, respectively.[26] The PTC is set to expire again for wind power by 2012 and for other renewable technologies by 2013. The ITC will expire at the end of 2016.[27] The lack of certainty over the tax credits for renewable technologies could make it

Figure 3 Production Tax Credit Renewals and U.S. Wind Installation



Source: World Resources Institute based on American Wind Energy Association (AWEA) data.

less likely that component manufacturers will locate themselves in the volatile U.S. market and create domestic jobs.[28]

Best-Fit Applications

Tax credits provide financial assistance for installing new renewable electricity generation, making them most effective at promoting renewable technologies that are in the commercialization or early deployment stages. They are less effective than loan guarantees in the demonstration phase, as the high perception of risk in this stage makes it difficult for project developers to access the needed capital. Tax credits can be removed once a technology reaches the late stages of deployment, when it is cost competitive without incentives. The ITC works best for projects that require high upfront capital investments. In contrast, the PTC is most effective for technologies with lower upfront investment costs and predictable electric output over their lifetime.

V. FEED-IN TARIFF

Policy Basics

In order to obtain financing, renewable energy projects try to secure a long-term buyer for their electricity at a price that yields a reasonable return on the upfront capital investment. A FIT requires utilities to purchase power from renewable energy producers at fixed rates, typically set above the prevailing market price for conventional power generation. FITs generally offer stable, long-term contracts (usually from 15 to 20 years) to renewable energy facility owners and require the utility to interconnect the plant to the grid. The benefit of this policy from the investor perspective is that it locks in revenue certainty and reduces risk, which correspondingly lowers the loan interest rate (i.e., the cost of capital).[29] FIT levels are set by regulatory agencies at the city, state, or federal level based on the cost of generation (in dollars per megawatt-hour) and differentiated by renewable energy technology type, and sometimes also by region, system size, or feedstock.

Best-Fit Applications

Because FITs can be set at any level of price support, they are useful for technologies in the commercialization and early deployment stages. At these stages technologies are proven technically and thus do not have significant performance risk. They do, however, have higher costs and/or development risks than alternatives and can be deployed faster with a well-structured feed-in tariff that covers their incremental cost. The policy of choice of the European Union has generally been feed-in tariffs, with Germany and Spain, in particular, using the FIT model to become the top two countries globally for installed megawatts (MW) of solar power. In 2010, Germany and Spain had cumulative installed solar capacities of about 16,000 MW and 4,000 MW respectively.[30]

The experience in Europe suggests that FITs are effective at lowering commercialization risks, capital constraints, and interconnection barriers.[31] By increasing deployment, they also promote "learning-by-doing" that moves technologies farther along the innovation chain. Project developers profit from the difference between the payment rate and generation cost, so FITs can provide an incentive to improve efficiency and thereby encourage such learning.[32] However, they can also create windfall profits by paying more than the actual investment cost for a project and can be expensive policies if the prices are set high. A comparative study of European wind policies found that, all else held equal, a high feed-in tariff led to higher capital equipment costs, which suggests that equipment suppliers raise their prices when given the chance.[33] The authors of this study [34] comment that feed-in tariffs are useful for new technologies to encourage learning and cost reductions, but that they can reduce competition and encourage more expensive projects. They note that "this effect is likely to be more destructive for relatively mature technologies (i.e., technologies with high diffusion levels) such as wind power."

Box 1 State and Local Feed-In Tariffs in the United States

U.S. experience with feed-in tariffs has occurred at the state and local levels. These early state and local programs offer lessons that could be applied to other interested states, or to any future national program:

- Vermont's feed-in tariff program took effect in May 2009. The program was capped once 50 megawatts (MW) were contracted, and provides between $0.14–0.20 per kilowatt-hour (kWh) for wind and $0.30/kWh for solar for 20 years.[35]
- At the local level, Gainesville Regional Utilities in Florida instituted a FIT in March 2009. The program initially provided $0.32/kWh for solar projects over a 20-year period with an annual cap of 4 MW through 2016.[36] Gainesville ratepayers were expected to receive an increase of $0.75 on their monthly bills as a result of the FIT program.[37]
- Sacramento Municipal Utility District approved a feed-in tariff in July 2009 allowing homeowners to sign up for between 10 and 20 years of fixed payments for solar generation, provided they are smaller than 5 MW and do not already participate in a net metering program.[38] The incentive is no longer available, but was extremely well—subscribed when it was. The program rates depended upon the time of day at which the power is generated and range from $0.05 to $0.30/kWh.[39]

One challenge to using FITs in the United States is that they need to be structured carefully to avoid conflict with federal legislation governing energy markets.[40] The sale from a renewable energy generator to a retail utility is a wholesale transaction which triggers regulation by either the Public Utility Regulatory Policies Act of 1978 (PURPA) or the Federal Power Act of 1935 (FPA). Hempling and colleagues at the National Renewable Energy Laboratory explain in detail how "each of these statutes… limit[s] the discretion of state-level tariff designers."[41] The Federal Power Act gives the Federal Energy Regulatory Commission (FERC) jurisdiction over wholesale power contracts and prohibits states from forcing utilities to buy power at the "state-set" price, so currently the only legal route for such contracts is through PURPA. PURPA allows standard offer contracts (which are essentially feed-in tariffs), but only if the prices are not set above the utilities' "avoided cost" (that is, what the utilities would have paid if not buying from a specific renewable project).[42]

The crux of the issue is thus the calculation of "avoided cost," which has historically been interpreted as the cost of a new natural gas plant. This has made PURPA fairly unhelpful to fund the incremental cost of renewable energy, because it can be more expensive than natural gas. However, FERC has clarified its position in recent rulings by stating that if a state has a renewable energy procurement requirement that the avoided cost must be calculated for a resource relevant to that requirement (i.e., not simply natural gas).[43] That option notwithstanding, Hempling et al. outlines three ways in which states could implement supplemental payments to be made on top of the avoided cost, if the avoided cost were set lower than the price of renewables. This would make the payment functionally equivalent to a standard-offer feed-in tariff.[44] In short, there is a way forward for FITs in the United States, but they require careful design to avoid violating jurisdictional issues and creating windfall profits for technologies in early deployment.[45]

It is no coincidence that two of the examples above were implemented by municipal utilities, which "are not subject to the FPA and therefore do not require any additional contract approval from the Federal Energy Regulatory Commission (FERC)."[46] In the case of Vermont, the legality of the law was questioned by the executive branch of the government but was found to be legal by the Vermont Public Service Board (PSB), Vermont's highest regulatory authority, which ruled that it will not seek clarification from FERC on the issue because it deemed the program valid. FERC has already ruled that it will not void a PURPA contract unless such a contract is challenged by the state's rate-setting process.[47]

This suggests that in the early deployment phase, a FIT should be transitioned out and/or adjusted frequently to ensure that the price reflects what the market needs and that pricing is competitive. A FIT is not as well suited for technologies before the commercialization phase since it would be difficult to determine the correct price to award for very new technologies; in this case spending on demonstrations is likely a better investment in the technology's eventual commercial viability.

Spain serves as an illustration of the need to set feed-in tariff levels carefully and of the potentially large costs of an uncapped program (i.e., a standard offer for which all projects that apply are guaranteed the same tariff). In 2007 it offered a tariff of €0.44/kWh to new solar installations and had an overwhelming response. It then retroactively repealed its standard offer to avoid paying subsidies which were estimated on the order of €26 billion over the lifetime of solar plants.[48]

Two measures are commonly used to reduce total program costs and avoid windfall profits with FITs. Feed-in tariff levels for new contracts should be periodically updated as technology costs decline on a transparent schedule. Second, total program capacity (MW) can be capped to limit the total cost within predictable limits. Typically FITs are set based on a calculation of the average cost of generation, including a reasonable rate of return. Making this calculation accurately is a difficult task and is particularly challenging when the cost of technology changes rapidly.[49] In Section VII we discuss the Renewable Auction Mechanism, which uses an auction to determine the appropriate price levels.

VI. RENEWABLE ELECTRICITY STANDARD

Policy Basics

A renewable electricity standard (RES), also called a renewable portfolio standard (RPS), is a regulatory tool that requires electricity suppliers to obtain a minimum percentage of their power from eligible renewable energy sources by a certain date. It is then incumbent on the electricity supplier to determine how to obtain the necessary supply of renewable energy at the lowest possible cost. In this way, the market determines the incremental cost of renewable deployment. In recent years, the RES has been the policy of choice in the United States. Twenty-nine states have binding renewable electricity standards, and six have non-binding RES goals.[50] Approximately 61 percent of new, non-hydro renewable energy capacity installed in the United States between 1998 and 2009 was installed in states with "active or impending" RES compliance obligations. To date wind has dominated, representing 94 percent of total capacity installed, with biomass, solar, and geothermal energies accounting for the other 6 percent.[51]

Box 2 The Evolution of New Jersey's Solar Renewable Energy Certificate (SREC) Program

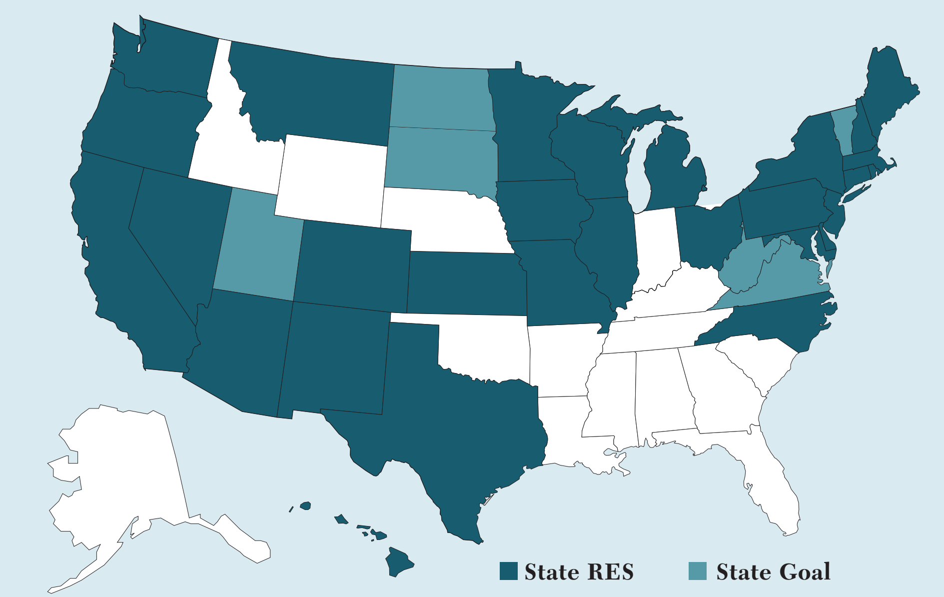
The New Jersey renewable energy standard, first enacted in 2003, includes a solar-specific requirement ("carve-out") that has propelled the state to second place in the nation for megawatts (MW) of solar power installed. The solar carve-out was recently amended and now requires "2,518 gigawatt-hours (GWh) from in-state solar electric generators during 2021, and 5,316 GWh by 2026 and each year thereafter."[52]

New Jersey provides a case study of policy evolution to try make solar photovoltaics (PV) financeable and to meet its solar carve-out requirement without incurring unreasonable costs on ratepayers. Originally, the solar incentive in New Jersey that strongly drove the majority of installations was the rebate from the Customer On-Site Renewable Energy (CORE) program, but this program was so successful that it ran into budget problems in 2006. The state decided to explore how to continue to incentivize PV development without further taxing the state's budget. In 2007 the New Jersey Board of Public Utilities (BPU) announced that SRECs would become the main incentive, and raised the alternate compliance payment (ACP) SRECs, making them more valuable by raising the price ceiling to $711.[53] However, because New Jersey utilities only have a three-year procurement cycle, they still had little certainty of their future SREC demand and did not offer long-term renewable energy credit (REC) contracts. Future SREC values were not known, nor "bankable," and this slowed solar deployment in New Jersey dramatically.

Recognizing, that their policy adjustment was still not adequate to address financing barriers, and that the state would be short of its solar compliance targets, the BPU modified its policy in 2008. It required that the state's large electricity distribution companies forward-procure SRECs for the years 2009–2011 (specifically, 60 percent of the new PV capacity called for by the RES in 2009, 50 percent of the same in 2010, and 40 percent in 2011).[54] The financing was to be provided through long-term contracts for SRECs at prices that would give system owners a payback period of about 10 years.[55] This has provided a strong incentive for solar deployment for the projects that were able to secure contracts with the distribution companies and has alleviated the financing barrier somewhat. SRECs traded between $600 and $700 over the first half of 2010, and New Jersey had installed 128 MW of solar capacity by the end of 2009.[56]

RES policies are "market mechanisms," but the New Jersey case illustrates that careful design must ensure that they work within existing financial markets and provide a bankable incentive. In this case, long-term procurement requirements have provided a limited solution, but they are currently only required through 2011.

Figure 4 Renewable Electricity Standards in the United States



Source: World Resources Institute.

Projections of utility purchases to meet their obligations in the West show that this balance is shifting as solar technologies become more cost competitive in utility solicitations.

An RES drives investment in the lowest-cost eligible renewable projects in both restructured and rate-regulated markets. In restructured electricity markets, where the market determines electricity rates and consumers can choose among several electric providers, utilities have a natural incentive to procure the lowest-cost renewable power because increased costs can reduce market share. In rate-regulated markets, however, public utility commissions determine what costs can be passed on to consumers, and thus play an important role in driving utilities to pursue the most cost effective renewable energy projects. In both restructured and rate-regulated markets, public requests for proposals can be used to increase transparency and competitiveness of renewable power procurement by utilities.

In some states, compliance flexibility is enhanced by decoupling the electricity from the renewable attributes of the electricity. This creates tradable renewable energy credits (RECs) for each megawatt-hour (MWh) of electricity generated by renewable sources that meet defined eligibility criteria. These RECs can be bought and sold independent of the electricity generated by the renewable project so long as at the end of the year each utility holds sufficient RECs to meet their renewable electricity standard. Decoupling the renewable attributes of the power from the electricity generated allows for enhanced geographic flexibility, since projects do not need to feed into the utility's distribution area. A broader geographic scope increases the opportunities for seeking out the lowest-cost renewable opportunities, which in turn allows greater deployment at lower costs. However, this flexibility has tradeoffs since it can lead to payments from the RES implementing state to projects in other states. Therefore, some states that have implemented tradable REC programs include geographic constraints.

Market liquidity for RECs is improved by making them tradable, and several trading platforms exist that sell RECs from projects of all sizes. This can also make it easier for smaller renewable energy projects to sell their RECs, since they do not have to contract with utilities to sell the power and can instead list them on exchanges, once they are certified with the appropriate registry. Utilities can bundle RECs from a portfolio of projects, even where they do not off-take the power.

Best-Fit Applications

Renewable electricity standards provide more demand for renewable projects, which can help to overcome financing barriers that would otherwise hinder them. An RES is much less effective for technologies that are still in the demonstration stage, or earlier, due to high cost and performance uncertainties. An RES allows technologies to compete for deployment, and thus effectively promotes deployment of the most mature renewable energy technologies with the lowest incremental cost of generation. RES programs can also be used to promote specific technologies that are not yet cost competitive with other renewable technologies through the use of a "carve-out," which establishes technology-specific deployment standards.

As a technology progresses along the innovation chain, the cost of deploying it will decrease, and thus the reimbursement provided through the RES program will decrease and eventually fall to zero (or nearly zero) when the technology is cost competitive without incentives. This feature can make it appealing to policymakers for rapidly advancing technologies, as there is natural protection against financial risk of overpaying should the policy be left in place too long.

Policymakers who seek to use an RES to support commercialization-stage and early-stage deployment technologies should consider the important role of technology carve-outs and long-term contracts in sound policy design. Less mature technologies will experience more rapid cost reductions as they mature; if this leads to corresponding reductions in REC prices it would create a reduction in compensation for projects over time. This can increase the risk of investment for the early movers in the system and increase the premiums for the financing of these projects. To address this issue, project developers prefer to enter into long-term contracts with utilities that guarantee a set price for RECs for the life of the project (see Box 2).

VII. RENEWABLE AUCTION MECHANISM

Policy Basics

The Renewable Auction Mechanism (RAM) is a new renewable energy procurement mechanism being spearheaded by California that has elements of an RES and a FIT. Similar to an RES, the RAM requires electricity suppliers to obtain a minimum percentage of their power from eligible renewable energy sources by a certain date.[57] Under the RAM, periodic auctions are held during which potential projects may submit bids to supply renewable power. The lowest cost projects are selected until the renewable goal is met. Selected projects receive compensation ($/MWh) equal to their actual bid price annually for the duration of the contracts. This differential pricing is intended to help prevent windfall profits.

Similar to a FIT, contracts awarded via the RAM guarantee revenue for a fixed period of time (generally in the 10 to 20 year timeframe), which helps provides financial certainty for the project. Similar to a FIT, the RAM also standardizes the contractual terms for each project.[58] This can aid the deployment of small-scale projects by reducing the administrative burden and allowing all projects to compete equally. While the RAM can be targeted to a wide range of project types, the California RAM is designed to encourage small-scale renewable projects and thus is restricted to projects that generate no more than 20 MW.

Best-Fit Applications

The RAM provides demand for new renewable energy projects, which overcomes financial barriers that would otherwise exist. Like the RES, the RAM is most effective once a technology has progressed to a stage where its risks are better understood, or when it has reached the commercialization stage (or later). If a RAM is left in place, the cost of meeting its procurement mandate will decrease over time and eventually fall to zero (or nearly zero) when the technology reaches late-stage deployment and is cost competitive without any incentives. This feature makes it appealing for rapidly advancing technologies, as there is no financial risk incurred by leaving it in place too long.

VIII. FAVORABLE REGULATORY ENVIRONMENT

Policy Basics

The financial and market-creation incentives described previously will be less effective if there is an unfavorable regulatory environment governing the target market for a technology. Renewable projects face a number of barriers not experienced by more traditional power generators, such as unfavorable interconnection and net metering policies, complex utility tariff structures, disproportionate backup penalties, and legal restrictions on some new business models designed to promote renewables. Some of these barriers are described below.

INTERCONNECTION AND BUY-BACK POLICIES

Unfavorable interconnection standards can make it difficult or impossible for distributed generation to connect to the grid. Some independent system operators do not allow the connection of all but the smallest distributed generation projects to the grid. Additionally, nearly half of states do not allow end users that build onsite projects to sell excess power back to the grid.[59] Onsite, distributed generation projects (as opposed to large utility projects), such as wind and solar, can result in a mismatch between the power generation and consumption of a facility.[60] Thus, failure to provide compensation for the excess power generated during peak generation times significantly increases the cost of distributed generation projects. Compensation is most commonly provided by net metering policies, whereby the utility agrees to buy back excess power from distributed energy projects at a predetermined price from the end user. The American Council on Renewable Energy (ACORE) cites Oregon as a good example of best-practice interconnection and net metering standards.[61]

PRICING POLICY

A barrier to scaling-up use of onsite renewables is the wide variation in rate structures across service territories and the lack of a common format for reporting these tariffs to consumers. This adds to the transaction costs of doing site assessments to identify facilities that would be good candidates for onsite renewable energy projects. These increased transaction costs can reduce private investment in renewables. One solution to this problem is to create a standard reporting format for rate tariffs that companies can easily use to compare rate structures across service territories and more easily identify where onsite renewables might have the most impact on energy costs.

An additional pricing barrier is what is sometimes referred to as a "load retention rate." In this case, a utility will offer a discounted rate to a customer who is considering an onsite energy project. This reduced rate makes the economics of the onsite project unattractive and the project is dropped from consideration. These pricing strategies have been observed by a number of the World Resources Institute's (WRI's) corporate partners, and can be a huge deterrent for renewable energy projects. To avoid these circumstances, regulators should ensure that pricing policy is transparent and consistently applied.

DISPROPORTIONATE PENALTIES FOR ONSITE GENERATORS

Onsite clean and renewable energy sources often face high backup or standby charges, which are used to ensure that grid reliability is maintained should the distributed generation unit need to be taken offline for maintenance during peak times. While renewable energy sources are variable, they are not necessarily unreliable so long as proper forecasting and grid planning is employed. Special attention should be paid to how these fees are set and how the rate structure is impacting the market for onsite projects. As of December 2008, only New York, California, and Massachusetts had implemented standby rates that valued onsite generation.[62]

REGULATORY FRAMEWORK THAT SUPPORTS THIRD-PARTY POWER PURCHASE AGREEMENTS

A recent development in the financing of onsite solar projects is the third-party power purchase agreement (PPA). Under this agreement, a third party (i.e., someone other than the property owner or utility) owns the system and recoups its cost by charging the host customer for each kWh generated. Solar PPAs have increased widely in popularity because they provide an attractive financing model for customers to buy solar. However, several states have passed legislation that make this model require that a solar installer, who retains ownership of the panels, be registered as a regulated utility, which may be burdensome and unnecessary. This can add such a high barrier to market entry that many potential solar projects are not implemented. Third-party PPAs are restricted by legal barriers in Florida, Georgia, and North Carolina, and are restricted to only some sectors in Utah and Arizona.[63] Other states without such restrictions have seen the market for solar PPAs grow significantly. Regulators should track whether their regulatory framework is allowing deployment of effective business models that can increase use of renewables in a safe and cost effective way.

Best-Fit Applications

Pricing policy, interconnection and net metering, and regulations that stifle third-party power purchase agreements can have a large impact on the deployment of renewable energy technologies, increasing cost and reducing the impact of support mechanisms. The policies outlined above are most significant for technologies in the demonstration stage and beyond. However, a particularly poor regulatory environment can—to a lesser extent—even affect initial investments at the R&D stage.

IX. Designing the Right Mix: Conclusions and Recommendations

Rapid deployment of renewable energy to meet our security, environmental, and economic needs will require a portfolio of technologies and policies designed to support those technologies. Designing policy support mechanisms to help push renewable energy technologies forward in the commercialization cycle can yield faster uptake and more affordable technology. In addition to the standard principles of sound policy implementation—stability, transparency, and ease of use—policymakers should consider this "right fit" approach when seeking ways to scale up the use of particular resources available in their regions. After considering the strengths and weaknesses of each policy option, along with evidence from past experiences, the policy options are described in this paper in accordance with their "fit" for specific stages of the innovation chain.

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Appendix 1

Summary Table of Policy Applicability Best Practices

Policy	Stage	Best Practices
Grants	R&D, Demonstration	• Projects should be competitively awarded based on technical merit and evaluated by a panel of independent experts in the field • Pilot projects should be funded as public-private partnerships, requiring at least 20% cost share for applied R&D and 50% for demonstrations (larger cost share from industry is desirable) • Conduct regular outreach to potential applicants to make sure potential beneficiaries are aware of the program and know how to apply • Maintain clear application procedures with a timely selection process for competitive applications
Loan Guarantee	Commercialization, Early Deployment	• Keep fixed transaction costs low, so as to not discourage applications from developers of smaller projects with breakthrough technologies • Conduct regular outreach to potential applicants to make sure potential beneficiaries are aware of the program and know how to apply • Maintain clear application procedures with a timely selection process for competitive applications
Tax Credits	Demonstration, Commercialization, Early Deployment	• Roles of administration should give confidence that the project will see the full value of credit after qualifying • Credits should not be subject to frequent expiration • Credit value should be high enough to drive additional investment, but not so high as to provide windfall profits to investors • Target tax credits based on cost of equipment for technologies that have major upfront capital investments • Target production-based credits to technologies with lower upfront investment costs and predictable electricity output • Make tax credits refundable to avoid complex financial arrangements
Feed-In Tariff (FIT)	Commercialization, Early Deployment	• Standard contracts should be for 15–25 years to provide investment security and allow for affordable financing • Tariff levels should be set carefully and be specific to unique technology needs, based on industry consultation and detailed analyses of development cost (including a reasonable rate of return) • Tariffs should increase to cover inflation, but should decrease for new projects each year on a predeter¬mined and transparent schedule • Ideally, a feed-in tariff should be linked to an overall megawatt (MW) goal for deployment of a technology • FITs are more effective with “must-take” provisions wherein the utility must buy power whenever generated by the renewable facility • Standard interconnection agreements should be made available for projects in a FIT program
Renewable Electricity Standard (RES)	Commercialization, Early Deployment	• Planning stage with strong stakeholder participation to clarify goals of the program and model expected impacts and achievable market penetration prior to setting targets • If the goal is to support technologies in earlier stages (i.e., commercialization) a separate carve-out for those technologies may be required • Compliance through tradable renewable energy credits (RECs) adds efficiency to an RES • Long-term contracts for RECs are most useful to help incentivize projects. In restructured power markets where most power purchases are made for short terms, long-term REC contracts can be incentivized or required by the RES or public utility commission (PUC)
Renewable Auction Mechanism (RAM)	Commercialization, Early Deployment	• Auction should be administered transparently • For other best practices, see FIT and RES
Regulatory Reforms	All stages	• Develop interconnection standards that provide consistency across technologies and strive to harmonize standards across regions • Interconnection should have a clear application process with a quick turnaround and be consistent across a range of technologies • Ensure pricing policy is transparent and does not inherently penalize onsite generation • Develop a regulatory framework that can be updated to allow for innovation in business models to reduce cost of deploying renewables

Source: Gallagher, K.S., and L.D. Anadon, 2011, “DOE Budget Authority for Energy Research, Development, and Demonstration Database,” Energy Technology Innovation Policy, John F. Kennedy School of Government, Harvard University, March 3.

Endnotes and Citations

1 Renewable energy provides 10.4 percent of total electricity generation in the United States. This number falls to 3.6 percent if large hydropower is excluded (2009 data from Energy Information Administration, (2011), *Electric Power Industry 2009: Year in Review.* Retrieved April 12, 2011, from Electric Power Annual: http://www.eia.gov/cneaf/electricity/epa/epa_sum.html.

2 WRI's Electricity Governance Initiative is an excellent and more exhaustive resource for materials on this subject: http://www.wri.org/project/electricity-governance.

3 Foxon, T., (2005), *UK innovation systems for new and renewable energy technologies: drivers, barriers and systems failures*, Energy Policy 33: 2123–2137.

4 Definitions of stages in the technology "innovation chain" are adapted from Foxon (2005); International Energy Agency, (2008), *Energy Technology Perspectives 2008,* Paris: IEA; and Forbes, S. (2011, February 22), Personal communication.

5 National Renewable Energy Laboratory, (2010), The Spectrum of Clean Energy Innovation, Golden, Colorado: NREL.

6 Forbes, 2011.

7 Forbes, 2011.

8 Definitions of technology stages described in this figure are adapted from Foxon (2005), IEA (2008), and Forbes (2011).

9 Forbes, 2011.

10 Tomlinson, S., P. Zorlu, and C. Langley, (2008), *Innovation and Technology Transfer: Framework for a Global Climate Deal,* London: E3G and Chatham House.

11 Massachusetts Clean Energy Center, (2011), *Renewable Energy Generation – Solicitations*. Retrieved January 7, 2011, from: http://www.masscec.com.

12 International Energy Agency, 2008.

13 Gallagher, K., (2011), *DOE Budget Authority for Energy Research, Development, and Demonstration Database,* Energy Technology Innovation Policy, Harvard University, John F. Kennedy School of Government.

14 Nemet, G.F., and D.M Kammen, (2007), *U.S. energy research and development: Declining investment, increasing need, and the feasibility of expansion*, Energy Policy 35: 746–755.

15 The use of 560 parts per million (ppm) as a target atmospheric stabilization of greenhouse gases (CO_2-equivalent) is intended by the authors to approximate a "safe" level of emissions, but is illustrative only, since it is above the 350–450 ppm level suggested by the Intergovernmental Panel on Climate Change (IPCC).

16 Not all fossil fuel technologies are equally mature. Carbon capture and storage, for example, is less mature than other fossil technologies and could be considered early stage.

17 Schilling, M.A., and M. Esmundo, (2009), *Technology S-curves in renewable energy alternatives: Analysis and implications for industry and government*, Energy Policy 37: 1767–1781.

18 Schilling & Esmundo, 2009.

19 Department of Energy, (2010), *Funded Projects*. Retrieved April 29, 2010, from Advanced Research Projects Agency, Department of Energy: http://arpa-e.energy.gov/Portals/0/documents/news/ARPA-ETableofProject%20Selection4-29-2010FINAL.PDF.

20 Department of Energy, 2010.

21 Government Accountability Office, (2010), *Further Actions Are Needed to Improve DOE's Ability to Evaluate and Implement the Loan Guarantee Program,* Washington D.C.: GAO.

22 Goodward, J., and M. Gonzalez, (2011), *Bottom Line on Renewable Energy Tax Credits,* Washington D.C.: World Resources Institute.

23 The 30 percent ITC is available for solar, fuel cells, and small wind projects, while the 10 percent ITC is available for geothermal, microturbines, and combined heat and power (CHP). The PTC is available for wind, geothermal, closed-loop biomass ($22/MWh), open-loop biomass, landfill gas, municipal solid waste, qualified hydroelectric, and marine and hydro-kinetic projects ($11/MWh for the latter list);

Database for State Incentives for Renewable Energy (DSIRE), (2009), *Renewable Electricity Production Tax Credit (PTC).* Retrieved April 29, 2010, from: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US13F&re=1&ee=1.

24 The ITC is available through 2011 as a refundable tax credit (meaning its value can be paid out as a grant), but projects must document that they have started construction by December 31, 2011 (after which this option expires);

Scharfenberger, P., (2010), *Developers and Investors Doing "Flips" for Government Tax Incentives: A Discussion of Partnership Flips.* Retrieved March 5, 2011, from Renewable Energy Project Finance Blog: http://financere.nrel.gov/finance/content/developers-and-investors-doing-%E2%80%9Cflips%E2%80%9D-government-tax-incentives-discussion-partnership-flip.

25 National Renewable Energy Laboratory, 2010.

26 American Wind Energy Association, (2008), *Installed U.S. Wind Power Capacity Surged 45% in 2007.* Retrieved April 29, 2010, from: http://archive.awea.org/newsroom/releases/AWEA_Market_Release_Q4_011708.html.

27 Goodward & Gonzalez, 2011.

28 Predictable regulatory and financial environments are essential to spur investment of any kind. Thus for tax credits to provide effective incentives for renewable deployment, the developer must have confidence that they will be able to capture the full value of the credit. A project qualifies for the ITC and PTC when it is placed in service (commences operation). In the United States, the ITC and PTC programs are established for fixed time periods and therefore must be periodically renewed. For example, the PTC for wind was allowed to expire in 2000, 2002, and 2004, and is set to expire again by 2012. In theory, this allows for periodic reassessment about the need for and the appropriate value of the credit. To reduce the uncertainty for project developers, once a project qualifies it can receive full value for the credit even if the ITC or PTC expires. Thus, expiration of the credit only affects the ability of new projects to receive credit. This still presents some challenges for investors as it can take some time to get a project up and running and projects do not qualify until they enter service. For example, wind farm development can take two years, and for utility-scale solar and geothermal projects the process is even longer.

Cory, K., (2009), *Renewable Energy Feed-in Tariffs: Lessons Learned from the U.S. and Abroad.* Retrieved April 28, 2010, from the National Renewable Energy Laboratory: http://www.cleanenergystates.org/Meetings/RPS_Summit_09/Cory_RPS_Summit2009.pdf.

Wiser, R., Bolinger, M., and Galen Barbose. (2007), *Using the Federal Production Tax Credit to Build a Durable Market for Wind Power in the United States.* Lawrence Berkeley National Laboratory. http://eetd.lbl.gov/ea/emp/reports/63583.pdf

29 Cory, 2009.

30 European Photovoltaic Industry Association, (2010), *Market Outlook 2010.* Retrieved June 2, 2011, from: http://www.epia.org/uploads/media/Market_Outlook_2010.pdf.

31 Cory, 2009.

32 EU Commission. (2008). *The support of electricity from renewable energy sources.* Brussels: Commission of the European Communities.

33 Klaassen, P.S., (2006), *Wind Power in Europe: A Simultaneous Innovation–Diffusion Model*, Environmental and Resource Economics 36: 163–190.

34 Klaassen, 2006.

35 Gipe, P., (2010), *Vermont Sees No Conflict between Feed-in Tariffs and Federal Law.* Retrieved April 15, 2011, from Alliance for Renewable Energy: http://www.allianceforrenewableenergy.org/2010/10/vermont-sees-no-conflict-between-feed-in-tariffs-and-federal-law.html.

36 Gainesville Regional Utilities, (2009, February 5), *Gainesville's Solar Feed-in-Tariff Program.* Retrieved April 28, 2010, from: http://www.gru.com/Pdf/AboutGRU/News/FIT/Gainesville%20FIT%20Synopsis.pdf.

37 Galbraith, K., (2009), *Europe's Way of Encouraging Solar Power Arrives in the U.S.* Retrieved April 28, 2010, from the *New York Times*: http://www.nytimes.com/2009/03/13/business/energy-environment/13solar.html.

38 DSIRE, (2010), *SMUD - Feed-in Tariff.* Retrieved April 28, 2010, from: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA207F.

39 DSIRE, 2010.

40 Detailed discussion of legality is beyond the scope of this paper but can be found in Hempling (2010). Regulations administered by FERC made it difficult to implement a cost-based tariff, instead FITs (like that created by PURPA) have been on an avoided-cost basis where the FIT cannot be worth more than the prevailing price for fossil fuels (or other alternative in absence of renewable energy).

41 Hempling, S., C. Elefant, K. Cory, and K. Porter, (2010), *Renewable Energy Prices in State-Level Feed-in Tariffs: Federal Law Constraints and Possible Solutions*, Golden, Colorado: National Renewable Energy Laboratory.

42 Cory, K., (2011), *FERC Ruling Changes Course and Assists Renewables.* Retrieved June 15, 2011, from Renewable Energy Project Finance Blog: http://financere.nrel.gov/finance/content/ferc-ruling-changes-course-and-assists-renewables.

43 Cory, 2011.

44 Hempling et al., 2010; Hempling et al. outline three options to supplement payments based on avoided cost, namely: a) assigning "renewable energy credits" with value that makes up the difference between avoided cost and the desired feed-in tariff; b) making cash grants or paying production-based incentives (funded, for example, by taxpayers through the general budget, or by ratepayers through a "system benefits charge"); or c) establishing a purchase price that exceeds avoided cost but granting the purchasing utility a tax credit equal to the excess.

45 Full treatment of these three options is beyond the scope of this paper, and readers should consult Hempling et al. (2010), which states that "Under the PURPA option and existing law, states can grant QF [qualifying facility] sellers incremental compensation above avoided cost, provided that this incremental compensation takes the form of cash grants, renewable energy credits, tax credits, and/or production-based incentive payments; or the state may set the rate above avoided cost as long as it issues a tax credit equal to the increment above avoided cost. This option is now available to states without any further action by FERC."

46 Cory, 2011.

47 Gipe, P., (2009), *Vermont FITs Become Law: The Mouse That Roared.* Retrieved 28 April, 2010, from Renewable Energy World: http://www.renewableenergyworld.com/rea/news/article/2009/06/vermont-fits-become-law-the-mouse-that-roared.

48 Voosen, P., (2009), Spain's Solar Market Crash Offers a Cautionary Tale About Feed-In Tariffs. *New York Times*.

49 Cory, K., T. Couture, and C. Kreycik, (2009, March), *Feed-in Tariff Policy: Design, Implementation, and RPS Policy Interactions.* Retrieved April 29, 2010, from National Renewable Energy Laboratory: http://www.nrel.gov/docs/fy09osti/45549.pdf.

50 Current as of September 20, 2010. Hanson, S., (2010), *Retrieved from Fact Sheet: U.S. Climate Action in 2009–2010*. World Resources Institute. Available at: http://www.wri.org/stories/2010/09/fact-sheet-us-climate-action-2009-2010

51 Wiser, R., G. Barbose, and E. Holt, (2010), *Supporting Solar Power in Renewables Portfolio Standards*, Berkeley, California: Lawrence Berkeley National Laboratory.

52 DSIRE, (2011a), *New Jersey Incentives/Policies for Renewables & Efficiency*. Retrieved June 2011, from: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ05R&re=1&ee=1.

53 Hart, D. (2009). *Making, Breaking, and (Partially) Remaking Markets: State Regulation and Photovoltaic Electricity in New Jersey*. Cambridge, MA: Industrial Performance Center, Massachusetts Institute of Technology (MIT).

54 Hart, 2009.

55 Hart, 2009.

56 SREC Trade Inc., (2010), *Auction History*. Retrieved June 3, 2010, from SREC Trade: http://www.srectrade.com/srec_prices.php.

57 California Public Utilities Commission, (2010), *Decision Adopting the Renewable Auction Mechanism. Order Instituting Rulemaking to Continue Implementation and Administration of California Renewables Portfolio Standard Program*, Sacramento: CPUC.

58 Each utility is required to develop a single contract. That contract will be non-negotiable for each renewable project. However, each utility is allowed to develop its own standardized contract.

59 The Network for New Energy Choices gives 27 states “passing” grades (above C) on net metering.

60 Rose, J., (2010), *Freeing the Grid*, Network for New Energy Choices and Interstate Renewable Energy Council.

61 Ellingson, M.A., and L. Hunter, (2010), *Compendium of Best Practices*, Washington, D.C. and Vienna, Austria: American Council On Renewbale Energy, Renewable Energy & Energy Efficiency Partnership and Alliance to Save Energy.

62 Environmental Protection Agency, (2010), *Combined Heat and Power Partnership*. Retrieved May 5, 2011, from Utility Rates: http://www.epa.gov/chp/state-policy/utility.html.

63 DSIRE, (2011b), 3rd-Party Solar PPA Policies. Retrieved from: http://dsireusa.org/documents/summarymaps/3rd_Party_PPA_map.ppt.

64 The best practices described here are drawn from the authors’ own research; Forbes (2011); from the best practices endorsed by the American Council on Renewable Energy, the Renewable Energy and Energy Efficiency Partnership, and the Alliance to Save Energy (as described in Ellingson and Hunter [2010]); and Deutsche Bank Group Climate Change Advisors, (2009, October), *Global Climate Change Policy Track: An Investor’s Assessment*. Retrieved April 29, 2010, from: http://www.dbcca.com/dbcca/EN/_media/Global_Climate_Change_Policy_Tracker_Exec_Summary.pdf.

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