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Overcoming Conceptual and Practical Hurdles to Market-Based Discovery of Prices for Utility Procurements from Rooftop Solar Systems

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Various state government programs seek to stimulate deployments of solar power systems on rooftops of residential, commercial, municipal and other facilities. All of these programs grapple with the fundamental economics of such power: generally, the cost of electricity from rooftop solar systems, when reflecting a reasonable commercial return on the required investment, exceeds the price of electricity available from utilities' power plants, wind turbines, and some other sources. Despite this economic challenge, many legislatures recognized benefits of rooftop solar systems and provided several types of incentives for such deployments, such as feed-in tariffs or renewable energy certificates pursuant to renewable energy portfolio standards. While in some cases the programs intend to create generous incentives for a nascent technology, most programs aim to avoid overburdening taxpayers or utility ratepayers. Deriving efficient levels of incentives—stimulating deployments of rooftop systems at least cost—is usually beyond the capabilities of administrative determinations which focus on cost estimates. Instead, there are several market-based methods for pricing and allocating these incentives that are more effective and transparent. Three market-based methods with conceptual and practical advantages are reverse auctions, iterative price adjustments, and offering a few prices simultaneously. By applying market-based methods to utility procurements from rooftop solar power systems, legislatures and regulators will expand the deployments of and political support for these systems.

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I. Introduction

Over the last decade, government programs promoting deployments of rooftop solar energy systems have proliferated around the world.[1] In the United States, there are a wide variety of federal, state, and municipal programs which lower the costs for rooftop solar systems and/or raise the benefits owners derive from these systems. These programs are judged in part on the metric of whether they have produced additional renewable energy resources. Also, these programs are scrutinized on their cost effectiveness as well as their penetration into residential, small commercial, and other segments of building owners.

Before the recent spate of government programs targeting rooftop solar systems, some of the incentives for solar systems were made available under programs offering revenues to system owners from "value-based" pricing reflecting the utilities' avoided costs of production and the utilities' prices to consumers.[2] However, such incentives generally failed to stimulate significant solar deployments, especially for power production projects operating on the small scale of most rooftop systems.[3]

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1. *See* RYAN WISER ET AL., ERNEST ORLANDO LAWRENCE BERKELEY NAT'L LAB., SUPPORTING SOLAR POWER IN RENEWABLES PORTFOLIO STANDARDS: EXPERIENCE FROM THE UNITED STATES (Oct. 2010), http://eetd.lbl.gov/ea/emp/reports/lbnl-3984e.pdf; *Welcome to Your Solar Feed in Tariff Search*, SOLARFEEDINTARIFF.NET, http://www.solarfeedintariff.net/ (last visited Feb. 22, 2012); DSIRE: DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://dsireusa.org/ (last visited Feb. 22, 2012); KEMA, INC., FEED-IN TARIFF DESIGNS FOR CALIFORNIA: IMPLICATIONS FOR PROJECT FINANCE, COMPETITIVE RENEWABLE ENERGY ZONES, AND DATA REQUIREMENTS (Aug. 2010), http://www.energy.ca.gov/2010publications/CEC-300-2010-006/CEC-300-2010-006.PDF; L.A. BUS. COUNCIL, DESIGNING AN EFFECTIVE FEED-IN TARIFF FOR GREATER LOS ANGELES, http://www.labusinesscouncil.org/online_documents/2010/Designing-an-Effective-Feed-in-Tariff-for-Greater-Los-Angeles-040110.pdf (last visited Mar. 19, 2012).

2. *See* JULIE TAYLOR, NAT'L ASS'N OF REGULATORY UTIL. COMM'RS, FEED-IN TARIFFS (FIT): FREQUENTLY ASKED QUESTIONS FOR STATE UTILITY COMMISSIONS 4 (June 2010), http://www.naruc.org/Publications/NARUC Feed in Tariff FAQ.pdf ("The Public Utility Regulatory Policies Act (PURPA) of 1978 was enacted with many of the same goals as those now specified in feed-in tariffs. The PURPA statute enabled independent power producers (IPPs) to build and operate generation and sell electricity to a utility via a fixed-price standard offer contract at the utility's avoided cost of building generation."); *see also Feed-In Tariff for Sale of Customer Sited Generation to SMUD: Questions and Answers*, SACRAMENTO MUN. UTIL. DIST. (Oct. 28, 2010), https://www.smud.org/en/business/customer-service/rates-requirements-interconnection/documents/FeedInTariffFAQs.pdf (explaining a recent program applying value-based pricing: rates based on the utility's marginal cost, cost of avoided greenhouse gas mitigation, and risk avoidance of future natural gas prices).

3. Joshua L Sturtevant, *The S-REIT: An Investment-Driven Solution to Solar Development Problems*, GW SOLAR INST., http://solar.gwu.edu/Research/Sturtevant_S-REIT.pdf (last visited Feb. 24, 2012).

Programs that have been more successful in promoting rooftop solar deployments provide incentives reflecting the potential owners' costs. Within the framework of "cost-based" pricing, there is a basic dichotomy in methods to arrive at such prices.[4] One approach uses an administrative determination of prices based on assessments of costs (including the costs of solar panels, installation services, meters, maintenance, insurance, leased space, a reasonable return on capital, expected energy output per unit of capacity installed, taxes, available grants and other credits, and the utilities' prices to consumers) along with administrative estimates of other relevant factors (including building owners' price sensitivity to deploy rooftop solar systems).[5]

An alternative approach to arrive at cost-based pricing is to rely on market mechanisms to discover the costs and price sensitivity of building owners, such as reverse auctions, using the quantity of applications for the program at one period's prices to adjust the prices for the next period, or offering a few prices simultaneously.[6]

Developing effective prices through administrative determinations is challenging in the context of rapidly changing costs for solar systems, high uncertainty about building owners' price sensitivity for rooftop systems, and other dynamic and unmeasured factors. In fact, several recent administrative determinations of cost-based prices led to either supply far in excess of the program's demand or a disappointing absence of interest from potential suppliers.[7]

The issue of how to set cost-based prices as incentives for rooftop solar systems applies to programs using feed-in tariffs as well as to programs using renewable energy certificates (RECs) pursuant to renewable energy portfolio standards. This Article explains (1) the

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4. Public Utility Regulatory Policies Act of 1978 (PURPA), 16 U.S.C. § 824a-3(d) (2006) (defining "avoided cost" as "the cost to the electric utility of the electric energy which, but for the purchase from such cogenerator or small power producer, such utility would generate or purchase from another source"); *see* KARLYNN CORY ET AL., NAT'L RENEWABLE ENERGY LAB., U.S. DEP'T OF ENERGY, FEED-IN TARIFF POLICY: DESIGN, IMPLEMENTATION, AND RPS POLICY INTERACTIONS 2 (Mar. 2009), http://www.nrel.gov/docs/Fy09osti/45549.pdf; Bradley Motl, Comment, *Reconciling German-Style Feed-In Tariffs with PURPA*, 28 WIS. INT'L L.J. 742, 743 (2011).

5. *See Proposed Feed-In Tariff Price Schedule Stakeholder Engagement—Session 4*, ONT. POWER AUTH. 21-36 (Apr. 7, 2009), http://www.fit.powerauthority.on.ca/storage/30/10147_FIT_Stakeholder_Engagement_-_Session_4_FIT_Price_Schedule_FINAL_(HP).pdf; ARNE KLEIN ET AL., EVALUATION OF DIFFERENT FEED-IN TARIFF DESIGN OPTIONS—BEST PRACTICE PAPER FOR THE INTERNATIONAL FEED-IN COOPERATION (2d ed. Oct. 2008), http://www.feed-in-cooperation.org/wDefault_7/wDefault_7/download-files/research/best_practice_paper_2nd_edition_final.pdf; CORY ET AL., *supra* note 4, at 2; TAYLOR, *supra* note 2, at 4-5.

6. *See* KLEIN ET AL., *supra* note 5; CORY ET AL., *supra* note 4; TAYLOR, *supra* note 2.

7. *See* TAYLOR, *supra* note 2, at 5.

problems to be addressed by incentives for rooftop solar systems, and (2) the conceptual and practical advantages of market-based methods to develop effective cost-based prices for programs aimed at increasing deployments of rooftop solar systems.

Economics and market experiences show that other features are also common to the success of either feed-in tariffs or RECs. These terms include long-term (fifteen to twenty-five years) purchase obligations by the utilities to reduce uncertainty for the solar system owner;[8] a simplified process with standard contract terms to reduce transaction costs for small systems; and transparency in the selection process.[9] While the focus of this Article is on developing prices for these programs, these other terms and conditions are important to a successful program through feed-in tariffs or RECs.

II. POLICY GOALS FOR STATE PROGRAMS PROMOTING ROOFTOP SOLAR DEPLOYMENTS

Various federal and state government programs seek to increase deployments of rooftop solar power systems. Among the major benefits noted by proponents of these energy sources are:[10]

- unlike electricity generating stations using fossil fuels, rooftop solar systems do not emit air pollutants which harm public health and the global climate;
- as the technologies and scale economies advance, solar power may provide a cost-effective source of energy;
- such systems avoid utilities' costs in transmission and distribution lines as well as in generation, also increasing the reliability of energy supply to the user regarding storm damage to the utilities' lines;
- these systems promote national energy security through independence from foreign suppliers of fossil fuels and less exposure to disruption by physical or cyber attacks on centralized facilities; and

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8. *See* KEMA, INC., *supra* note 1, at 14-21; *see also* Warren G. Lavey, *Making and Keeping Regulatory Promises*, 55 FED. COMM. L.J. 1 (2002).

9. *See* KEMA, INC., *supra* note 1, at 22-23.

10. *See About SunShot*, U.S. DEP'T OF ENERGY: SUNSHOT INITIATIVE, http://www1.eere.energy.gov/solar/sunshot/about.html (last updated Nov. 16, 2011); L.A. BUS. COUNCIL, *supra* note 1, at 1; Jeffrey H. Michel, *The Case for Renewable Feed-In Tariffs*, 1 J. ENERGY UTIL. & ENV'T CONFERENCE, Paper #01, at 1, 2, 13 (2007).

- manufacturing and installing rooftop solar systems create jobs, with strong domestic demand required for U.S. manufacturers to compete for global business.

Despite these attractions, government interventions in the markets for electricity and generating equipment are necessary to achieve more than minimal penetration of rooftop solar systems.

III. FUNDAMENTAL ECONOMIC CHALLENGE TO DEPLOYMENTS

Why does expanding deployments of rooftop solar systems require the support of government programs? This policy goal encounters a fundamental economic challenge.

This goal relies largely on independent decision-makers to choose to invest in new solar systems. These decision makers are residential, commercial, nonprofit, municipal and other building owners, or commercial developers leasing space from, or systems to, such entities. (In contrast, some energy programs are implemented through buildings, vehicles, and other equipment owned and managed by the federal government,[11] and other energy programs require compliance with regulatory standards.[12]) The supply side as envisioned by state legislators and regulators would involve many providers deploying systems of various sizes and locations.

However, these independent decision-makers generally confront the following market signals: the cost of electricity from rooftop solar

11. *See* Federal Leadership in Environmental, Energy, and Economic Performance, Exec. Order No. 13514, 74 Fed. Reg. 52,117, 52,117-18 (Oct. 8, 2009) (making it "the policy of the United States [for] Federal agencies [to] increase energy efficiency," including by "increasing agency use of renewable energy and implementing renewable energy generation projects on agency property"); Press Release, Office of the Press Sec'y, The White House, We Can't Wait: President Obama Announces Nearly $4 Billion Investment in Energy Upgrades to Public and Private Buildings (Dec. 2, 2011), http://www.whitehouse.gov/the-press-office/2011/12/02/we-cant-wait-president-obama-announces-nearly-4-billion-investment-energ.

12. *See* Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) (describing the phase-in of permitting requirements for GHG emissions); Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, 76 Fed. Reg. 57,106 (Sept. 15, 2011) (explaining the first program to reduce GHG emissions and fuel consumption for heavy-duty highway vehicles); Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25,324 (May 7, 2010); Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals, 76 Fed. Reg. 48,208, 48,210-12 (Aug. 8, 2011) (describing the "Cross-State Air Pollution Rule," which limits the interstate transport of emissions of nitrogen oxides and sulfur dioxide that contribute to harmful levels of fine particle matter and ozone in downwind states, affecting oil- and coal-fired power plants); *Port of Los Angeles Clean Truck Program*, PORT L.A., http://www.portoflosangeles.org/ctp/CTP_Fact_Sheet.pdf (last visited Mar. 28, 2012).

systems, when reflecting a reasonable return on the required investment, exceeds the price of electricity available from utilities' power plants, wind turbines, and some other sources.[13] Put differently, for many potential deployments, the expected savings in energy costs to the owner of the rooftop system do not cover the owner's costs of acquiring and installing the system. This economic challenge limits the supply side of sales by rooftop solar systems to electric utilities.

A. *Conceptual Basis for Intervening in the Market for Rooftop Solar Systems*

According to a report from the National Renewable Energy Laboratory:

> Adding a [photovoltaic] system to just 1% of single-family, owner-occupied residences would represent approximately 6,000 [megawatts] of new capacity. However, the high up-front cost of solar is still a significant challenge. The financial benefit of a lower utility bill as a result of installing the [photovoltaic] system is usually not enough of an economic incentive for the homeowner.[14]

Consequently, without government intervention in markets, building owners will not invest in rooftop solar systems and utilities will not buy power from these systems in the quantity of deployments desired by many legislatures and regulators. This economic challenge may be short-lived as the costs of rooftop systems are expected to decline with advancing technologies and scale.[15] However, in the past and for at least the next few years, U.S. deployments would be anemic (less than the levels targeted by these legislatures and regulators) without the assistance of government programs.[16]

In mathematical terms shown below, the economic challenge can be expressed as finding paths for the benefits of the solar system to the

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13. *See* JASON COUGHLIN & KARLYNN CORY, NAT'L RENEWABLE ENERGY LAB., U.S. DEP'T OF ENERGY, SOLAR PHOTOVOLTAIC FINANCING: RESIDENTIAL SECTOR DEPLOYMENT 45 (Mar. 2009), http://www.nrel.gov/docs/fy09osti/44853.pdf.

14. *Id.*

15. *Solar PV: A Reliable, Cost-Effective Climate Solution*, UN ENV'T PROGRAMME 1 (Aug. 12, 2008), http://www.unep.org/pdf/factsheet-Poznan.pdf. The benefits of current deployments in lowering the costs of future deployments, which do not accrue to the current buyer of a rooftop system, are an economic externality which warrants market intervention by government programs in support of rooftop solar. This externality is in addition to the more widely recognized externality discussed below, the failure of fossil-fuel prices to reflect the harms caused to public health and the global climate.

16. *See* COUGHLIN & CORY, *supra* note 13, at 1. *See generally* FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT: CASES AND MATERIALS 834-930 (3d ed. 2010).

owner (left hand side) to equal or exceed the costs of the system to the owner (right hand side):[17]

$$\sum_{t=1}^{T} \frac{(U_t + R_t)}{(1+i)^t} \geq C$$

t = time in years
T = end of useful life of solar system
U_t = decrease in owner's payments to electric utility attributable to the solar system, in year t
R_t = monetary or nonmonetary benefits to the owner from operating the solar system, other than savings on energy purchases, in year t
i = annual discount rate, reflecting owner's cost of capital and risk of investing in the solar system
C = cost to owner of acquiring and installing the solar system[18]

B. *Addressing the Economic Challenge Through Four Types of Programs*

Government programs have taken at least four different paths that would help overcome the fundamental economic challenge of solar power systems.

1. Correcting Implicit Subsidies in Pricing Electricity from Fossil-Fuel Power Plants

One path involves pricing into the use of fossil fuels a portion of the externalities they cause in harming public health and the global climate. According to a recent peer-reviewed paper by Paul Epstein and others, solar power would be price-competitive with electricity from coal-fired power plants if the social costs of coal were properly reflected in the prices:

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17. *See* Govinda R. Timilsina et al., *A Review of Solar Energy: Markets, Economics and Policies* (World Bank, Policy Research Working Paper No. 5845, 2011), *available at* http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2011/10/17/000158349_20111017113749/Rendered/PDF/WPS5845.pdf; Brad Carson, The Economics of Renewable Energy (last revised Mar. 10, 2012) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2014773 (follow "One-Click Download" hyperlink); Durward Jackson, *Rooftop $olar PV as an Investment: Case Studies*, ROOFTOP SOLAR INVESTMENTS, http://www.rooftop-solar-investments.org/images/Revised_article.doc (last visited Mar. 7, 2012); Paul Rauber, *Solar's Moment in the Sun*, SIERRA, Sept./Oct. 2011, http://www.sierraclub.org/sierra/201109/solar.aspx.

18. The cost element assumes no maintenance expenses; alternatively, the cost element reflects the discounted value of maintenance expenses over the useful life of the solar system.

> Accounting for the damages conservatively doubles to triples the price of electricity from coal per [kilowatt hour] generated, making wind, solar, and other forms of nonfossil fuel power generation, along with investments in efficiency and electricity conservation methods, economically competitive.[19]

Similarly, a 2011 study published in the *American Economic Review* estimated that the gross economic damages from U.S. coal-fired electric power generation are about 3.6 cents per kilowatt hour;[20] and a 2010 report by the National Research Council estimated that the public health costs and related damages not reflected in the price of electricity from U.S. coal power plants was on average 3.2 cents per kilowatt hour (without attempting to quantify costs of climate change).[21] Current pricing of electricity from coal power plants does not reflect these damages.

Regulatory mechanisms such as mandated reductions in harmful air emissions (by installing scrubbers and other control technologies) or pricing permits for such emissions raise the prices of electricity from coal power plants.[22] There are many public health, environmental, and energy independence benefits from addressing these externalities. Typically, these programs are not driven by the goal of increasing deployments of rooftop solar systems. Yet, these government programs make the cost of clean power from rooftop systems more attractive relative to the price of electricity from many traditional sources, thereby increasing the potential return on investing in rooftop systems and the deployments of such systems.

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19. Paul R. Epstein et al., *Full Cost Accounting for the Life Cycle of Coal*, 1219 ANNALS N.Y. ACAD. SCI. 73, 73 (Paul R. Costanza et al. eds., 2011).

20. Nicholas Z. Muller et al., *Environmental Accounting for Pollution in the United States Economy*, 101 AM. ECON. REV. 1649, 1669-71 (2011) (explaining that the estimated gross external damages produced by oil- and coal-fired power plants far outweigh their value added to the U.S. economy).

21. NAT'L RESEARCH COUNCIL, HIDDEN COSTS OF ENERGY: UNPRICED CONSEQUENCES OF ENERGY PRODUCTION AND USE 6 (2010); *see also* WILLIAM NORDHAUS, ESTIMATES OF THE SOCIAL COST OF CARBON: BACKGROUND AND RESULTS FROM THE RICE-2011 MODEL (Oct. 2011), http://nordhaus.econ.yale.edu/documents/CFDP1826.pdf (estimating the social cost of carbon as forty-four dollars per ton); Nathan Mee & Marc Miller, *Here Comes the Sun: Solar Power Parity with Fossil Fuels*, 36 WM. & MARY ENVTL. L. & POL'Y REV. 119 (2011).

22. *See* PAUL J. HIBBARD ET AL., ANALYSIS GROUP, THE ECONOMIC IMPACTS OF THE REGIONAL GREENHOUSE GAS INITIATIVE ON TEN NORTHEAST AND MID-ATLANTIC STATES 34 (Nov. 15, 2011), http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf; *see also* WESTERN CLIMATE INITIATIVE, DESIGN FOR THE WCI REGIONAL PROGRAM 15-16 (July 2010), http://www.westernclimateinitiative.org/document-archives/general/program-design/Design-for-the-WCI-Regional-Program.

Referring to the mathematical terms shown above, this approach increases *U* (the owner's saving in payments to the utility for energy because of the rooftop system) on the benefits side of the expression.

2. Decreasing the Capital Costs of Rooftop Solar Systems

Another path to overcome the fundamental economic challenge of rooftop solar systems is decreasing the investment required for building owners.

Federal and state tax credits and tax deductions as well as grants have been used to create incentives for building owners to acquire and install such systems. For example, in 2011 homeowners in Oregon could qualify for a credit from the Oregon Department of Energy of $3 per watt of installed output, up to a maximum of $6,000, as well as a federal solar tax credit for 30% of the installed cost.[23] The Illinois Department of Commerce and Economic Opportunity offered incentives up to 30% of total project cost (system acquisition and installation) for residential and business applicants, and 50% for public sector and nonprofit entities (maximum rebate of $30,000).[24] As another illustration, the New York State Energy and Research Development Authority offered cash incentives paid directly to prequalified installers, who passed the savings on to homeowners.[25] Other government programs require utilities to grant rebates to customers who take various energy measures, including installing solar systems.

Government programs offering tax advantages or grants at the time of acquiring and installing a system decrease the amount of investment required by building owners (*C* on the costs side of the mathematical expression). With lower costs of rooftop systems to building owners, there will be more instances in which the benefits exceed the costs to the owner, resulting in more deployments.

3. Decreasing the Discount Rate

The annual discount rate, applied to estimate the present value of a stream of benefits over the life of the system, is a third factor that government programs can influence. This rate reflects the time value of money invested in the system, including factors such as the carrying cost

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23. *Go Solar*, PORTLAND GEN. ELECTRIC, http://www.portlandgeneral.com/renewables_efficiency/generate_power/home/go_solar/default.aspx (last visited Feb. 22, 2012).

24. *Solar and Wind Energy Rebate Program*, ILL. DEP'T COM. & ECON. OPPORTUNITY, http://www.commerce.state.il.us/dceo/Bureaus/Energy_Recycling/Energy/Clean+Energy/01-RERP.htm (last visited Feb. 22, 2012).

25. COUGHLIN & CORY, *supra* note 13, at 10.

of the capital and the relative riskiness of the expected future benefits. Some government programs offer low-interest loans for rooftop solar systems, such as a New York program making a one-time payment to a participating lender to bring down the homeowner's interest rate by up to 4%.[26]

Reducing the owner's cost of capital yields a lower annual discount rate for the stream of benefits over the life of the system (i in the denominator on the benefits side of the mathematical expression). With the lower discount rate, the total net present value of savings in utility costs and other benefits arising from a rooftop solar system grows, leading to more deployments.

4. Increasing the Revenues to Owners of Rooftop Solar Systems Through Utility Procurements

Another path for government programs to promote rooftop solar provides revenues to owners in addition to their savings in utility energy costs. This approach, which will be the focus of this Article, channels procurements by electric utilities toward rooftop solar systems.

State programs referred to as "renewable portfolio standards" require electric utilities to make procurements from qualifying renewable energy resources. Often, these programs establish quotas for the utilities' renewable energy procurements expressed as a minimum percentage of their power.[27] The mechanisms include purchasing from renewable energy sources (1) power through feed-in tariffs, net metering, or other contracts, or (2) certificates signifying the renewable energy operation regardless of the user of the associated power (RECs, or for solar specifically, SRECs).[28]

The resulting payments to the owner raise the benefits of owning such systems (R in the mathematical expression), helping to overcome the costs of such investments. Feed-in tariffs and net metering involve sales of the solar energy to the utilities through the grid. In contrast, owners receive payments for SRECs and can use the solar energy on-site

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26. *Id.* at 10-11.

27. *States with Renewable Portfolio Standards*, U.S. DEP'T ENERGY, http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm (last updated June 16, 2009).

28. *See generally* BOSSELMAN ET AL., *supra* note 16, at 879, 906; JOHN FARRELL, INST. FOR LOCAL SELF-RELIANCE, CLEAN V. SRECS: FINDING THE MORE COST-EFFECTIVE SOLAR POLICY (Oct. 2011); Chad Laurent et al., *FITness Testing: Exploring the Myths and Misconceptions About Feed-In Tariff Policies*, WORLD FUTURE COUNCIL, http://www.worldfuturecouncil.org/fileadmin/user_upload/PDF/FITness_Testing_Myths.pdf (last visited Feb. 27, 2012); PAUL GIPE, WORLD FUTURE COUNCIL, GRADING NORTH AMERICAN FEED-IN TARIFFS (May 2010), http://www.wind-works.org/FeedLaws/USA/Grading%20N.Am.%20FITs%20Report.pdf.

to reduce their payments for electricity to the utilities or sell the solar energy in separate transactions.

Well-designed programs recognize several elements of the economic challenge and may attempt to address multiple elements simultaneously. For example, the California Solar Initiative, started in 2009, provided incentive payments from utilities to both small and large systems.[29] In light of the capital-cost hurdle for residential and small business customers, the program's Expected Performance Based Buydowns for small systems were upfront payments, as opposed to monthly payments over five years for larger systems.

C. Unknown Supply Curve Creates Risks of Ineffectiveness, Inefficiency, and Inequity of Programs Based on Administrative Estimates

Regardless of the path chosen by a government program to address the fundamental economic challenge of rooftop solar deployments, the details are difficult. Getting the details wrong can lead to few deployments, selecting from a surplus of applications, excessive expenditures, inefficiencies, and/or inequities.

As shown in the mathematical expression, the building owner's deployment decision depends on at least five factors—U (saving in utility energy costs, varying by year), R (additional benefits, varying by year), i (annual discount rate), C (cost of acquisition and installation), and T (life expectancy of the system). These factors vary across buildings and systems, even within the same state. For example, there are a variety of solar technologies, with different acquisition and installation costs as well as life expectancies; the amount and time of day for energy usage differs from one building to the next; utility prices vary by service area in a state; installation costs differ by area in a state and rooftop characteristics; energy produced by a system can depend on location in a state and any shadowing; building owners face different costs of capital and opportunity costs for alternative investments, including a greater likelihood that wealthier building owners will install rooftop solar systems than lower-income utility customers (raising concerns about equity and regressive taxation);[30] some owners qualify for

29. CAL. PUB. UTILS. COMM'N, CALIFORNIA SOLAR INITIATIVE PROGRAM HANDBOOK 10 (Dec. 2011), http://www.gosolarcalifornia.org/documents/CSI_HANDBOOK.PDF.

30. *See* Tim Nelson et al., *Australian Residential Solar Feed-In Tariffs: Industry Stimulus or Regressive Form of Taxation?*, 41 ECON. ANALYSIS & POL'Y 113, 125 (2011). Nelson commented, in an econometric study of residential rooftop solar installations in Australia in response to feed-in tariffs:

government and nongovernment grants and other tax advantages; and some building owners derive substantial additional benefits not valued by or available to other owners (such as enhancing the owner's "green" lifestyle or a business's "green" brand that has value to its customers).

Moreover, estimates of the factors should capture the current expectations of building owners. There is substantial uncertainty in forecasting utility prices over the life of a rooftop system, and expectations of prices shift often. Similarly, the potential supplier faces uncertainty in trying to compare the values of current incentives against future combinations of tax, utility, and other initiatives which may be available. As another example, the costs and performance characteristics of technologies change rapidly. The details of a program may have to be updated frequently.

The analysis of technologies and costs risks getting lost in the weeds when it comes to the penetration of a government program promoting an emerging, clean technology. Response to any program is heavily affected by nonprice factors, including the dissemination of information about the offer, neighborhood effects (whether local solar installations are visible, and whether municipal buildings and other community leaders have installed and promoted solar systems), tipping-point effects, recognition for participants, whether utility power in the area suffered recent interruptions, trust in the program, ease of applying, selection criteria, and payment delays. In addition to being critical elements for success, such nonprice factors make estimating the price-sensitivity of supply (setting the price that best achieves the program's goals) highly complex and error-prone.

Stated in economic terms, the supply curve for rooftop deployments may be difficult to estimate and sensitive to a range of program details as well as other factors that may be unmeasured or changing. Once a legislature or regulatory agency develops a target number of deployments, many programs rely on determinations of the details by the government. Such administrative determinations may focus on a few major, readily measurable factors, like the cost of a "typical" rooftop system at a specific time. However, as explained in later sections, these determinations often have only sketchy information on the relevant portion of the supply curve.

> The households least able to afford the upfront capital costs associated with installing solar [photovoltaic systems] are those that pay the highest effective rate of taxation. As such, in addition to being a regressive form of taxation, [feed-in tariffs] are a cross subsidy of wealth from lower income households to higher income households.

Id.

Some of the conceptual and practical problems with the designs and details of these programs are clear. A few illustrations follow.

1. *Some government programs have been unable to estimate how many people would respond to specific levels of energy-efficiency incentives*. While energy efficiency tax incentives have been largely successful at increasing demand for high-efficiency products,[31] examples of incorrect estimates include the vast oversubscription to the "Cash for Clunkers" auto trade-in program in 2009;[32] a high number of "free riders" for windows tax incentives because eligibility levels were too easily met (that is, the tax incentive had little incremental effect on installations);[33] and the failure of tax incentives for residential fuel cell cogeneration and heavy duty hybrids to stimulate appreciable market share increases.[34] A recent analysis of energy efficiency tax incentives found that instead of relying on a one-time assessment of costs, "[m]arket transformation efforts work best when they are systematically re-evaluated and updated throughout the lifetime of the effort."[35]

2. *Tax credits* to reduce the cost of solar systems provide greater benefits to individuals and corporations paying taxes at the highest marginal rates. For lower income households, government entities, nonprofit organizations, and other taxpayers with large tax deductions, the programs may have no or little effect on their fundamental economic challenge to deploying rooftop solar. To address this design problem, some programs use cash payments instead of tax credits; still, many potential participants are unwilling to finance the system costs upfront, file the necessary paperwork, and wait for refunds. Additionally, tax credits can be difficult to analyze and have unintended consequences for potential investors. For example, some applicants in CPS Energy's feed-in tariff program in San Antonio, Texas, withdrew their applications after

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31. RACHEL GOLD & STEVEN NADEL, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., ENERGY EFFICIENCY TAX INCENTIVES, 2005-2011: HOW HAVE THEY PERFORMED 10 (June 2011) (white paper issued by the American Council for an Energy-Efficient Economy).

32. U.S. GOV'T ACCOUNTING OFFICE, AUTO INDUSTRY: LESSONS LEARNED FROM CASH FOR CLUNKERS PROGRAM 2-3 (Apr. 2010), http://www.gao.gov/new.items/d10486.pdf ("The act originally appropriated $1 billion for the CARS program (commonly known as 'Cash for Clunkers') and established a period of eligibility between July 1, 2009, and November 1, 2009. . . . High consumer interest during the first days of the program led Congress to appropriate an additional $2 billion for the program on August 7, 2009. To ensure the program's appropriated funding would be sufficient for all completed transactions, NHTSA closed the program to new transactions on August 24, 2009 . . . ." (footnote omitted)).

33. GOLD & NADEL, *supra* note 31, at 12.

34. *Id.* at 2.

35. *Id.* at 11.

learning that the exemption from Texas property taxes applies to solar power consumed on-site but not to solar power sold to a utility.[36]

3. *Interest rate reductions* for financing solar systems fail to reach homeowners and other entities that do not require debt to purchase the systems, are not creditworthy for long-term loans, or are unable or unwilling to incur long-term debt.

4. *Short-term (spot) procurements* by utilities leave large uncertainties about the volumes and prices of future utility procurements from rooftop systems. In addition to exposing utilities to potentially high spikes in spot prices, such procurements may do little to stimulate investments in long-lived rooftop systems.[37] In contrast, utility procurements pursuant to long-term contracts decrease the uncertainty of future benefits to owners, resulting in lower capital costs and lower discount rates.[38]

5. *Oversubscriptions for grants and in utility procurements* at predetermined prices have led to use of lotteries, short time windows for accepting applications, and other noneconomic methods of allocating the scarce resources. This mechanism results in the government or utility paying more than the market required to acquire the desired quantity of solar power or SRECs. Additionally, the applicants bear the costs of uncertainty during the administrative process as well as the costs of filing more applications than the demand. The next section describes some recent problems with oversubscriptions in programs providing solar feed-in tariffs.

To illustrate the difficulties of governmental determinations of how and how much to adjust the benefits and costs relevant to building owners' decisions to install rooftop solar systems, consider the recent observations by Daniel Yergin on the tax incentives provided to encourage purchases of fuel-efficient, hybrid automobiles:

> *Consumer Reports* may have questioned whether a hybrid was actually superior to a high-mileage car from a dollar-savings point of view, taking into account vehicle as well as fuel costs, but that was not the point. Although there were tax incentives to encourage hybrid purchases, the hybrid was about more than just incentives and economics. Driving a Prius was also a statement—both to others and oneself—about the owner's concern about the environment, climate change, and oil dependence. . . .

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36. Tracy Idell Hamilton, *Solar Program's Profile Dimmer; After Mad Race To Sign Up, More Than Half of Participants Have Dropped Out.*, MYSANANTONIO.COM (May 28, 2011, 12:02 AM), http://www.mysanantonio.com/living_green_sa/article/Solar-program-s-profile-dimmer-1399774.php.

37. *See* FARRELL, *supra* note 28, at 4.

38. *Id.* at 10.

> . . . .
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> . . . In 2007 Americans bought more Priuses than Ford Explorers . . . .[39]

Put in terms of the mathematical expression shown above, R (owner's benefits from a clean energy technology in addition to savings on energy purchases) was significantly greater than zero for many auto buyers.

Similarly, this factor is likely to be significant for some (perhaps many) individuals and businesses deciding on rooftop solar even without revenues from government programs. What means can a government program use to determine how these benefits are valued by different building owners across a state? That is, how many consumers require only a small government incentive to make the solar investment, and how many more consumers will jump in after a small increase in that government incentive? More generally, what means can a government program use to determine the adjustment to the fundamental economics of rooftop solar which will achieve the targeted level of installations at minimum cost to taxpayers and utility ratepayers?

The answer is that the government programs should rely greatly on market-based mechanisms to discover the optimal prices. One-time administrative analyses of costs or some of the other hard-to-measure factors cannot substitute for market determinations.

To draw on decades of experience in regulating utility rates, the Appendix describes difficulties government agencies have had in implementing cost-of-service (also known as rate base/rate of return) rate-making for monopoly regulated companies. There has been a movement to replace administrative determinations of reasonable costs with more flexible, market-driven pricing practices.[40]

IV. OVERCOMING THE ECONOMIC CHALLENGE FOR ROOFTOP SOLAR SYSTEMS

A. Oversubscription or Minimal Response to Some Programs Using Administratively Set Prices for Utility Procurements from Solar Systems

Several recent state programs to stimulate rooftop solar are described below.

Each of these programs starts with a limit on demand. This limit usually reflects cost constraints on the program, or how much ratepayers

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39. DANIEL YERGIN, THE QUEST: ENERGY, SECURITY, AND THE REMAKING OF THE MODERN WORLD 682-85 (2011).

40. *See infra* Part IV.B.

would pay for the higher cost of solar power compared to electricity from fossil fuels. The limit possibly also derives from the benefits of delaying some solar installations, with the expectation of declining prices as the technology improves and system production grows. Another rationale for limits on procurements of any one renewable technology or size of project goes to diversity of suppliers and local development goals.[41]

Next, the programs use administrative determinations to set prices and other standard terms for solar feed-in tariffs. The program administrator then announces a window for applications at those prices. In three instances (Gainesville, Florida, Vermont, and most allocations in Oregon), the prices proved to be so attractive that the programs were vastly oversubscribed. In contrast, other programs (the most recent allocation in Oregon and Hawaii) suffered from little interest in the prices and terms offered.

In economic terms, the prices for the oversubscribed programs were above the point of intersection between the demand and supply curves, resulting in (1) higher payments for the quantity procured and (2) a problem for the administrator in selecting suppliers from the excessive number of applicants. In the undersubscribed programs, the prices were below the point of intersection between the demand and supply curves, yielding less than the targeted amount of supply of the renewable energy projects.

1. *Gainesville Regional Utilities* (GRU) in 2009 offered the first solar feed-in tariff in the United States.[42] GRU offered a standard contract at predetermined rates (depending on the system size and type of installation) for twenty years. The program set an annual capacity limit of four megawatts (MW). After opening the window for applications, GRU hit the first annual capacity limit in one week, and in four months had applications for seven years of capacity. GRU applied the first-come, first-served principle for handling the excess applications and established a queue. Despite the excess supply, GRU committed to continue the initial price in the second year. In a public presentation on the program, GRU observed that it set the price "to assure profitability for investor[s]"; the heavy flow of applications "suggests strong pent up demand for solar"; and "scarcity leads to unscrupulous behaviors: phantom projects, speculators and squatters; demands for special

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41. *See* TAYLOR, *supra* note 2, at 6-7.

42. *Leading the Nation: GRU's Solar Feed-In-Tariff*, GAINESVILLE REG'L UTILS. (Feb. 6, 2009), https://www.gru.com/AboutGRU/NewsReleases/Archives/Articles/news-2009-02-06.jsp.

treatment, carve-outs, exemptions, exceptions, preferential status, special deals, etc. etc."[43]

2. *Vermont Sustainably Priced Energy Development Program* offered standard rates and long-term contracts for seven renewable energy technologies, including solar systems.[44] In 2009, the total capacity for this program was capped at 50 MW, intending that no single technology would exceed 25% of this amount (12.5 MW).[45] During the first eight hours that the program was open, it received applications for more than 208 MW of capacity, including 172 MW of capacity from 196 applications for solar projects.[46] The program held a lottery selecting 16 solar projects (only 8% of the applicants, accounting for 14.25 MW) for the next stage of processing.[47] In light of the oversubscription in 2009, the Vermont Public Service Board reduced the standard offer rate for solar contracts by 20% for the 2010 procurement.[48] A managing consultant with the nonprofit Vermont Energy Investment Corporation (which operates the state's Efficiency Vermont efforts) commented about the program's initial experience:

> [C]reating an FIT [feed-in tariff] that is oversubscribed immediately, and in which most of the market applicants cannot participate, risks equating solar development with a "lottery mentality" that is not conducive to sustained orderly development of the resource or of solar markets. . . .
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> . . . .
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> . . . [T]he Vermont experience with the standard offer program illustrates that setting an accurate cost-based rate is at least difficult, and is characterized by a good amount of uncertainty around key inputs that are subject to very rapid change in dynamic financial and solar markets.[49]

3. *Oregon*. The Oregon Public Utility Commission has been running a pilot feed-in tariff program which had its first window for applications in July 2010 and continues through 2014 with eight

43. John Crider, *Gainesville's Solar Feed In Tariff: Early Lessons Learned*, GAINESVILLE REG'L UTILS. (Mar. 18, 2010), http://www.chpcenterse.org/pdfs/GainesvillesSolarFIT_Crider.pdf; *see also* Paul Gipe, *Solar PV Leads Small Town into Solar Big Leagues*, RENEWABLEENERGYWORLD.COM (Nov. 21, 2011), http://www.renewableenergyworld.com/rea/news/article/2011/11/solar-pv-leads-small-town-into-solar-big-leagues?cmpid=SolarNL-Tuesday-November22-2011. The feed-in tariff for SMUD also quickly filled the queues. *Feed-In Tariff for Sale of Customer Sited Generation to SMUD: Questions and Answers*, *supra* note 2, at 1-2.

44. DAVID G. HILL, FEED-IN TARIFFS—THE VERMONT SUSTAINABLY PRICED ENERGY DEVELOPMENT PROGRAM: CASE STUDY AND LESSONS FOR FUTURE DESIGN 2 tbl.1 (SOLAR 2010 Conference Proceedings), http://www.ases.org/papers/194.pdf (last accessed Jan. 19, 2012).

45. *Id.* at 2.

46. *Id.*

47. *Id.*

48. *Id.*

49. *Id.* at 3-4.

enrollment periods.[50] In the first enrollment period, the Oregon commission set rates between 55 and 65 cents per kilowatt hour (kWh) for small- and medium-sized systems.[51] The agency explained its determination of cost-based prices:

> A critical element of the pilot program is the rates offered for energy produced by the small-scale and medium-scale systems. To determine the initial volumetric incentive rate (VIR), the Commission relied on actual system cost data provided by the [Energy Trust of Oregon] for systems installed between the last quarter of 2009 through the first quarter of 2010. For each project, the Commission added loan financing costs, insurance costs, income taxes, and utility meter service charges to achieve a 15-year payback.
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> . . . [T]he Commission also adopted different rates for four different geographic zones.[52]

Using a first-come, first-served method to handle applications, the capacity was subscribed in just fifteen minutes.[53] The government agency reduced rates by 10% for the next enrollment period, which filled up in under an hour.[54] In the third period, rates were decreased by another 20% (to between 39.6 and 46.8 cents per kWh), and again the flood of applications quickly filled the capacity.[55] The peak annual rate impacts of the utilities' payments pursuant to this program ranged from 0.45-1.33% of customer-required revenue for the utilities, substantially higher than the 0.25% cap that was targeted when the legislature created the program.[56] A manager for the regulatory commission observed about the oversubscription at the prior administratively determined prices: "What that's a sign of is that we could lower the rate, still incentivize solar development in Oregon and lower the rate impacts."[57]

The Oregon commission decided to make three changes for the fourth enrollment period (October 2011): (1) decrease the prices further by 20%, (2) replace the first-come, first-served strategy with a lottery for oversubscription, and (3) use bids to determine prices for medium-sized

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50. Lee van der Voo, *Feed-In Tarrif* [*sic*] *Changes Planned for Oregon Solar Industry*, SUSTAINABLE BUS. OR. (May 12, 2011, 11:16 AM), http://www.sustainablebusinessoregon.com/articles/2011/05/feed-in-tarrif-changes-planned-for.html.

51. *Id.*

52. PUB. UTIL. COMM'N OF OR., SOLAR PHOTOVOLTAIC VOLUMETRIC INCENTIVE RATE PILOT PROGRAM: REPORT TO THE LEGISLATIVE ASSEMBLY 6 (Jan. 1, 2011), http://www.puc.state.or.us/PUC/123010finalsolarreport.pdf.

53. Van der Voo, *supra* note 50.

54. *Id.*

55. *Id.*

56. *Id.*

57. *Id.* (quoting Maury Galbraith, Oregon Public Utilities Commission).

(capacity between 10 and 100 kWh) systems in one utility's area.[58] Compared with the option of simply closing the application window, the lottery may indicate better the amount of excess supply at the prices. The new prices and rules led to deficiencies of applications (about 45% to 80% of the available capacity) one week after the enrollment period opened for projects subject to the administratively determined prices; in contrast, the projects subject to bidding received bids for 200% of the available capacity.[59]

4. *Hawaii.* Hawaii implemented a feed-in tariff program in November 2010 that has largely failed to stimulate growth in renewable energy supply.[60] The tariff offered fixed prices for twenty years, with cost-based rates and terms that were approved by the Hawaii Public Utilities Commission through a two-year proceeding.[61] More than one year before the initial tariffs were approved, the commission stated the following standard for the rates:

> FIT rates should support a typical or average project that is reasonably cost-effective, and that included in the calculation of FIT rates should be project and generation cost information, energy production, and the target internal rate of return. The project costs . . . should include, but are not limited to, capital costs for generation equipment and transmission; initial development costs; financing costs; the ongoing costs associated with operating and maintaining the project; and applicable federal and State taxes or other incentives.[62]

In addition to rates, some terms in the standard contracts were contentious. The contracts allowed the utility to curtail the amount of energy it buys from the producers at any time.[63] Also, the utility could require an applicant to submit an interconnection study showing that the proposed renewable energy system would not disrupt the electric grid.[64] In approving the feed-in tariff, the commission noted the different

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58. *Incentive Rate Pilot Program for Solar PV Systems*, OR. PUB. UTIL. COMM'N, http://www.puc.state.or.us/PUC/solar/SolarIncentivePilotProgram10711.pdf (last visited Feb. 22, 2012); Mark Pengilly, *Oregon's Solar Pilot Program: Snapshot of October 2011 Capacity Allocation*, OREGONIANS FOR RENEWABLE ENERGY POL'Y, http://www.oregonrenewables.com/Resources/OregonsFIT/Oregon_FIT_1011Snapshot.html (last visited Feb. 22, 2012).

59. Pengilly, *supra* note 58.

60. Sophie Cocke, *Feed-In-Tariff Program Has Worked for Only 3 Projects*, PAC. BUS. NEWS (May 27, 2011, 12:00 AM), http://www.bizjournals.com/pacific/print-edition/2011/05/27/feed-in-tariff-program-has-worked-for.html?s=print.

61. *See* Decision and Order at 85, *In re* Pub. Utils. Comm'n: Instituting a Proceeding To Investigate the Implementation of Feed-In Tariffs, No. 2008-0273 (Pub. Utils. Comm'n Haw. Sept. 25, 2009), http://dsireusa.org/documents/Incentives/HI29F.pdf (citations omitted).

62. *Id.* at 62-63 (footnotes omitted).

63. *See id.* at 88.

64. *Id.* at 45.

positions in the record on rates and terms, decided in favor of gaining market experience rather than conducting further administrative proceedings, and committed to a review after two years with the possibility of interim adjustments.[65]

As of May 27, 2011 (about six months after inception), only three projects using feed-in tariffs went online.[66] Over 87% of the capacity allocated to the program remained available for new projects.[67] The first installation was on the roof of a commercial property owned by Maui's energy commissioner.[68] This building owner may not have been driven solely by financial returns; a news report stated that the feed-in tariff was expected to result in annual earnings for this owner of $2,200 to $2,800 on a net investment (after federal and state tax credits) for the system of $17,500.[69] Apparently, the market judged such returns inadequate to bring forth widespread investments in new systems, particularly in the context of the other contract terms and application process.

Some analysts and potential participants blamed the lack of new projects primarily on the nonprice contract terms and application process, especially the uncertainty for owners surrounding the utilities' ability to curtail purchases. Still, one industry executive claimed that the feed-in tariff price should be raised by more than 37% in order to make projects profitable and induce new investments.[70] In further regulatory proceedings to determine the feed-in rate to offer for large projects, there were substantial disputes among parties over the cost modeling used by the utilities to develop feed-in rates.[71]

Over half of the applications in the Hawaii program were terminated for being unprepared to move forward or withdrawn.[72]

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65. Order Approving FIT Tiers 1 and 2 Tariffs, Standard Agreement, and Queuing and Interconnection Procedures at 2, *In re* Pub. Utils. Comm'n: Instituting a Proceeding To Investigate the Implementation of Feed-In Tariffs, No. 2008-0273 (Pub. Utils. Comm'n Haw. Oct. 13, 2010), http://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A10J13B20505B87966 [hereinafter Order Approving FIT Tiers 1 and 2 Tariffs].

66. Cocke, *supra* note 60.

67. ACCION GROUP, STATUS REPORT OF THE INDEPENDENT OBSERVER 2 (July 8, 2011), https://www.hecofitio.com/_heco/docs/Oahu/Tier1/documents/IO FIT Status Report 07082011.pdf.

68. Cocke, *supra* note 60.

69. *Id.*

70. *Id.*

71. *See* Joint Filing of the Parties and Participants, *In re* Pub. Utils. Comm'n: Instituting a Proceeding To Investigate the Implementation of Feed-In Tariffs, No. 2008-0273 (Pub. Utils. Comm'n Haw. Sept. 23, 2011), http://dms.puc.hawaii.gov/dms/OpenDocServlet?RT=&document_id=91+3+ICM4+LSDB15+PC_DocketReport59+26+A1001001A11I27B04155C4455018+A11I27B04155C445501+14+1960.

72. Cocke, *supra* note 60.

Similarly, a feed-in tariff program in San Antonio suffered widespread withdrawals of applications.[73] Some withdrawing applicants in Texas claimed that the administratively determined price was not high enough in light of the loss of an exemption from state property taxes when rooftop systems sell to a utility; this tax impact was not understood by these building owners when they filed their applications and may not have been understood by the administrators in setting the price.[74]

B. *Market-Based Mechanisms for Expanding Rooftop Solar Deployments*

Simply put, developing prices that accomplish the purposes of feed-in tariffs or RECs are difficult. In pricing either instrument for stimulating rooftop solar, administrators face uncertainties in the relevant costs as well as large unknowns about the supply curve of potential investors. The preceding review of four programs shows that cost accounting methodologies, industry consultants, modeling by utilities and administrators, and multiyear regulatory proceedings may fail to produce prices for feed-in tariffs or RECs which approximate levels needed to achieve the targeted supply without imposing unnecessary cost burdens on ratepayers.

Where else can government programs look to develop these prices? The alternative direction is to tap into the analyses by the independent decision makers who are critical to supplying rooftop solar energy and will respond to the programs' prices. Each individual building owner and rooftop solar developer is best positioned to decide whether a price is high enough to stimulate a particular new investment. In aggregate, the market performs an analysis of the relevant costs and benefits for the programs' offerings. Moreover, each of these decision-makers is also best positioned to decide and signal whether, in light of the relevant costs, he or she would accept a lower or higher price. Collectively, the market determines whether any given price could be adjusted upward or downward to better accomplish the program's objectives.

A variety of market-based mechanisms for pricing feed-in tariffs and RECs are available. Three market-based mechanisms described in this Part are (1) reverse auctions, (2) iterative price adjustments reflecting supply responses at prior prices, and (3) offering a few prices simultaneously. Each of these mechanisms relies on the market to discover prices that promote the programs' goals. Each approach can

73. Hamilton, *supra* note 36.
74. *Id.*

offer the same standard contract terms, including long-term commitments on price and quantity, to reduce uncertainty.[75]

1. Reverse Auctions

a. Characteristics of and Concerns About Reverse Auctions

Participants in a reverse auction bid prices at which they would be willing to invest in a new rooftop solar system on the terms in the standard contract. The quantity allocated for the program in a specific period would be satisfied by selecting the lowest bids that aggregate to that level. Generally, the utility pays the "market-clearing price" to all winning bidders; that price is the level at which equal and lower bids aggregate to the desired quantity of solar energy or SRECs.[76]

The auction design could involve a single round for bidding in which each participant submits its final bid. Alternatively, the auction could involve multiple rounds of bidding; in any round, the bidders gain information on the willingness of others to supply at a given price and then decide whether to lower their bids in the next round in order to make them more attractive for selection. A well-designed auction would result in the lowest cost to ratepayers for the targeted quantity from rooftop solar systems, and enable those building owners who demand the lowest subsidies to obtain the contracts.

Reverse auctions are used in some programs for utility procurements from renewable energy systems.[77] In some cases, the auctions are dominated by large commercial developers with sophistication in evaluating options, resources to devote to an auction,

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75. *See FAQs: Purchase and Sale Agreement*, Answer to *FAQ-272*, SREC-BASED FINANCING PROGRAM, http://www.njedcsolar.com/faqs.cfm?faqCategoryId=3 (last updated Nov. 17, 2011) (explaining that the term of the New Jersey solar renewable energy certificate Purchase and Sale Agreement can be from ten to fifteen years, with quarterly payments at the fixed price determined by the initial auction).

76. *See generally* PAUL MILGROM, PUTTING AUCTION THEORY TO WORK (2004); VIJAY KRISHNA, AUCTION THEORY (2d ed. 2010); PAUL KLEMPERER, AUCTIONS: THEORY AND PRACTICE (2004).

77. *See* Decision Adopting the Renewable Auction Mechanism at 2, Order Instituting Rulemaking To Continue Implementation & Admin. of Cal. Renewables Portfolio Standard Program, Rulemaking 08-08-009 (Pub. Utils. Comm'n Cal. Dec. 17, 2010), http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/128432.pdf ("[The Renewable Auction Mechanism] relies on market-based pricing, utilizes project viability screens, and selects projects based on least cost rather than on a first-come first-served basis at an administratively determined price."); ILL. POWER AGENCY, FY 2011 ANNUAL REPORT, http://www2.illinois.gov/ipa/Documents/IPA_Annual_Report_2011_final_pdf (last visited Mar. 19, 2012); *Previous Results*, SALE SOLAR RENEWABLE ENERGY CERTIFICATES (SRECS), http://www.solarrec-auction.com/index.cfm?s=background&p=previousResults (last visited Feb. 22, 2012); *The SRECTrade Auction*, SRECTRADE, http://www.srectrade.com/how_it_works.php (last visited Feb. 22, 2012).

and lower costs from economies of scale. The costs of auction participation for large developers may be minor relative to the expected revenues from selection. In contrast, concerns about this mechanism include that residential and small commercial building owners are unlikely to participate in a reverse auction because of uncertainties about the outcome, high transaction costs relative to their expected revenues, and disadvantages for them in competing against larger property owners and developers.[78]

Regarding these concerns, it appears that well-designed reverse auctions offer advantages over approaches relying on administratively set prices, a queue for oversubscription, and lottery selections (referred to as the "Admin/Queue Model") on some major criteria. Moreover, the possible disadvantages of auctions on other criteria do not appear to be significant.

An auction requires participants to decide to incur expenses and obligations in qualifying in the face of uncertainty about the price they will be offered. In order to deter speculative participants, an auction may require bidders to make a deposit, demonstrate certain qualifications (such as describing the proposed system and location), and agree to some penalties for withdrawal or, if selected, for failure to install a rooftop system within a specified period of time.[79] Nevertheless, the burdens on and risks for applicants in a reverse auction do not need to be much greater than in applying under the Admin/Queue Model.

First, the Admin/Queue Model and auctions require similar protections against speculative, unqualified applicants, and use similar qualifications and penalties. Both mechanisms can reduce transaction costs for small systems by allowing agents or aggregators to participate in the selection process.[80]

Second, an auction's administrator could announce a reserve price, the ceiling for bids. Auctions often use reserve prices. Reserve prices protect the auctioning party against having to make awards at unacceptable prices, provide some guidance to potential bidders, and in multiround auctions, accelerate the process of arriving at bids which will be selected. In an auction for utility procurements to stimulate rooftop

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78. *See* Edgar A. Gunther, *California Reversal of Feed-In Tariff Auction Proposal*, GUNTHER PORTFOLIO (Sept. 8, 2009, 1:22 AM), http://guntherportfolio.com/2009/09/california-reversal-of-feed-in-tariff-auction-proposal/.

79. *See* HILL, *supra* note 44, at 5.

80. *FAQs: New Jersey's Solar Renewable Energy Certificates (SREC) Program and New Jersey's Solar Market: Transition to Market-Based REC Financing System,* Answer to *Can Someone Else Sell My SREC for Me?*, NEW JERSEY'S CLEAN ENERGY PROGRAM, http://www.njcleanenergy.com/renewable-energy/tools-and-resources/faqs/srec (last visited Mar. 7, 2012).

solar, this price would protect ratepayers from paying a high amount for the particular type of renewable energy. Additionally, the reserve price would help guide potential small participants in an auction so that the process of developing a bid is not completely open-ended. As in the Admin/Queue Model, auction participants could choose to submit an application at the announced price. An auction provides the additional option for bidders to submit a lower price. Bidding at the reserve price involves the hope that any bidders at a lower price would not aggregate to the quantity allocated for selection. If the bids below the reserve price fail to satisfy the quantity allocated for selection, then the selection of bids at the announced price is similar to the Admin/Queue Model.

Third, an auction could be designed as a single submission or multiple rounds of submissions. A multiround auction provides bidders with valuable information about the supply from competing sources. Auction participants could use this information to adjust their bids from one round to the next, in a process that economists call "price discovery."[81] On the other hand, a multiround auction entails submission of multiple bids. The regulators may decide that for small participants the burdens of submitting multiple bids outweigh the benefits of price discovery in a multiround auction. In that case, the small participants would make a single submission in the auction, just as in the Admin/Queue Model.

Next, regarding the uncertainty of participating in an auction, the winning applicants and bids would be announced at the close of the single-round or multi-round bidding. Participants in the Admin/Queue Model have, in several instances, also faced uncertainty because of vast oversubscription at the announced price.[82] In some cases, the applicants in an Admin/Queue Model have to wait until the outcome of a lottery; in other cases, they are delayed by perhaps several years. Even though the price is known in the Admin/Queue Model, potential applicants cannot decide to incur planning and application costs with certainty that they will be able to obtain a contract at that price. It is not clear whether the auction or Admin/Queue approach involves substantially less uncertainty and would induce significantly greater participation by smaller building owners.

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81. *See* Giuseppe Lopomo et al., *Carbon Allowance Auction Design: An Assessment of Options for the United States*, 5 REV. ENVTL. ECON. & POL'Y 25, 31 (2011); Peter Cramton, *The FCC Spectrum Auctions: An Early Assessment*, 6 J. ECON. & MGMT. STRATEGY 431, 435 (1997) ("An essential advantage of open bidding is that the bidding process reveals information about valuations. This information promotes the efficient assignment of licenses, since bidders can condition their bids on more information.").

82. *See* Van der Voo, *supra* note 50.

Finally, the Admin/Queue Model and auctions could similarly categorize potential participants by size and restrict some allocation to smaller building owners. In an auction approach, larger projects would bid in one auction and smaller projects would compete in a separate auction.

b. Observations from the Vermont Program

The managing consultant for the Vermont Energy Investment Corporation made these observations comparing the Admin/Queue Model that was used in that state against a possible reverse auction alternative:

> The risks—of setting a rate too low and under stimulating the market, or of setting the rate too high and having an over-heated market that ends up paying more than necessary for the resources—are unfortunately only avoided when the "price is right".
>
> The fundamental aspect of a [feed-in tariff] and the standard offer program that is likely to be the most important and critical for promoting rapid development is the availability of a long term, credit worthy, contract. If the stable long term contract is made available, there are alternative means to set the contract rate.
>
> Faced with these conditions, policy makers and program designers may want to consider alternative approaches to setting standard offer contract rates that provide more direct market dynamic inputs through direct bidding for participation in the program.
>
> A declining price auction can be used to identify bidders willing to develop projects sufficient to meet renewable development targets. In order to qualify to bid, projects could be required to meet certain minimum pre-project feasibility criteria. The declining price auction would permit market actors to determine their own risk tolerance, required rate of return, and financial input assumptions, rather than relying on regulatory or stakeholder processes to set prices.[83]

c. Auctions for SRECs

Auctions as well as privately negotiated transactions have been used for several years to price and transfer SRECs in state programs. As of February 2012, SREC market prices were publicly tracked and reported on a monthly basis for Delaware, Maryland, Massachusetts, New Jersey, Ohio, Pennsylvania, and Washington, D.C.[84] For example, starting in

83. HILL, *supra* note 44, at 4-5.

84. *SREC Market Prices*, SRECTRADE, http://srectrade.com/srec_prices.php (last visited Feb. 22, 2012).

August 2009, the New Jersey SREC program issued three Requests for Proposals per year.[85] The solicitations had one segment for small projects (50 kW and less) and a separate segment for larger projects.[86] Bidders submitted Pricing Proposals which included a fixed price per SREC and a contract length from ten to fifteen years.[87] Proposals were ranked based on their net present value, with the lowest bid receiving the highest ranking for purchases by the utilities.[88]

The state laws and regulations allow for market-based pricing of SRECs. However, in some state markets, the volume and prices are influenced by an administratively determined price, the penalty paid by a utility if it fails to acquire sufficient SRECs to comply with the applicable renewable portfolio standard.[89] In contrast, the penalty in Pennsylvania is based on double the value of market-priced SRECs for the reporting period.[90] Just as an announced reserve price in an auction, an administratively-determined penalty price acts as a ceiling on market prices for SRECs. If the "solar alternative compliance payment" is lower than the price needed to cover the cost that building owners demand to produce SRECs, then utilities will pay the penalty to the program

85. *New Jersey: Utility Solar Financing Programs (ACE, JCP&L, RECO)*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ41F&re=1&ee=1 (last visited Mar. 7, 2012).

86. *Id.*

87. *Id.*

88. *Id.*

89. *See Massachusetts DOER—Solar Renewable Energy Credits (SRECs)*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MA98F&RE=1&EE=1 (last visited Feb. 23, 2012); *About the RPS Solar Carve-Out Program*, MASS. EXECUTIVE OFF. ENERGY & ENVTL. AFF., http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/about-the-rps-solar-carve-out-program.html (last visited Feb. 23, 2012); *Maryland Public Service Commission—Solar Renewable Energy Certificates (SRECs)*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD55F&re=1&ee=1 (last visited Feb. 23, 2012); *New Jersey Board of Public Utilities—Solar Renewable Energy Certificates (SRECs)*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ07F&re=1&ee=1 (last visited Feb. 23, 2012); *Delaware Public Service Commission—Solar Renewable Energy Credits*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=DE13F&re=1&ee=1 (last visited Feb. 23, 2012); *District of Columbia Public Service Commission—Solar Renewable Energy Certificates*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=DC13F&re=1&ee=1 (last visited Feb. 23, 2012); *Public Utilities Commission of Ohio—Solar Renewable Energy Credits*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OH61F&re=1&ee=1 (last visited Feb. 23, 2012).

90. *Pennsylvania Public Utilities Commission—Solar Alternative Energy Credits*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=PA64F&re=1&ee=1 (last visited Feb. 23, 2012).

administrator instead of purchasing SRECs from solar system owners. In that case, SREC owners and potential producers are not able to sell them through auctions or privately negotiated transactions, and the SREC market fails to stimulate investments in solar systems. Some programs announce the levels of these penalties for many years into the future, subject to possible reviews and revisions.[91] In Massachusetts, another administratively determined price acts as a floor on market prices for SRECs, the price of the "solar credit clearinghouse," which is available to purchase any unsold SRECs from system owners.[92]

Some programs include features to help owners of smaller systems, such as websites for utilities to post their offers, prioritization for smaller systems' multiyear contracts, and sales to intermediate aggregators.[93]

2. Iterative Price Adjustments Reflecting Supply Responses at Prior Prices

a. Characteristics of Iterative Price Adjustments

A second approach uses market information to adjust prices in the context of the Admin/Queue Model. As in the Oregon program described above, this approach may employ frequent (quarterly or semiannually) windows for applications,[94] or, as in the California program described below, the price adjustments may be automatic as a continuous window for applications yields predetermined levels of supply. In contrast, the Gainesville and Hawaii programs set prices for two years,[95] and other programs attempt to provide more certainty by announcing prices for even longer periods.[96]

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91. *Maryland Public Service Commission—Solar Renewable Energy Certificates (SRECs)*, *supra* note 89 (fixing the solar alternative compliance payment at $400/MWh for 2009-2014, with reductions to $50/MWh for 2023); *New Jersey Board of Public Utilities—Solar Renewable Energy Certificates (SRECs)*, *supra* note 89 (explaining that solar alternative compliance payment declines by 2.5% annually for eight years); *Public Utilities Commission of Ohio—Solar Renewable Energy Credits*, *supra* note 89.

92. *Massachusetts DOER—Solar Renewable Energy Credits (SRECs)*, *supra* note 89.

93. *Maryland Public Service Commission—Solar Renewable Energy Certificates (SRECs)*, *supra* note 89; *Massachusetts DOER—Solar Renewable Energy Credits (SRECs)*, *supra* note 89; *FAQs: New Jersey's Solar Renewable Energy Certificates (SREC) Program and New Jersey's Solar Market: Transition to Market-Based REC Financing System*, Answer to *Can Someone Else Sell My SREC for Me?*, *supra* note 80.

94. *See* Van der Voo, *supra* note 50.

95. Crider, *supra* note 43, at 8; Order Approving FIT Tiers 1 and 2 Tariffs, *supra* note 65, at 2.

96. *See* MASS. EXEC. OFFICE OF ENERGY & ENVTL. AFFAIRS, RENEWABLE ENERGY PORTFOLIO STANDARD: GUIDANCE ON THE FORWARD SCHEDULE OF THE SOLAR CARVE-OUT ALTERNATIVE COMPLIANCE PAYMENT (ACP) RATE 1 (Dec. 28, 2011), http://www.mass.gov/eea/docs/doer/rps-aps/forward-solar-acp-rate-guideline.pdf (stating that a ten-year schedule of annual

For each application window or quantity of supply in the iterative approach, the administrator announces a price and uses a queue to reflect the total applications submitted at that price. In contrast, closing the window when the quantity has been met on a first-come, first-served basis, as in the early versions of the Vermont program, provides less information about the supply curve.[97] If the quantity bid exceeds the quantity allocated at a given price, the administrator may use the size of the queue to determine whether to reduce the price by a small or significant amount. Conversely, if the quantity bid falls short of the quantity allocated at a given price, the administrator may use the amount bid to determine whether to raise the price by a small or significant amount. In this way, the approach uses market responses at a series of prices to discover prices which are more likely to equate supply and demand in the future. The downward price adjustments also reduce the cost of the program to utility ratepayers.

Unlike an auction, this approach does not necessarily produce market-clearing prices at any particular time. Rather, it uses market information and an adjustment process to converge on prices for future allocations, which are more likely than the preceding prices to reduce queues or inadequate supply. The recent Oregon experience shows that the administrator's judgments that go into tuning the adjustment process are difficult and sensitive; some adjustments in response to large past queues resulted again in large queues, whereas another adjustment in response to a large past queue led to substantial undersupply.[98] Furthermore, when market conditions are changing rapidly, the market information used in the adjustment process may be outdated. This is likely to be true of utility procurements from rooftop solar systems in light of changes in technologies; economies of scale; revisions in taxes, grants, financing and other cost factors; and evolving nonmonetary values placed on having rooftop systems by various building owners.

On the other hand, the iterative approach may be more attractive to some legislatures and regulators than auctions. Some states may like the control by the administrator in the iterative approach, including its ability to form an orderly sequence of prices and to assess market conditions. In contrast, a series of auctions may produce a sequence of prices that

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rates for solar payments "will provide the necessary market certainty needed for the Solar-Carve Out to work optimally"); *New Jersey Board of Public Utilities—Solar Renewable Energy Certificates (SRECs)*, *supra* note 89 (eight-year rate schedule); *Maryland Public Service Commission—Solar Renewable Energy Certificates (SRECs)*, *supra* note 89 (six-year rate schedule).

97. HILL, *supra* note 44, at 2.

98. *See* Van der Voo, *supra* note 50.

would be difficult to forecast. Also, some programs may view the administrators' announcement of prices as more transparent to smaller bidders.

b. Iterative Price Adjustment Mechanisms in California, Michigan, and Germany

In addition to the Oregon experience described above, the California Solar Initiative uses volume-based, predetermined price adjustments. California divided the program's total, multiyear budget of SREC purchases into ten steps.[99] Each step had a lower payment per MW and larger MW target than the preceding step. When applications filled the MW target of one step, the automatic trigger decreased the incentive payment for subsequently-filed applications. The direction of price adjustments corresponded to the expectation that system costs would decline with higher program volume over time, as technologies improved and economies of scale occurred. Additionally, the higher prices in the early steps were reasonable from the perspective that suppliers at those stages were more reluctant to undertake investments in unfamiliar solar systems and less likely to know about and file applications in an emerging program. Applying ten steps provided for generally gradual adjustments. Nevertheless, the regulators set triggers that were not market-based in terms of the target quantities and prices for each step. To illustrate, going from step six to step seven reduced the residential incentive payment from $1.10 per watt to $0.65 per watt.[100] Would that adjustment be too large to continue stimulating investments in residential solar systems? The mechanism did not provide for a partial reversal of the price change even if the market demonstrated that the incentive payment had been cut too much to overcome the economic challenge facing rooftop solar.

The program for Consumers Energy of Michigan also involved volume-based price adjustments to its feed-in tariff.[101] The pilot version of this utility's Experimental Advanced Renewable Program began in 2009 with a residential rate of $0.650/kWh.[102] After the allowed capacity quickly filled at that price, the company offered additional pilot capacity

99. CAL. PUB. UTILS. COMM'N, *supra* note 29, at 3-5.

100. *Id.* at 5 tbl.4.

101. *See Experimental Advanced Renewable Program AR*, CONSUMERS ENERGY (Aug. 19, 2011), http://www.consumersenergy.com/tariffs.nsf/ELECTRIC_TARIFFS/5284C90103A97CD6852578F50063A971/$FILE/elerates.pdf?Open.

102. *Id.*

at $0.525/kWh in 2010.[103] The expanded version of this program announced in 2011 offered 1,500 kW in total for residential systems through quarterly offerings of 125 kW each (another 1,500 kW in total would be available for nonresidential customers, awarded in 250 kW phases every six months).[104] In the first offering, residential contracts were at the rate of $0.259/kWh.[105] Prior to opening for applications, the utility announced the following guidance on price setting: "The rates offered for subsequent residential phases shall be based on the total amount of capacity offered in the applications received for prior residential phases, except that the base rate will not be less than $0.200/kWh or more than $0.259/kWh."[106] The utility did not provide further information on the formula for adjusting prices to reflect the amount of capacity offered.

The solar feed-in tariff program in Germany, often viewed as a leading, successful design, also evolved to market-based adjustments to prices.[107] In 2000-2003, Germany offered administratively-determined, cost-based rates and imposed caps on the volume of solar capacity in the program.[108] From 2004-2008, the caps on capacity procurements were lifted and prices were announced to drop by 5% annually.[109] The schedule of annual automatic price decreases was intended to provide transparency to potential investors and to reflect anticipated cost declines through technology changes and economies of scale.

Starting in 2009, Germany moved to a more flexible adjustment approach reflecting the volume of installations in the preceding year.[110] The program established baseline annual price decreases for 2009-2011 of 6.5% along with a baseline projection of installation volumes.[111] The formula allowed for price adjustments of 1% around the baseline if the actual volume in the prior year exceeded the baseline projection (leading

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103. *Id.*

104. *Michigan: Consumers Energy—Experimental Advanced Renewable Program*, DSIRE: DATABASE ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MI24F&re=1&ee=1 (last visited Feb. 23, 2012).

105. *Id.*

106. *EARP—Rates*, CONSUMERS ENERGY, http://www.consumersenergy.com/content.aspx?id=4841 (last visited Mar. 13, 2012).

107. DEUTSCHE BANK GRP., THE GERMAN FEED-IN TARIFF FOR PV: MANAGING VOLUME SUCCESS WITH PRICE RESPONSE 15-18 (May 23, 2011), https://www.dbadvisors.com/content/_media/DBCCA_German_FIT_for_PV_0511.pdf.

108. *Id.* at 13, 15-16.

109. *Id.* at 13, 16.

110. *Id.*

111. *Id.* at 16.

to a downward price adjustment) or fell below the baseline (leading to an upward price adjustment).[112]

In light of the rapid growth in installations and falling solar module costs, the German government made further price reductions and adopted more market-based pricing formulae. A law passed in July 2010 immediately decreased rates for rooftop systems by 13%; going forward, each gigawatt of solar capacity installed in a year above the baseline projection would result for 2011 in an additional 1% price decrease (up to a maximum price decrease of 13%), and for 2012 in an additional 3% price decrease (up to a maximum of 21%).[113] The formulae provided similar upward price adjustments if installation volumes fell below the projected baseline.[114] The formulae were revised again in February 2011, allowing for price adjustments ranging from 1.5% to 24% and reflecting the volumes of past installations.[115]

The German experience demonstrates two key points about developing prices for utility procurements from rooftop systems. First, administrative determinations of prices, even after several years of experience in a country, are unlikely to yield the targeted response from potential suppliers in light of changing solar module costs, other market conditions, and nonmonetary factors. The impact on utility ratepayers of announcing prices that are above the level needed to stimulate the targeted level of supply can be limited by imposing a cap on utility procurements. Market-based price adjustments can be helpful in revising administratively-announced prices to control program costs and efficiently distribute contracts to potential suppliers. Second, an iterative, volume-based approach to price adjustments is workable, but the revised prices may still significantly vary from the levels that would yield the targeted installations. Cost and other supply conditions are moving rapidly for rooftop solar systems, adding substantial uncertainties to projections of volumes and formulae for price adjustments.

3. Offering a Few Prices Simultaneously

A third version of market-based pricing involves a relatively minor revision to the Admin/Queue Model. Instead of announcing a single price for all applications (take it or leave it), the administrator could provide a few price options for selection by the applicants.

112. *Id.*
113. *Id.* at 17.
114. *Id.*
115. *Id.*

For example, the administrator's cost analysis might develop a price of ten units. A solicitation of applications at this price pursuant to the standard Admin/Queue Model would be subject to substantial uncertainty about whether applicants would respond to this price with large oversupply or undersupply. A revised approach might give applicants the option of selecting a price of nine, ten, or eleven units. Choosing the lowest price would increase an applicant's likelihood of selection. On the other, a potential applicant may be unwilling to invest in a system at a price at or below ten; having the option to apply at eleven gives that building owner the possibility of winning a contract at a price that would induce him or her to invest in the system. The market would then respond with quantities at these three price levels. If the quantity can be filled at nine, then the ratepayers would pay less than the administrator estimated and building owners requiring the lowest subsidy would be selected to install the systems. If the quantity allocated cannot be filled at nine or ten but receives some applications at eleven, then the program would come closer to satisfying the targeted quantity at a cost to ratepayers that is constrained.

The applicants would see this approach as a simplified, limited auction. The legislatures and regulators may be attracted to the greater control asserted by the administrator, and ratepayers may save money.

V. CONCLUSION

Solar energy produced by rooftop systems offers many attractions for public policy. Benefits from rooftop solar systems occur from the perspectives of public health, global climate sustainability, other environmental concerns, national energy independence, reliability of electricity supplies, local jobs, and lower costs of future energy. However, public policymakers who recognize the attractions of rooftop solar systems confront the fundamental economic challenge that, in the absence of government programs, most potential owners currently see more costs than benefits.

Moreover, policymakers face difficulties in developing programs which stimulate the targeted quantity and distribution of rooftop solar investments at the least cost to taxpayers and utility ratepayers. Unnecessary costs for the programs threaten their continuity and size. In particular, administrators trying to set prices for utility procurements from rooftop systems through feed-in tariffs, SRECs, or other incentives need to estimate many factors going far beyond a straightforward cost accounting. The willingness of building owners to invest in rooftop systems is largely unknown in any area and changing over time. Also, solar costs and other relevant factors move rapidly. Despite multiyear regulatory proceedings, utilities' models, consultants' reports, and analyses submitted to regulators by solar system installers, the administrators' prices have in several programs resulted in major oversupply or undersupply responses from potential owners.

These programs should focus on market-based determinations of prices for feed-in tariffs and SRECs. Three market-based mechanisms are reverse auctions, iterative price adjustments reflecting supply responses to prior prices, and offering a few prices simultaneously. Administrators can still exercise controls over the upper and lower bounds on prices, and should review the program design at regular intervals. Through market-based pricing, the programs can develop more cost-effective, sustainable approaches to stimulating rooftop solar investments.

APPENDIX
DECLINE OF COST-BASED DETERMINATIONS OF MONOPOLY PUBLIC UTILITY RATES

During most of the twentieth century, government regulators applied a cost-based approach to determining just and reasonable rates for monopoly public utilities.[116] The classic statement of the rate-setting task in the context of a utility offering a single service is:[117]

$$P = [E + (B * Y)] / D$$

P = price of regulated service
E = utility's operating expenses that were reasonably incurred
B = utility's rate base (capital investment in plant and other assets) that was reasonably incurred
Y = utility's rate of return (cost of capital), reflecting a reasonable capital structure, cost of debt and cost of equity
D = demand for regulated service

Even for a single-product utility, this equation is deceptively simple. Of course, most utilities offer multiple services at differing rates, raising additional complications in terms of cost allocations, cross-elasticities of demand, and other factors. Many months of administrative hearings and filings were required typically to set a cost-based rate of a single utility, involving complex, contested testimony on accounting practices, finance, engineering, operations, marketing, economic forecasting, and other disciplines.

Some conceptual and practical shortcomings of cost-based rate regulation are:[118]

- Regulators have great difficulty in determining whether a portion of the utility's expenses or rate base is not reasonably incurred. As long as a regulated firm is allowed to recover its expenses through rates, it has no incentive to take innovative actions to raise its operating efficiency and reduce its expenses. Worse yet, when a

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116. *See generally* Smyth v. Ames, 169 U.S. 466 (1898); Bluefield Waterworks & Improvement Co. v. Pub. Serv. Comm'n of W. Va., 262 U.S. 679 (1923); Fed. Power Comm'n v. Hope Natural Gas Co., 320 U.S. 591 (1944); Fed. Power Comm'n v. Natural Gas Pipeline Co. of Am., 315 U.S. 575 (1942); Duquesne Light Co. v. Barasch, 488 U.S. 299 (1989); BOSSELMAN, *supra* note 16, at 51-116; JAMES C. BONBRIGHT ET AL., PRINCIPLES OF PUBLIC UTILITY RATES (1988); W. KIP VISCUSI ET AL., ECONOMICS OF REGULATION AND ANTITRUST (4th ed. 2005); ALFRED E. KAHN, THE ECONOMICS OF REGULATION: PRINCIPLES AND INSTITUTIONS 25-54 (1988); STEPHEN BREYER, REGULATION AND ITS REFORM (1982).

117. BOSSELMAN, *supra* note 16, at 65.

118. *Id.* at 65-101; BREYER, *supra* note 116, at 36-70; Warren G. Lavey, *Innovative Telecommunications Services and the Benefit of the Doubt*, 27 CAL. W. L. REV. 51, 58-60 (1990).

regulated firm is allowed to earn a return that exceeds its current cost of capital, it has a strong incentive to expand its rate base, including inefficient investments. While regulators can use benchmarks, like the past performance of that utility or measures of "comparable" firms, such comparisons are limited by technology changes, differences in operations across service areas, differences in size of utilities and the age of their equipment, etc.

- Regulators need to determine a reasonable cost of capital for the utility, which may be applied for many years amidst fluctuations in the broad corporate debt and equity markets as well as changing risks in the particular utility's service area. Again, it may be difficult to identify "comparable" firms and to apply that information in determining a reasonable capital structure, cost of debt and cost of equity.
- The timing of regulatory cost analyses is out of synch with the marketplace. While the rates are forward-looking (apply to services provided after the end of the rate case), the analysis of expenses and rate base usually uses a historic test year. As the months of administrative proceedings grind on, that test year has declining relevance to a future, changing marketplace. Regulators are poorly positioned to determine the reasonableness of the parties' attempts to adjust historic financials for expected future developments. Additionally, the lag in regulatory decisions impedes the ability of the utility to adjust its offerings and rates to changing market conditions.
- Forecasting future demand for a regulated service is difficult. The challenge is particularly great for an innovative offering in the context of a changing marketplace. The regulators are forced to apply estimates of price elasticity of demand (the sensitivity of the amount purchased to small changes in price) that often are not based on relevant market experience.
- Cost-based rate regulation requires high expenditures of resources by regulators, utilities, and other interested parties. In addition to the rate case proceedings, this form of rate regulation entails on-going accounting practices and reports. Audits by regulators or their agents are costly and often do not coincide with ordinary corporate financial reporting categories and timing.

In the last decades of the twentieth century, legislatures and regulators moved the process of utility rate regulation away from administrative determinations of costs. Instead, the new models rely greatly on market-based mechanisms to promote lower rates, efficient utility operations and financing, and innovative offerings as well as savings in administrative expenses. A few of the market-based mechanisms to replace administrative determinations of cost-based rates are:[119]

- Increasing the scope of services subject to competition instead of monopoly. Allowing competition to set prices instead of administrative determinations. Interconnecting the new production and distribution systems with the monopolists' plant and operations.
- Applying price caps for regulated rates. By breaking the link between a utility's costs and its regulated rates, the new model increases incentives for efficient operations by the utility. The price caps are based on broad indicators (such as economy-wide inflation and industry-wide productivity gains). The utility is allowed to set rates below the caps, and to keep all or more of its earnings (without having to refund all earnings in excess of its estimated cost of capital).
- Auctions among potential providers of a service.[120] Instead of determining the cost of providing a service in an area, the regulators conduct an auction and award payments to the winner (the entity bidding to take the lowest payment from a regulatory fund or charge the lowest price to customers in providing the service).

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119. *See* BOSSELMAN, *supra* note 16, at 101-09, 489-542, 613-721; *see also* Andrej Juris, *Development of Competitive Natural Gas Markets in the United States*, PUB. POL'Y FOR PRIVATE SECTOR, Apr. 1998, Note No. 141, at 1, http://siteresources.worldbank.org/EXTFINANCIALSECTOR/Resources/282884-1303327122200/141juris.pdf; *Status of Natural Gas Residential Choice Programs by State as of December 2009*, U.S. ENERGY INFO. ADMIN. (May 17, 2010), http://www.eia.gov/oil_gas/natural_gas/restructure/restructure.html; State v. Pub. Util. Comm'n, 344 S.W.3d 349 (Tex. 2011) (restructuring Texas electric power industry and regulation to full competition, using power capacity auctions); Jeffrey H. Rohlfs, *Regulating Telecommunications: Lessons from U.S. Price Cap Experience*, PUB. POL'Y FOR PRIVATE SECTOR, Jan. 1996, Note No. 65, at 1, http://rru.worldbank.org/documents/publicpolicyjournal/065rohlfs.pdf; W.M. WARWICK, A PRIMER ON ELECTRIC UTILITIES, DEREGULATION, AND RESTRUCTURING OF U.S. ELECTRICITY MARKETS (May 2002), http://www1.eere.energy.gov/femp/pdfs/primer.pdf; 1 G.A. COMNES ET AL., PERFORMANCE-BASED RATEMAKING FOR ELECTRIC UTILITIES: REVIEW OF PLANS AND ANALYSIS OF ECONOMIC AND RESOURCE-PLANNING ISSUES (Nov. 1995), http://eetd.lbl.gov/ea/ems/reports/37577.pdf.

120. *See* Decision Adopting the Renewable Auction Mechanism, *supra* note 77, at 11-20. *See generally* ILL. POWER AGENCY, 2012 POWER PROCUREMENT PLAN (Sept. 2011), http://www2.illinois.gov/ipa/Documents/IPA_2012_Procurement_Plan_Conforming_to_ICC_Order_in_DKT_11-0660.pdf; Report and Order and Further Notice of Proposed Rulemaking, *In re* Connect Am. Fund, FCC 11-161, at 11 (Nov. 18, 2011), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0206/FCC-11-161A1.pdf.

Cost-based rate regulation has been narrowed but has not disappeared entirely. Reviews of the market-based mechanisms have been positive. The trend is away from cost-based rate regulation.[121]

In designing programs to expand rooftop solar deployments, government agencies should consider the ways that regulators of utilities' rates have turned to market-based mechanisms to replace administrative determinations of costs.

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121. *See* Richard J. Pierce, Jr., *Completing the Process of Restructuring the Electricity Market*, 40 WAKE FOREST L. REV. 451 (2005); Ingo Vogelsang, *Incentive Regulation and Competition in Public Utility Markets: A 20-Year Perspective*, 22 J. REG. ECON. 5 (2002); Paul L. Joskow, *Restructuring, Competition and Regulatory Reform in the U.S. Electricity Sector*, 11 J. ECON. PERSP. 119 (1997); DEREGULATION OF NETWORK INDUSTRIES (Sam Peltzman & Clifford Winston eds., 2000); *see also* Rohlfs, *supra* note 119.