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Can Urban Solar Become a "Disruptive" Technology?: The Case For Solar Utilities

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CAN URBAN SOLAR BECOME A "DISRUPTIVE" TECHNOLOGY?: THE CASE FOR SOLAR UTILITIES

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At the rate things are going, the sun is going to become a red giant and engulf the inner planets before we ever get our solar panels. It took us months to navigate the government and utility bureaucracies, we're now waiting for the installers to work through their backlog, and we're worried about the installation glitches that other solar bloggers have reported. What I wouldn't have given for a power purchase agreement (PPA), whereby an outside company navigates the bureaucracy and installs the panels for you, in return for collecting a share of the public subsidies.[1]

– Scientific American writer George Musser, blogging on the process of installing his solar system.

Residential solar has enormous potential for homeowners to generate electricity[2] and address our formidable climate challenge.[3] Deploying

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1. George Musser, *Solar Power Purchase Agreements, aka Let Someone Else Deal with the Paperwork for You*, Solar at Home, SCI. AM., Aug. 3, 2009, http://www.scientificamerican.com/blog/post.cfm?id=power-purchase-agreements-aka-let-s-2009-08-03.

2. One study has found that "27% of total residential rooftop area and 65% of total commercial and industrial rooftops are suitable for converting sunlight into electricity," and that rooftop solar could yield 712 gigawatts by 2015, or 27% of all U.S. electricity needs. CTR. FOR ENERGY AND ENVTL. POL'Y, UNIV. OF DELAWARE, CREATING A SOLAR CITY: DETERMINING THE POTENTIAL OF SOLAR ROOFTOP SYSTEMS IN THE CITY OF NEWARK 7 (2009) [hereinafter CREATING A SOLAR CITY].

The potential for solar in new homes is also significant. *See, e.g.*, GEORGE SIMONS, CAL. ENERGY COMM'N, DEVELOPING COST-EFFECTIVE SOLAR RESOURCES WITH ELECTRICITY SYSTEM BENEFITS (2005), *available at* http://www.energy.ca.gov/2005publications/CEC-500-2005-104/CEC-500-2005-104.PDF (observing that if each new home slated to be built in California by the year 2017 "had a 2 kW solar installation, then the total potential residential solar generation would be . . . 4,886 MW").

3. *See, e.g.*, Merrian C. Fuller et al., *Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power*, 51 ENV'T. MAG. 22, 24 (2009) (noting that, "it may be virtually impossible to reduce greenhouse gas emissions to the levels

more renewables in existing and new homes[4] can make such an important contribution to reducing rising global temperatures that I will not elaborate on it further here.[5] It also has considerable advantages over any

described by the lower-risk scenarios of the IPCC and adopted by local municipalities, states, and nations without a targeted effort to reduce energy demand in existing homes and commercial spaces," and that for this reason "retrofit efforts, such as improving energy efficiency and adding solar photovoltaics (PV) and solar thermal systems to buildings, need to expand dramatically" (footnotes omitted)); Osha Gray Davidson, *When it Comes to Energy, Mark Jacobson Thinks Big*, GRIST, Jan. 18, 2010, http://www.grist.org/article/2010-01-17-when-it-comes-to-energy-mark-jacobson-thinks-big (interviewing Mark Z. Jacobson, director of the Atmosphere/Energy Program at Stanford University) ("To complete the change to a sustainable energy society we'll need 3.8 million wind turbines, 90,000 solar plants and many geothermal, tidal and rooftop photovoltaic installations around the world."). *See generally* ARJUN MAKHIJANI, CARBON-FREE AND NUCLEAR-FREE: A ROADMAP FOR U.S. ENERGY POLICY (2007).

4. I use "homes" and "homeowners" throughout this Article with some caution. Incentives to install solar technology are different in landlord-tenant and condominium or cooperative building situations. UC BERKELEY SCHOOL OF LAW CTR. FOR LAW, ENERGY & THE ENV'T. & UCLA ENVIRONMENTAL LAW CTR., IN OUR BACKYARD: *How to Increase Renewable Energy Production on Big Buildings and Other Local Spaces* (2009), *available at* http://cdn.law.ucla.edu/SiteCollectionDocuments/Media%20Press/White%20Paper.pdf [hereinafter IN OUR BACKYARD] ("Multifamily residential property owners have little incentive to install renewable energy arrays that will lower energy costs for their tenants but not for them, while tenants lack incentive to invest in renewable energy technology for a rental property that they may vacate before they see a return on the investment.").

Extending my model for deploying solar technology to multifamily properties would pose considerable challenges that I do not mean to minimize. *See* Noah M. Sachs, *Greening Demand: Energy Consumption and U.S. Climate Policy*, 19 DUKE ENVTL. L. & POL'Y F. 295, 307–08 (2009) (noting that "landlords usually choose the major appliances for apartments and tenants usually pay the utility bills," and observing that "the impact of this divergence is far from negligible"). This is but one of many issues that will require further research. *See infra* Part V.B (discussing a research agenda). However, even if properly structured incentives only reached single-family homeowners, millions of Americans would have solar panels installed. Professor Michael Vandenbergh notes that this type of action would have enormous impact because "individual and household emissions make up roughly 30 to 40 percent of U.S. CO2 emissions." Michael P. Vandenbergh et al., *Individual Carbon Emissions: The Low-Hanging Fruit*, 55 UCLA L. REV. 1701, 1719 (2008) (citing the installation of solar PV panels as one of many actions to be taken).

5. There are contrary voices, of course. Some, such as economist Robert Michaels, question a focus on renewables. *See* Robert J. Michaels, *National Renewable Portfolio Standard: Smart Policy or Misguided Gesture?*, 29 ENERGY L.J. 79 (2008); Robert J. Michaels, *A Federal Renewable Electricity Requirement: What's Not to Like?*, Cato Institute Policy Analysis No. 627, Nov. 13, 2008, *available at www.cato.org/pubs/pas/pa-627.pdf*. But, as noted above, it is virtually "impossible" to address climate change without scaling up renewable power.

Others propose cleaning up coal or turning to more nuclear power, but both of those face considerable obstacles. *See* Victor B. Flatt, *Paving the Legal Path for Carbon Sequestration from Coal*, 19 DUKE ENVTL. L. & POL'Y F. 211 (2009) (discussing carbon capture and storage, a technology that, unlike solar, is still years off in the future). As for nuclear power, as one observer notes, "[n]uclear energy has long been the drumbeat for Republican lawmakers on how to reduce greenhouse gases," and, in response, President

central power stations (powered by either renewables or conventional fossil fuel). For example, it requires no new transmission capacity to accommodate it.[6]

Current initiatives promoting deployment of solar technology to homeowners,[7] however, are insufficient to motivate large numbers of

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Obama recently proposed tripling the amount of loan guarantees available to the industry. *See* Tom Doggett & Matt Spetalnick, *Obama Seeks to Boost Nuclear Power in New Budget*, REUTERS, Jan. 29, 2010 (quoting Josh Margolis of carbon brokerage firm CantorCO2e). For the past several years, a handful of utility companies have begun work on new nuclear power projects, but progress has been anything but smooth. *See, e.g.*, David Biello, *Nuclear Power Reborn*, SCI. AM., Sept. 26, 2007. *But see* Katarzyna Klimasinska, *NRG Energy May Stop Texas Nuclear-Plant Expansion*, BLOOMBERG, Jan. 29, 2010 (noting that San Antonio municipal utility CPS Energy may withdraw from the project, jeopardizing its future).

6. This avoids a host of ongoing problems related to siting of new transmission lines. Because renewable sources (particularly wind) tend to be located far from existing transmission lines, new solar and wind farms require new transmission lines to reach them. Sachs, *supra* note 4, at 304; Ronald H. Rosenberg, *Making Renewable Energy a Reality—Finding Ways to Site Wind Power Facilities*, 32 WM. & MARY ENVTL. L. & POL'Y REV. 635, 651–53 (2008) (describing promising locations for wind power across the nation and off shore).

Transmission siting has been a hot button issue of late, involving Not In My Backyard ("NIMBY") attempts to resist new lines; an attempt in the Federal Power Act to give Federal Energy Regulatory Commission "backstop" permitting authority where local jurisdictions fail to act; a successful Fourth Circuit challenge to the FERC's rules on the subject in Piedmont Environmental Council; and a Supreme Court denial of certiorari that for now leaves the matter in the hands of the states, confusing the issue and possibly blocking interstate transmission projects planned or in the works. *See* Saulius Mikalonis, *Energy Siting Decisions Likely to Remain Local, for Now*, GREEN BLAWG, Jan. 28, 2010, http://blog.mlive.com/green-blawg/2010/01/energy_siting_decisions_likely.html. Distributed generation (generation at a home or other customer's premises) avoids this problem. *See* David Morris, *Distributed Energy First, Wait On New Transmission Lines*, RENEWABLEENERGYWORLD.COM, Apr. 28, 2008, http://www.renewableenergyworld.com/rea/news/article/2008/04/distributed-energy-first-wait-on-new-transmission-lines-52252.

7. Homes are by no means the only place where solar can be scaled up. Excellent recent studies discuss how more urban commercial buildings could go solar. *See* IN OUR BACKYARD, *supra* note 4; TIMOTHY HASSETT & KARIN BORGERSON, WORLD RESOURCES INST., HARNESSING NATURE'S POWER: DEPLOYING AND FINANCING ON-SITE RENEWABLE ENERGY (2009), *available at* http://www.wri.org/publication/harnessing-natures-power. The challenge of addressing climate change requires increasing deployment of solar technology in *both* residential and commercial settings.

This is also not meant to slight the enormous promise of solar at the utility scale. For example, in 2009, the company First Solar and the utility Southern California Edison planned to build two large solar "farms," which would add 550 megawatts (MW) to the grid in California. *First Solar, SoCal Edison Set New Solar Projects*, REUTERS, Aug. 18, 2009, *available at* http://www.reuters.com/article/idUSTRE57H3OH20090818. *See also* Adam Browning, *Let the Era of Solar Wholesale Distributed Generation Begin*, GRIST, Jan. 21, 2010, http://www.grist.org/article/let-the-era-of-solar-wholesale-distributed-generation-begin (describing Southern California Edison's plans to buy solar power for 250 MW from independent solar developers at the scale of one to two MW, larger than residential size systems). Google has invested in concentrated solar power to bring the

consumers to adopt the technology. Renewables have gained little ground in the past thirty years[8] and the amount of residential solar generation can be measured in mere megawatts,[9] an infinitesimal fraction of total residential electricity demand. Solar panels are more common in some urban and suburban areas, but we are nowhere near having millions of homes with photovoltaic (PV) panels, solar hot water heaters, and solar shingles on their roofs.

Any incentives for increased deployment of urban solar must solve four problems. The first has been widely recognized for decades: the high upfront cost[10] of solar installations and long payback periods. The second is the significant transaction costs associated with a solar installation—ranging from time spent evaluating technology alternatives to finding the subsidies available and applying for them, in addition to wrangling with local land use officials and monitoring what is effectively a major home improvement project. Asking homeowners to become the equivalent of general contractors deters all but the most determined from installing solar panels. Without considerably revamping this process, it is highly unlikely that residential solar will be anything other than a niche market for years to come. If there is too much hassle associated with

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cost down. Kit Eaton, *Google Funds New Solar Power Tech, Plans to Cut Solar Thermal Costs by a Quarter*, FAST COMPANY, Sept. 10, 2009, http:// www.fastcompany.com/blog/kit-eaton/technomix/google-yes-google-funds-new-solar-power-tech.

8. For over thirty years, the federal and state governments have promoted increased use of renewable energy in the United States. This has not budged the needle on the speedometer much. The percentage of electricity generated from non-hydropower renewables (the ones with less controversial environmental impacts) has barely increased since 1978, from a mere 2.5% to 4.5%. Richard Schmalensee, *Renewable Electricity Generation in the United States*, MIT CTR. FOR ENERGY AND ENVTL. POL'Y RES., Nov. 2009, at 3, *available at* http://www.docstoc.com/docs/23304579/by-November-2009-Richard-Schmalensee-Renewable-Electricity; *see also* ENERGY INFO. ADMIN., U.S. DEPT. OF ENERGY, 2008 ANNUAL ENERGY REVIEW 288 (June 2009), *available at* http://www.eia.doe.gov/aer/pdf/aer.pdf.

9. At the end of 2009, there were 1676 MW of PV installed in the U.S., and the total installed solar capacity of 2108 MW made up less than 1% of the nation's total electricity generation. Solar Energy Indus. Ass'n, About Solar Energy, http://www.seia.org/cs/about_solar_energy/industry_data (last visited June 6, 2010).

California, the most solar state in the nation by far, has installed 140 MW of residential solar capacity through its California Solar Initiative as of June 2, 2010. California Solar Initiative, California Solar Statistics, http://www.californiasolarstatistics.ca.gov/reports/6-02-2010/Dashboard.html (last visited June 6, 2010). To put this number in perspective, in 2008, there were 1445 coal-fired generating units in the U.S., with 337,300 MW of capacity. U.S. ENERGY INFO. ADMIN., EXISTING CAPACITY BY ENERGY SOURCE 2008 (2010), http://www.eia.doe.gov/cneaf/electricity/epa/epat1p2.html (last visited June 12, 2010).

10. *See* George Musser, *Introducing 60-Second Solar: A Family Installs Panels on its Roof*, Solar at Home, SCI. AM., Feb. 25, 2009, http:// www.scientificamerican.com/blog/60-second-science/post.cfm?id=introducing-60-second-solar-a-famil-2009-02-25.

installing a solar panel, few will do it out of altruism or because they get a few cents per kilowatt hour back on their electric bill each month.

The third problem relates to the solar industry's fragmented and decentralized structure. Because most firms in it are still relatively small, they do not capitalize on the potential economies of scale in deploying residential solar widely. Most also do not have the comprehensive expertise to address the wide variety of legal, financial, technical, and administrative tasks associated with solar installations in multiple states. This makes it more difficult for widespread solar deployment to become a reality. It increases transaction costs for homeowners who must deal with several different entities during a solar installation and guess which ones will be around in the long term when they need maintenance or other support.

The fourth problem is a lack of incentives for any company to realize the potential regulatory economies of scale. There are many moving parts to the current regulatory environment for renewable energy systems. Any company that would offer a comprehensive solution for urban solar must deal with state and federal utility regulators, local governments, and even private entities such as homeowners' associations. The system is far too byzantine for one company that operates at current scale to expend the upfront transaction costs of dealing with federal, state, and local regulators in return for long-term predictability.

Regulatory uncertainty and instability have hampered companies that are not large enough to weather a fickle regulatory climate. Some incentives for solar power depend on financial support from governments that have an inconsistent history of providing it. Tax incentives for renewables tend to come and go with the political winds, and smaller companies relying on them cannot survive when these incentives are unavailable. Other incentives are constrained by state laws that vary widely in their implementation. For example, a developer intending to use renewable energy certificates (RECs) as a source of revenue may find its plan stymied by state laws or judicial decisions that assign REC ownership inconsistently. Some new programs might exacerbate the problem of regulatory complexity by requiring companies to deal with local governments that are not prepared or willing to handle the additional workload.

Existing and proposed governmental incentives for renewables do not address these four challenges adequately. We need a bold idea, and I argue that a new form of governmental assistance is required beyond feed-in tariffs, tax credits and rebates, solar power purchase agreements, and property tax financing.[11] There is a fundamental disconnect between

11. The DSIRE and Pew Center websites contain comprehensive descriptions of state and federal incentives for renewables, breaking them down by state. Database of State Incentives for Renewables and Efficiency, http://www.dsireusa.org/ (last visited June

these programs and incentives and how a technology gets in the hands of ordinary people on a large scale. Revolutionary deployment of renewables requires us to focus on what makes consumers likely to adopt a new technology.[12] The existing incentives are far smaller than those offered to fossil fuel power producers,[13] but the bigger challenge is that they will not lead us toward a rapid scaling up of solar technology deployment.

We require a completely new marketing and distribution solution to achieve "disruptiveness" in solar technology. Harvard Business School Professor Clayton Christensen developed this term to describe technologies that become so common that we wonder about the world before they existed.[14] Often a disruptive technology completely displaces an existing one, providing an entirely new way of communicating or computing (to take two examples), and making the previous technology obsolete. Technological breakthroughs that reduce costs and increase capabilities are important. Once upon a time, for example, cellular telephones were as big as briefcases;[15] when they shrunk to palm size and could be purchased for far less, it appeared that all of a sudden everyone had one. However, technology alone is not sufficient to achieve disruptiveness. It takes a number of factors, including governmental support of some industries.

After examining the theory of disruptiveness and the inadequacy of current initiatives for renewables, I argue for a disruptive solution to solar. Achieving the kind of deployment that would be required to make a serious down payment on our climate obligations will take something far different than we have seen to date: companies devoted to national (or

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6, 2010) [hereinafter DSIRE]; Pew Center on Global Climate Change, http://www.pewclimate.org (last visited June 6, 2010). Climate bills pending in Congress would provide still more incentives. Section 102 of the American Clean Energy and Security Act of 2009 (ACES), for example, would empower states to establish rates to be paid by the utilities they regulate, which would provide incentives for development of renewables. H.R. 2454, 111TH CONG. § 102 (2009).

12. Erwin Danneels, *Disruptive Technology Reconsidered: A Critique and Research Agenda*, 21 J. Prod. Innov. Mgmt. 246, 255 (2004) (noting that "companies focusing on future customers, rather than on current customers, had a greater degree of radical product innovation").

13. Tyson Slocum, Director, Public Citizen's Energy Program, Slide Presentation: Promoting Locally-Owned Renewable Electricity for Households: The Case for Feed-In Tariffs 3 (Jan. 29, 2010), *presented at* Annual Symposium, Diversify Your Portfolio: Regulating Energy Sources with Renewable Energy Portfolio Standards, WM. & MARY ENVTL. L. & POL'Y REV. (2010) (copy on file with author) (noting that "the oil industry [is] receiving $9 billion/year in tax breaks + royalty relief").

14. Joseph L. Bower & Clayton M. Christensen, *Disruptive Technologies: Catching the Wave*, HARV. BUS. REV., Jan.–Feb. 1995, at 43; *see* also CLAYTON M. CHRISTENSEN & MICHAEL E. RAYNOR, THE INNOVATOR'S SOLUTION (2003).

15. Mobile Planet, History of the Mobile Phones, http://mobile-planet.org/history_of_mobiles.html (last visited June 6, 2010) (noting that First Generation cell phones "were the size of a large briefcase and very inconvenient").

at least regional), large-scale installations of solar technology, and which are deeply capitalized and willing to take risks to bring solar to many homeowners. I will term these "solar utilities," and I propose that one or more of them should take over the entire process of solar marketing and distribution in a wide geographic area.

Governmental policies must support and encourage developers to offer a comprehensive solution to homeowners and help them overcome the obstacles that currently hinder more widespread deployment of solar. Specifically, I argue that protection from competition through the creation of regulated utilities is necessary to capitalize on both the economies of scale of performing multiple installations, and the regulatory economies of scale. In the current landscape, there are numerous barriers to this, and governmental intervention is required to overcome them.

Widespread deployment of urban solar requires that the upfront cost for most (if not all) transactions be reduced to zero or something close to it. In the structure I propose, a solar utility would provide the solar panels to a homeowner and recoup the cost in three ways. One would be a monthly charge to homeowners for the electricity provided, as is done in the increasing number of "power purchase agreements" ("PPA") in the commercial setting.[16] I argue that homeowners would view this more favorably than other current incentives. The developer would also earn tax breaks for installing renewable energy systems, and would take in revenue from the sale of RECs generated by projects, assuming the ongoing legal issue regarding their ownership is addressed.

Some assert that existing utilities have incentives to take on this task because building power plants is becoming increasingly costly and renewable resources can be deployed more quickly.[17] Climate change regulation might even lead to the elimination of one traditional generation option: coal-fired power plants.[18] A network of small solar generators, connected to the utility's grid, might someday provide enough capacity to allow a utility to forego construction of a new power plant.[19] One

16. *See infra* Part IV.D.

17. *See, e.g.*, SUNPOWER CORP., THE DRIVERS OF THE LEVELIZED COST OF ELECTRICITY FOR UTILITY-SCALE PHOTOVOLTAICS 2 (2008) ("All PV can be constructed quickly and even utility-scale power plants can begin delivering power within a few quarters of contract signing—a major advantage when compared to conventional power plants.").

18. New rules regulating GHG emissions might spur development of non-polluting options if companies are unwilling to bear the costs involved in complying with them. *See, e.g.*, Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) (to be codified at 40 C.F.R. pts. 51, 52, 70 and 71) (EPA proposal to regulate GHG emissions at major facilities).

19. The "Million Solar Roofs" program, part of the California Solar Initiative, has a goal of 3,000 MW of rooftop solar by 2020. Press Release, Office of the Governor, Schwarzenegger Signs Legislation to Complete Million Solar Roofs Plan (Aug. 21, 2006), *available at* http://gov.ca.gov/index.php?/press-release/3588. This is equal to the output

might expect utilities to embrace this idea, but to date they largely have not.[20] Appealing to them to change their ways is a low-value proposition at best, and we need to bypass electric utilities to make urban solar happen.[21] This may be difficult to see today, just as it would have been hard to foresee the rise of the personal computer industry in 1965.

Establishing new solar utilities and an accompanying regulatory structure for deploying solar widely cannot be done without addressing a number of issues. I describe several of these in a "research agenda,"[22] and I conclude that even though they require further study, this new structure is the most promising way that solar could change electricity generation as profoundly as the Internet, digital photography and cell phones changed existing industries.

II. URBAN SOLAR AS A DISRUPTIVE TECHNOLOGY

There are signs that solar is at a tipping point. One commentator compares it to "watching the Internet mature in 1995."[23] Technological breakthroughs in solar PV media have created higher efficiencies in converting sunlight into electricity, and brought the cost of panels down substantially.[24] Design changes have blunted objections that solar technology is unsightly.[25] This is not a technology that exists only in the minds of dreamers in lab coats. It is here today and ready to go. The technology will continue to improve, but right now homeowners can simply go down to a home improvement store and purchase off-the-rack

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of several large conventional power stations. U.S. ENERGY INFO. ADMIN., FORM EIA-860 DATABASE ANNUAL ELECTRIC GENERATOR REPORT, http://www.eia.doe.gov/cneaf/electricity/page/eia860.html (follow "Download: 2007: ZIP" hyperlink; open "PlantY07.xls" file) (last visited Mar. 30, 2010) (492 coal-fired power plants in the U.S., with an average size of 667 MW).

Utility-scale installations also hold potential for replacing conventional power plants. *See* MAKHIJANI, *supra* note 3, at 43 (discussing potential for hypothetical 1,000 MW plant in the Southwest); SUNPOWER CORP., *supra* note 17, at 2 (discussing a proposed 250 MW solar central power station for California's Central Valley).

20. *See infra* notes 46–50 and accompanying text.

21. Moreover, the experiment with electric utility restructuring in the past two decades has largely been a failure, and a number of states have reverted to strengthening incumbent utilities' dominant positions. They do not seem amenable to new competition, and rewarding them for their incumbent status is not a good idea.

22. *Infra* Part V.B.

23. George Musser, *Prospects for solar: "It's like watching the Internet mature in 1995"*, Solar at Home, SCI. AM., Oct. 29, 2009, http://www.scientificamerican.com/blog/post.cfm?id=prospects-for-solar-its-like-watchi-2009-10-29.

24. MAKHIJANI, *supra* note 3, at 37–40.

25. Solar Power, Solar Panels—Power For Homes, Apr. 3, 2009, http://solarpowerhomes.biz/solar-panels-power-for-homes ("The designs of solar panels today are not ugly to look at. In fact, solar panels can now blend with your home's existing design") (last visited June 6, 2010).

systems.[26] That technology could be scaled up and widely deployed,[27] and China, where a large and growing percentage of the population has solar hot water heaters, has shown us this is possible.[28]

The barrier to bringing solar to the masses is getting consumers to adopt it, not a lack of technological maturity. The federal or state governments could possibly overcome this barrier by simply mandating more solar installations. State renewable portfolio standards (RPS) require many utilities to generate a specified percentage of their electricity from renewable sources or purchase credits to make up the difference,[29] and some pending climate bills would extend these mandates to the entire nation.[30] Utilities could achieve these targets in large part by installing solar panels on their customers' roofs.[31] However, RPSs have had more

26. See *infra* note 202 and accompanying text regarding the Home Depot installation service.

27. Davidson, *supra* note 3 (quoting Mark Jacobson's statement that, "we have proven, up-and-running technologies right now that could do the job").

28. Joel B. Eisen, *China's Renewable Energy Law: The "Green" To China's "Black,"* WM. & MARY ENVTL. L. & POL'Y REV. (forthcoming 2010) (on file with author) [hereinafter Eisen, *China's Renewable Energy Law*] (noting that one in ten Chinese households have solar hot water heaters). On his blog, Green Leap Forward, author Julian L. Wong, a noted energy analyst at the Center for American Progress, describes numerous steps that China is taking to promote solar. Julian L. Wong, *Solar Hops: US-China Cooperation; Provinces Get Going; Suntech Shining Strong*, GREEN LEAP FORWARD, http://greenleapforward.com/2010/01/21/solar-hops-us-china-cooperation-provinces-get-going-suntech-shining-strong (last visited June 6, 2010).

29. As of 2009, twenty-eight states have RPS mandates and an additional five have voluntary goals or other RPS-like programs. Approximately 50% of total electricity load is now in states that have RPS programs. U.S. Envtl. Prot. Agency, Renewable Portfolio Standards Fact Sheet, http://www.epa.gov/chp/state-policy/renewable_fs.html (last visited June 6, 2010). *See generally* K.S. CORY & B.G. SWEZEY, RENEWABLE PORTFOLIO STANDARDS IN THE STATES: BALANCING GOALS AND IMPLEMENTATION STRATEGIES, NAT'L RENEWABLE ENERGY LAB (2007).

30. Section 101 of ACES, for example, would establish a "Combined Efficiency and Renewable Electricity Standard," amending the Public Utility Regulatory Policies Act (PURPA) to require retail electric suppliers selling more than four million megawatt hours (MWh) of electricity to meet a combined renewable electricity, energy efficiency, and conservation target of 20% in 2020. H.R. 2454, 111th Cong. § 101 (2009); *see also* U.S. House of Rep., Comm. on Energy and Com., *The American Clean Energy and Security Act (H.R. 2454)*, June 1, 2009, *available at* http://energycommerce.house.gov/index.php?option=com_content&view=article&id=1633&catid=155&Itemid=55 (last visited June 12, 2010) (offering a brief executive summary of the bill).

31. The largest proposed projects are in California and the Southwest. *See, e.g.*, Martin LaMonica, *Utility PG&E to Finance Rooftop Solar Panels*, CNET.COM, Jan. 20, 2010, http://news.cnet.com/8301-11128_3-10437876-54.html (proposed project by utility PG&E, which is subject to California's aggressive RPS, to "install more than 1,000 solar power systems for U.S. homeowners and businesses").

One Eastern utility pursuing a residential distributed generation program is Duke Energy. *See* In the Matter of Duke Energy Carolinas, LLC, No. E-7, 2008 N.C. PUC LEXIS 2244 (Dec. 31, 2008) (conditionally granting approval of a solar photovoltaic distributed generation program and a proposed method for recovering associated costs,

effect in prompting development of large-scale renewable energy facilities.[32] As Professor Jim Rossi points out, "past efforts to use legal reforms, and especially mandates, to induce technological change have produced mixed results," and "a national RPS mandate is unlikely to be the silver bullet that slays all of the barriers to renewable power development."[33] However, as I discuss below, a RPS can be a useful part of the policy foundation for solar utilities.

What would be the best approach for widespread solar deployment? One answer may come from scholarship that focuses on technologies that dramatically alter the competitive landscape. These disruptive technologies "change the bases of competition because they introduce a dimension of performance along which products did not compete previously."[34] The technologies "initially underperform existing ones," but then, over time, catch up and displace them.[35] Disruptiveness connotes speed and an abrupt dislocation of an industry's trajectory: once the new innovation catches on, it rapidly displaces existing technology.[36] Incumbent firms tend to miss opportunities to innovate, and thus disruptive technologies "tend be associated with the replacement of incumbents by entrants."[37]

There are grey areas in disruptiveness theory. One is whether a technology is inherently disruptive, or whether we measure disruptiveness after the fact by seeing how it revolutionized the competitive environment.[38] It can be tough to answer this because many case studies are retrospective views after disruption has taken place. For this reason, the theory may be better at explaining how certain innovations succeeded (or

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and describing the twenty MW program, up to ten percent of which will involve small-scale facilities on rooftops). As a utility doing business in North Carolina, Duke Energy is subject to that state's RPS, which this program is intended to help meet. *Id* at *5.

32. Slocum, *supra* note 13, at 5. The extent to which an RPS encourages new generation is a subject of considerable debate, with one study concluding that the national RPS proposed in climate legislation "would have 'effectively zero' impact on renewable energy generation." *Id.*

33. Jim Rossi, The Limits of a National Renewable Portfolio Standard (unpublished manuscript, on file with author) (quoting Gary E. Merchant, *Sustainable Energy Technologies: Ten Lessons from the History of Technology Regulations*, 18 WIDENER L.J. 831, 834 (2009) ("Notwithstanding the many available legal options for attempting to induce technology change in energy supply and demand, forcing beneficial technology change is a difficult endeavor.")). *See also* Slocum, *supra* note 13, at 9 (an RPS is no guarantee that new renewable generation capacity will be built).

34. Danneels, *supra* note 12, at 249.

35. *Id.*

36. *See generally* LARRY DOWNES & CHUNKA MUI, UNLEASHING THE KILLER APP: DIGITAL STRATEGIES FOR MARKET DOMINANCE (1998). This can make it difficult to decide when a particular technology has become disruptive. Danneels, *supra* note 12, at 249.

37. Danneels, *supra* note 12, at 249.

38. *Id.* at 247.

did not, as the case may be) than at predicting which ones will succeed.[39] On the other hand, explaining why companies in existing industries fail to recognize new technologies' potentials[40] can help us describe how technologies may succeed, and even a retrospective look can tell us much about the preconditions for success.

Professor Christensen focuses on incumbent companies' organizational resources, processes, and values. Applying disruptiveness principles to a different public policy problem (health care), he explains that, "[d]isruptions are rarely plug-compatible with the prior value network, or commercial ecosystem."[41] Existing companies are often incapable of departing from existing business models.[42] New technologies require incumbent companies to downplay or even jettison existing businesses, and their business structures may not allow for the nimbleness it takes to enter a new market.[43] "Not one of the minicomputer companies," Christensen observes, "succeeded in the personal computer business."[44] Incumbent companies ignore disruptive innovations because existing technologies look more profitable than innovative products.[45] Many innovations find smaller markets at first than one would expect at the relatively mature state of their development. In other words, disruptive technologies are often well-developed before disruption happens, and require companies with the foresight to capitalize on their potential.

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39. *Id.* at 250 (citing Don S. Doering & Roch Parayre, *Identification and Assessment of Emerging Technologies*, *in* WHARTON ON MANAGING EMERGING TECHNOLOGIES 75 (George S. Day, Paul J. H. Schoemaker, & Robert E. Gunther eds., 2000) ("Significant emerging technologies are easily seen after the fact, and companies are then congratulated or castigated for their decisions to pursue them or ignore them. But rarely are the winners clear at the outset.")). Professor Danneels points to this as another way in which disruptiveness theory needs further testing. *Id.* ("Even though Christensen never claims that all (potentially) disruptive technologies succeed, his exclusive selection of those that did presents an analytical problem.").

40. *Id.* at 251 (noting that "much prior research has found that innovations that ultimately transform an industry often do not originate from the industry's leaders").

41. CLAYTON M. CHRISTENSEN ET AL., THE INNOVATOR'S PRESCRIPTION: A DISRUPTIVE SOLUTION FOR HEALTH CARE xxviii (2009).

42. Clayton M. Christensen & Michael Overdorf, *Meeting the Challenge of Disruptive Change*, HARV. BUS. REV., Mar.–Apr. 2000, at 68 ("[W]hen a new venture captures their imagination, they [companies] get their people working on it within organizational structures . . . designed to surmount *old* challenges—not ones that the new venture is facing.").

43. For example, managers may be expected to keep up historical growth rates of sales and may balk at new products that entail risks. *Id.* at 73.

44. *Id.* at 72.

45. *Id.* at 73. *See also* Clayton Christensen, Key Concepts—Disruptive Innovation, http://www.claytonchristensen.com/disruptive_innovation.html (last visited June 6, 2010) ("Characteristics of disruptive businesses, at least in their initial stages, can include: lower gross margins, smaller target markets, and simpler products and services that may not appear as attractive as existing solutions when compared against traditional performance metrics.").

Electric utilities have an entrenched monopoly position delivering electricity to consumers, which makes them obvious candidates to scale up solar. Yet as incumbent companies, most of them have not warmed to this task.[46] Utilities often view renewables as too intermittent to ensure that the lights never go out.[47] Under existing business models, distributed generation does not appear as lucrative as building and operating central power stations. In my home state, Dominion Virginia Power makes huge profits by selling power generated from coal, nuclear, and natural gas plants.[48] It has a new coal-fired power plant coming soon,[49] and no plans to deploy residential solar panels.[50]

The electric utility industry's regulatory environment promotes technological stagnation,[51] and utilities also lack "marketing competence." They do not have "the skills to conduct research on a new market, to set up a new distribution and sales channel, to build a reputation

46. Slocum, *supra* note 13, at 13 (noting that "the last thing an investor-owned utility wants to do is turn its customers into independent power producers"); Sachs, *supra* note 4, at 310 ("The rate structures of electric and natural gas utilities serve as yet another barrier to the adoption of energy-efficient products and practices.").

47. *See, e.g.*, Statement of James Y. Kerr, II, Counsel, Electric Reliability Coordinating Council, before the U.S. House of Rep., Comm. on Energy and Commerce, Subcomm. on Energy and Air Quality (Apr. 23, 2009), *available at* http://energycommerce.house.gov/Press_111/20090423/testimony_kerr.pdf. Kerr, the former president of the National Association of Regulatory Utility Commissioners, argued that "[u]nlike natural gas or coal, which can be extracted and stored or transported for later use, renewable power is highly variable and must be backed up." *Id.*

48. Peter Bacque, *SCC staff: Cut Electric Rates of Va. Power*, RICHMOND TIMES-DISPATCH, Dec. 10, 2009 (noting that utility earned a 17.26% rate of return on average equity in 2008).

49. Dominion's new 585-MW coal-fired power plant, under construction and scheduled to be completed in mid-2012 in Wise County in southwest Virginia, has attracted considerable controversy. In 2004, Virginia ended its experiment with electric utility restructuring with a re-regulation law that included a rate adder for the Wise plant. In 2007, Virginia Power applied to the Virginia State Corporation Commission for approval of the plant and the rate increase, sparking a number of legal challenges. *See* Chris Graham, *Environmental Groups Challenge Wise County Coal Plant*, AUGUSTA FREE PRESS, Sept. 30, 2009; Appalachian Voices v. State Corp. Comm'n, 675 S.E.2d 458 (Va. 2009); Appalachian Voices v. State Air Pollution Ctrl. Bd., No. 2199-09-2, 2010 WL 2035119 (Va. Ct. App. 2009).

50. Mark Webb, *Dominion: New Directions in Energy*, *in* Annual Symposium, Diversify Your Portfolio: Regulating Energy Sources with Renewable Energy Portfolio Standards, WM. & MARY ENVTL. L. & POL'Y REV. (Jan. 29, 2010) (copy on file with author) (listing Dominion's plans for expansion of generation, none of which involve residential installations). In his symposium presentation, Webb, Director of Policy and Business Evaluation for Dominion's Alternative Energy Solutions unit, termed residential generation an option for the unspecified future.

51. An excellent example of this is the ongoing debate in a number of states over whether developers implementing power purchase agreements should be defined as public utilities under state law, where incumbent utilities have used existing laws to argue in favor of protecting their incumbency. *See infra* Part IV.D.

in a different market, and so forth."[52] They are accustomed to generating power at central power stations or purchasing it from other generators, not installing home solar systems. To install home solar systems would require thousands of installations at residential and commercial sites, all posing unique site characteristics. Utilities are like homebuilders that reproduce the same boxes repeatedly rather than custom build homes.

Rapid scaling up of solar would therefore take disruptive innovation in the business model of the entity accomplishing it. New entrants in industries often have fundamentally different resources and competences than companies burdened with incumbency's disadvantages. They have different technologies *and* simpler, better ways of doing things that are "tailored to the nature of competition in these disruptive markets."[53] This is a familiar explanation for the rise of startup companies that became household names—the Microsofts, Oracles, Googles, and so forth.[54] As we will see, there is no entity like this at present for urban solar, and, without one, solar is forever likely to be a niche product.

III. How Technology Disrupts, and Why Solar Technology Hasn't

What would this entity be? First, we should ask what factors lead to disruptiveness. As one would expect, the answer is different for different industries, but there are some constants. What appears to be happening instantaneously requires a number of elements to fall in place over a period of years.[55] One of those crucial factors, in many cases, is governmental support.

A. *Government Support Is Often Essential*

Disruptiveness often depends on a long string of evolutionary and revolutionary discoveries, and on crucial support from federal and state governments.[56] Direct government support to industries to encourage

52. Danneels, *supra* note 12, at 254.

53. Christensen et al., *supra* note 41, at 8.

54. To take one of many examples, consider how Google revolutionized the task of searching the Internet by ranking pages depending on the links pointing back at a specific site. *See* History of Search Engines: From 1945 to Google 2007, http://www.searchengine history.com/#google (last visited June 6, 2010).

55. Danneels, *supra* note 12, at 254. This leads some to criticize disruptiveness theory as simplistic. *See* John C. Dvorak, *The Myth of Disruptive Technology*, PCMag.com, Aug. 17, 2004, http://www.pcmag.com/article2/0,2817,1628049,00.asp ("When there is true disruption, it comes from inventions, *regulatory and social change*, complementary technologies, coincidence, and demand.") (emphasis added).

56. *See, e.g.*, Al Gore, Vice President of the United States, Speech at the University of Pennsylvania, The Technology Challenge: How Can America Spark Private Innovation? (Feb. 14, 1996) *available at* http://ftp.arl.army.mil/~mike/comphist/96gore/index.html (noting for several different consumer devices that "the federal government provided the initial spark that eventually flickered into these extraordinary products").

their growth is not new, as it dates to Hamilton's Report on Manufactures.[57]

To illustrate this, let's start with a technology that has become commonplace: the cell phone. Millions of consumers now carry devices with them that can do what the most sophisticated computers taking up large rooms would have done in the 1950s.[58] The diffusion of computing power to the fingertips of American eleven-year-olds is a remarkable achievement, but not too long ago the prospect of it seemed futuristic. What changed? Technology (really, many discrete technologies) advanced, but we should also credit the development of a national network on which to use the phones. The story of this development is well known and spans several decades, beginning with the federal government's assignment of bands on the cell phone spectrum and licenses to telecommunications companies, and continuing with the construction of networking towers and ancillary infrastructure, and the establishment of national cellular telephone networks.[59]

This development would not have happened without governmental involvement in selecting the companies that subsequently delivered service to large numbers of end users. Some entrants were start-ups that arose to compete with existing telephone companies, but others were the telephone companies themselves, benefitting from regulatory decisions that assigned geographic territories to existing wire line companies alongside new cellular ones.[60] The development of a national cellular phone network did not in and of itself put cell phones in the hands of millions, but it was vital to the industry's success.

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57. ALEXANDER HAMILTON, REPORT ON MANUFACTURES (1791).

58. *See, e.g.*, Clayton Christensen et al., *The Great Disruption*, FOREIGN AFF., Mar.–Apr. 2001, 80, 83–85 (discussing the evolution of computers from the ENIAC room-size computer of 1946 to the present and noting that personal computers "today do tasks far more complex than those that mainframes and mini computers used to solve").

59. *See* In re Wireless Tel. Servs. Antitrust Litig., 385 F. Supp. 2d 403, 408 (2005) ("Wireless telephone service was first introduced in the U.S. in the early 1980s. At that time, the Federal Communications Commission ("FCC") allocated spectrum such that only two companies could provide service in any given market. Beginning in 1995, however, the FCC auctioned new spectrum for PCS, which ultimately consisted of more than twice the amount of spectrum previously allocated to wireless telephone service. The allocation of PCS spectrum enabled as many as eight competitors to operate within a single market . . . The mid-1990s increase in the amount of spectrum allocated paralleled and enabled another significant change in the wireless industry: the switch from analog to digital technology."). *See also* Jeremy T. Fox, *Consolidation in the Wireless Phone Industry* (NET Inst., Working Paper No. 05-13, 2005), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=850445.

60. Until the late 1980s, the FCC licensed two cellular carriers in each metropolitan area, an "A Block" (non-wire line) and "B Block" (wire line) carrier. *See* United States Federal Communication Commission, Data Band Plan, http://wireless.fcc.gov/services/index.htm?job=service_bandplan&id=cellular (last visited June 6, 2010).

Going back to the early days of our nation and *Charles River Bridge*,[61] we have understood that some endeavors are so large that they require early intervention by the federal and state governments. These are opportunities that deter all initial entrants except the government or a company that stands in its shoes by virtue of a regulator's blessing (for example, a public utility's certificate of convenience and necessity). But they are also compelling enough that initial entrants are willing to capitalize on their first-mover advantages and run the risk that their success attracts other competitors, and, eventually, full blown un-tethering from government support.[62]

These endeavors have often centered on construction of infrastructure on a large scale (telecommunications networks, for example). The Internet was the product of direct governmental involvement.[63] The situation with respect to urban solar is different because companies are not required to build a massive physical network. The electricity grid already exists, although President Obama and others have pushed for "smart grid" initiatives to modernize it.[64] The purpose of the network is also different. A cell phone user wants assurances that she will be able to use her phone no matter where she travels; a solar panel owner uses her panel at her residence. However, this distinction may not matter. To bring solar to American households, I will conclude that, much as we did with cable television and cellular phones, we need to think both bigger and better—with the government's help—than we do now about marketing and distributing the technology.

B. *The Centrality of the Consumer Experience*

People may be interested in buying solar panels one day, but are not yet able to or may not even know where to go to buy the panels.[65]

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61. Charles River Bridge v. Warren Bridge, 36 U.S. 420 (1837).

62. *Id.* As one commentator notes, the case is a touchstone of our "legal attitude toward technological change" because it stands for the proposition that courts will not allow "vested rights to block technological progress" when that progress is in the public interest. Peter Linzer, *From the Gutenberg Bible to Net Neutrality—How Technology Makes Law and Why English Majors Need to Understand It*, 39 MCGEORGE L. REV. 1, 14–18 (2008).

63. JOYCE OLDHAM APPLEBY, THE RELENTLESS REVOLUTION: A HISTORY OF CAPITALISM 345 (2010).

64. Grant Gross, *Obama Includes Broadband, Smart Grid in Stimulus Package*, ITWORLD, Jan. 8, 2009, http://www.itworld.com/government/60362/obama-includes-broadband-smart-grid-stimulus-package; BRACKEN HENDRICKS, CTR. FOR AM. PROGRESS, WIRED FOR PROGRESS: BUILDING A NATIONAL CLEAN-ENERGY SMART GRID (2009). Section 1301 of the Energy Independence and Security Act of 2007 contains provisions designed to spur smart grid development. *See* U.S. DEPT. OF ENERGY, SMART GRID STATUS REPORT (2009).

65. Jen Lynch, *10 Things Every Company Should Know: Why RE Needs PR in 2010*, RENEWABLE ENERGY WORLD, Jan. 5, 2010, http://www.renewableenergyworld.com/rea/blog/post/2010/01/top-10-for-2010-why-re-needs-pr.

A new technology is disruptive both to the industry it displaces and to consumers who purchase it. One difficult element of disruptiveness is assessing the role of consumer demand in the process. Forecasting consumer demand for a new product is one of the most difficult enterprises in American business. When we look at the competitive landscape after a product has gained widespread acceptance, it is often nearly impossible to tell what factors led to its success.[66] Does a technology become disruptive when a critical mass of new customers demands it and the market responds? Or can proper product development and marketing by a savvy company stimulate latent demand? Often, we are not quite sure.

Our *ex post* evidence can yield some clues. Because market share increases rapidly at some point, a form of contagion appears to take over when enough consumers have the technology (such as the latest smartphone) that others demand to have it as well. This enthusiasm for a new product can accelerate demand, bringing the technology to more consumers more quickly than anyone had thought possible beforehand.[67] Is there a real possibility that this would happen with solar—that thousands or even millions of consumers would demand the solar panels they saw going up on their neighbors' roofs? As I discuss in this section, there is little likelihood of this in today's decentralized system of deploying panels. This in and of itself is an important reason to change the business model by which solar is installed. Until systems go up in large numbers in proximity to one another, it is unrealistic to expect strong consumer demand.[68]

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66. Beyond the work of Professor Christensen and others, there is an enormous body of literature on the lag between introduction of a product and its general acceptance. Economist H. Peyton Young's work on innovation diffusion focuses on the role of three different models: contagion, social influence, and social learning, which are defined as:

1. *Contagion.* People adopt when they come in contact with others who have already adopted; that is, innovations spread much like epidemics.
2. *Social influence.* People adopt when enough other people in the group have adopted; that is, innovations spread by a conformity motive.
3. *Social learning.* People adopt once they see enough empirical evidence to convince them that the innovation is worth adopting, where the evidence is generated by the outcomes among prior adopters. Individuals may adopt at different times due to differences in their prior beliefs, amount of information gathered, and idiosyncratic costs.

H. Peyton Young, *Innovation Diffusion in Heterogeneous Populations: Contagion, Social Influence, and Social Learning*, 99 AM. ECON. REV. 1899, 1900 (2009). Young uses a classic study of Midwestern farmers' adoption of hybrid corn in the 1930s to illustrate the difficulties of attributing the speed of adoption to any one factor. *Id.*

67. Young describes this as "contagion." *Id.*

68. This assumes that homeowners might be enthusiastic about installing solar panels under the terms of the model I propose in this Article. Needless to say, we have no evidence to support this proposition, and some careful market research would be necessary to support it. *See infra* Part V.B (discussing agenda for further research).

Moving the focus to the beginning of the product deployment cycle, one question is what differentiates companies that succeed in selling disruptive products from those that fail. Already, we have seen that these companies are structured differently from incumbent companies.[69] This focus in the literature on how companies miss out on new technologies can make it seem that consumers' needs are not important.[70] However, scholars conclude that focusing on these companies inevitably highlights their myopic failures to understand "the latent and unexpressed needs of [their] customers."[71]

We should resist any notion that dynamic companies respond to consumer preferences that are well articulated from the outset. When the "performance levels offered by a disruptive technology meet or exceed the minimum levels demanded by the mainstream market,"[72] that technology is poised to succeed. Yet that statement is a bit circular: we know that consumers demand certain features of disruptive technologies, but how, and when? If, by definition, a consumer does not know a disruptive technology exists, she cannot demand it. So it must be the case that certain product characteristics are known ahead of time but others (speed, processing rates, and so on) that consumers could not have easily foreseen take on importance during the time period when the product is gaining acceptance.

1. Disruptiveness Relates to the New Technology's Promise

This insight that products satisfy latent demand is at the core of disruptiveness theory. Defining consumers' objectives in conventional terms (that is, by existing products' performance metrics) makes new technology look unpromising. Consider solar technology. If the goal is defined as generating power as cheaply and easily as possible, solar is not yet there. A solar panel does not replicate the existing electricity delivery system. Solar does not guarantee that lights will come on and computers will keep running. The sun has to shine, which is not always assured in many locations,[73] and the intermittent nature of solar power generation makes it difficult in many areas to rely on it to meet households' entire

69. *See generally* Christensen & Overdorf, *supra* note 42 (offering cautionary tales of businesses that failed to adapt and making suggestions for restructuring companies to take advantage of innovations).

70. Danneels, *supra* note 12, at 255.

71. *Id.* (noting that these companies pursue "a very reactive, narrow notion of customer orientation").

72. *Id.* at 249.

73. MAKHIJANI, *supra* note 3, at 46 ("The average over 24 hours is, of course, considerably lower due to a variety of factors, mainly no sunshine at night, considerably reduced insolation in the early morning and late afternoon hours, cloud cover, seasonal variations, and precipitation. As a result, the average annual insolation across most of the contiguous United States and Hawaii ranges from about four to about eight kilowatt hours per day per square meter.").

electricity demands. In some parts of the nation, electricity generated from solar panels is nearly cost-competitive with that purchased on the wholesale market,[74] but it still costs more. Solar systems might require maintenance, unlike conventional electricity, which can be had at the flip of a switch.

Yet all of this is exactly what can make it disruptive. A new technology is often *not* superior to existing technologies.[75] New technologies perform differently,[76] and may not offer all of the functions of existing ones. For example, Internet telephone services such as Skype lack access to 911 emergency dialing.[77] A disruptive technology does not succeed because it does the existing task well (it doesn't), but because it offers a simpler, more affordable, and different way of achieving goals that consumers did not previously know were achievable.

Solar's disruptive potential is to satisfy an entirely different set of goals. It produces cheaper power if environmental externalities are accounted for. A number of utilities have "green pricing" programs to provide consumers power today at a small premium to internalize those externalities.[78] The limited reach of these programs shows that arguing on altruism alone is not sufficient to attract most consumers.[79] However, solar can have other attributes. It can be more resilient and reliable because it does not rely on a complex system of generation, transmission, and distribution to bring power to the house. The system can be simple enough that maintenance could be done with hand tools. The potential for terrorists to take out generating capacity would be virtually nonexistent. Finally, although solar is more expensive today, the cost of power

74. *Id.* at 38 (quoting a U.S. Department of Energy study that technology breakthroughs will "put the U.S. industry on track to reduce the cost of electricity produced by PV from current levels of $0.18–$0.23 per kWh to $0.05–$0.10 per kWh by 2015—a price that is competitive in markets nationwide"). On a "levelized cost" basis, with the cost of new transmission capacity factored in, solar is currently on par with fossil fuel options. Slocum, *supra* note 13, at 4.

75. CHRISTENSEN ET AL., *supra* note 41, at 5.

76. Danneels, *supra* note 12, at 249.

77. Steven I. Oster, *Internet Telephone Services for Individuals and Small Businesses*, J. ACCOUNTANCY, May 2009, *available at* http://www.journalofaccountancy.com/Issues/2009/May/2008843.htm.

78. See U.S. DEPT. OF ENERGY, GREEN PRICING: UTILITY PROGRAMS BY STATE, http://apps3.eere.energy.gov/greenpower/markets/pricing.shtml?page=1 (last visited June 6, 2010) for a comprehensive list of these programs.

79. News Release, Nat'l Renewable Energy Lab., NREL Highlights Utility Green Power Leaders (Apr. 13, 2009), *available at* http://www.nrel.gov/news/press/2009/679.html (noting that, "600,000 customers are participating in utility programs nationwide," with the largest program accounting for an average of 82 MW). The NREL finds this an encouraging number but it is still a very small share of overall generation. *Id.*

generated by the panels is constant over the long term. A homeowner can lock in peace of mind about electricity rates for years to come.[80]

New and unforeseeable uses for some disruptive innovations also drive demand. Want to purchase a piece of software for your phone? Push a few buttons, anywhere in the United States, and that "app" is instantly downloaded to your phone. That was not on anyone's radar screen in the 1980s when the cell phone network began. Urban solar may have its own "killer app": if automakers sell more plug-in hybrid vehicles, consumers could use their own renewable energy facilities to charge their cars and bypass the gas pumps.[81]

Solar's advocates have been touting these advantages for years.[82] Critics of an emerging technology can be proven wrong, but only in hindsight; as noted above, we are better at recognizing disruptiveness after it has taken place.[83] In other words, solar looks now like other disruptive technologies in their early days. Viewed years from now, its strengths could seem so obvious that it would be difficult to imagine that electricity had ever been generated any other way.

This tells us that solar is ripe to become a disruptive technology. Still, we need to account for *how* best to foster disruptiveness. How does a product become one that a lot of people demand? Appeals to adopt an innovation because it is superior to existing technology, or even mandates to do so, are not enough. Consumers who do not recognize a new technology's potential need more: an approach that capitalizes on the advantages the technology can offer them.

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80. Much research focuses on shortening the "payback period" (the time it takes to recoup an initial investment in solar technology). *See, e.g.*, NAT'L RENEWABLE ENERGY LAB., PV FAQs (2004), *available at* http://www.nrel.gov/docs/fy05osti/37322.pdf (last visited June 6, 2010) (claiming a payback period of as short as four years for a rooftop PV system). After that period, the remainder of the lifespan of an average system provides virtually zero-cost electricity to the owner, with only maintenance costs factored in. That can be as long as twenty-five years. *See* Adam Sewall, *Why Payback Period Is a Crude Measure for Solar Panels*, GETSOLAR.COM, Aug. 20, 2009, http://www.getsolar.com/blog/payback-period-solar-power-panels/2097.

81. An example of how this could work is found in Kimberly Madrigal, *Solar Paneled HOA: An Association Lets the Sun Shine On*, GREENLANDLADY, Jan. 18, 2010, http://greenlandlady.com/site/success-stories/solar-paneled-hoa-an-association-lets-the-sun-shine-on (observing that architect Amber Richane, who oversaw the installation of PV panels on the roof of her condominium building, "was allowed to run power to her parking spot and can now recharge her GEM car in the building's garage").

82. The National Renewable Energy Laboratory (NREL) has issued numerous reports on solar technology, analyzing all of the claimed advantages. *See* Nat'l Renewable Energy Lab., Energy Analysis—Policy Analysis, http://www.nrel.gov/analysis/policy_analysis.html (last visited June 6, 2010) (search of "Solar Energy Technologies" under "Publications' yields over 200 results).

83. This can lead to criticism that disruptiveness theory cannot predict results *ex ante*. *See* Danneels, *supra* note 12, at 251.

2. Matching the Business to the Opportunity

> *An industry whose products or services are still so complicated and expensive that only people with a lot of money and expertise can own and use them is an industry that has not yet been disrupted.*[84]

As Professor Christensen puts it, firms succeed when they reach consumers by "market[ing] understanding that [m]irrors how [c]ustomers [e]xperience [l]ife."[85] He distinguishes between a "low-end disruption" and a "new-market disruption."[86] The former addresses a firm's existing customers; the latter (like urban solar) is "an innovation that enables a larger population of people who previously lacked the money or skill now to begin buying and using a product."[87] Professor Erwin Danneels observes that firms fail at popularizing new-market disruptive technology when they lack marketing competence: the ability to identify and access customers the company has not previously served.[88]

Cell phone companies understand this concept. One reason why cell phones have found widespread adoption is the relative simplicity of the purchase experience, even for a new customer. "Relative" is an important qualifier, as anyone who has dealt with a cell phone carrier can attest. Cell phone company rate and service plans are not simple,[89] and choosing among companies is not easy, as the smirking television ads of the strengths and weaknesses of each other's plans remind us.[90] However, there are still relatively few carriers to choose from[91] and the entire purchase-to-use process can be completed in an afternoon. Many complex aspects of cell phone operation, such as CDMA, UMTS, and GSM technical standards that allow cell phones to be used across the nation, are hidden from the device owner.[92]

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84. CHRISTENSEN ET AL., *supra* note 41, at 8.

85. Clayton Christensen, Presentation at World Innovation Forum (May 24, 2009), *available at* http://www.business-strategy-innovation.com/2009/05/top-10-clayton-christensen-insights.html (slide 14 of SlideShare presentation).

86. Christensen & Raynor, *supra* note 14.

87. Danneels, *supra* note 12, at 250.

88. *Id.* at 254.

89. *See How to Buy a Cell Phone*, PC WORLD, Oct. 13, 2008, *available at* http://www.pcworld.com/printable/article/id,125653/printable.html (listing different features to look for in cell phones and stating that "just getting one can be a huge hassle").

90. *See, e.g.*, Sprint Television Commercial, Just Phone Calls, http://www.youtube.com/watch?v=KVeFm-z_EQ8 (last visited May 10, 2010) (discussing the difference between Sprint's plan and other plans).

91. This is particularly true if a consumer wants a specific phone, given exclusivity deals that have become common. *See* In re Wireless Tel. Servs. Antitrust Litig., 385 F. Supp. 2d 403 (2005) (involving a challenge to this practice).

92. *See, e.g.*, Heath Row, *The History and Lessons of the Cellular Industry*, FAST COMPANY, Mar. 13, 2004, http://www.fastcompany.com/blog/heath-row/history-and-lessons-cellular-industry (noting that consumers "don't care about TDMA, GSM, or CDMA, they just want it to work fast, at a competitive price, and at high quality").

Contrast this to the likely experience of a homeowner who has the best intentions of installing a solar panel on her roof. The experience will never be as simple as waltzing into a cell phone store and walking out with a device, but at present it occupies the extreme other end of the spectrum, with a troubling lack of standardization. Every homeowner who wants to install solar starts virtually from scratch, as if she were building a custom home, and with a steep learning curve.[93]

A homeowner needs a wide variety of skills to assess what equipment might be suitable for her house, what it would take to install it, and even from whom to purchase it. There is no standard solar panel product, but a range of products available from competing manufacturers and distributors.[94] Choosing from among them is a complex undertaking.[95] We're not talking about installing carpet in a bedroom—this is a sophisticated set of technical and electrical tasks that requires skills beyond the reach of many homeowners. And, unlike the cell phone experience, a solar installation burdens the consumer with difficult legal and technical challenges.

Throughout the United States, there is a near complete lack of a standard way to get solar technology. The homeowner must work with a contractor to figure out what type and size of system to purchase, what will be needed to install the new equipment, and so on. Requiring the consumer to evaluate the technology is as daunting as requiring her to judge ignition systems before buying a car.[96] The jargon ("inverter," "photovoltaic array," and so on) is enough to deter many. Numerous

93. *See, e.g.*, George Musser, *Should You Get Solar Now, or Wait?*, Solar at Home, SCI. AM., Dec. 8, 2009, http://www.scientificamerican.com/blog/post.cfm?id=should-you-get-solar-now-or-wait-2009-12-08 ("Right now, you need a good deal of patience and fortitude to install solar panels.").

94. GetSolar.com maintains a national database of professional solar installers searchable by state. *See* GetSolar.com, http://www.getsolar.com (last visited June 6, 2010). Not all installers are alike, however. A Consumer's Guide issued by the Department of Energy provides the following under "Selecting a PV Provider":

> In some areas, finding a PV provider can be as simple as picking up the telephone directory and looking under "Solar Energy Equipment and Systems—Dealers." However, many of the listings are solar water-heating companies and many companies might not be experienced in PV system design or installation. Similarly, many electrical contractors, although proficient in typical electrical contracting work, might not have expertise in PV or residential roof-mounting techniques.

U.S. DEPT. OF ENERGY, ENERGY EFFC'Y AND RENEWABLE ENERGY, A CONSUMER'S GUIDE: GET YOUR POWER FROM THE SUN 13 (2003).

95. *See, e.g.*, Dave Llorens, *Nine Crucial Solar Installer Considerations* (Dec. 22, 2007), http://www.solarpowerrocks.com/solar-trends/what-to-look-for-in-a-solar-installer (last visited June 6, 2010).

96. *See, e.g.*, Solar Panels Guide, http://www.solarpanelsguide.org/ (last visited June 6, 2010) (offering links for consumers to learn about "Solar Panel Installers," "Solar Panel Mounts," "Solar Panel Inverters," "Solar Panel Distributors," and "Solar Panel Manufacturers").

solar companies operate at the size and scale of local HVAC contractors, which makes every installation a new one with little precedent.[97] The installation also puts the consumer in the position of dealing with multiple entities: the solar installer, the electric utility to which the panel will be connected, and the local government or neighborhood association (or both) that will approve the land use.

Even though professional assistance is available, anecdotal evidence suggests that people simply give up at this stage.[98] It does not help that an Internet search yields many sites that advocate a hardy, do-it-yourself approach to installing solar. That reinforces the perception that home solar is for resourceful tinkerers, the Dr. Emmett Browns of the world.[99] Personal computers did not become widespread in the 1970s when engineers were assembling their own motherboards in their garages.

Many people are reluctant to have workers come to their homes to do anything, much less a lengthy construction project. In today's busy world, homeowners have to juggle schedule commitments to be home at the right times to supervise work. It is one thing to set aside an afternoon for the "cable guy," and quite another to monitor an ongoing project. Finding a reputable contractor is always an important consideration, and many homeowners will insist on a longer track record than most solar installers can demonstrate.[100] In many metropolitan areas, few companies are fully devoted to solar, and even fewer have long-term track records.[101] A certification association, the North American Board of Certified Energy Practitioners (NABCEP), sets national standards for solar photovoltaic installers, but as of March 2010 there were only 1091

97. The sobering experience of Scientific American editor George Musser, cited throughout this Article, is hardly atypical, as he notes. George Musser, *Solar Snafu: The Contractor Finally Installs the Panels, but Goofs*, Solar at Home, SCI. AM., Oct. 22, 2009, http://www.scientificamerican.com/blog/post.cfm?id=solar-snafu-the-contractor-finally-2009-10-22 (observing that "solar is still not a matter of plug and play," that Musser is—rather unexpectedly—an "early adopter," and that the installation industry is suffering "teething pains" on a "learning curve").

98. The title of one blog post on consumer reluctance to adopt solar is self-explanatory: David Llorens, *Why No One Has Solar Power*, SOLARPOWERROCKS.COM, Jan. 26, 2008, http://www.solarpowerrocks.com/solar-trends/why-no-one-has-solar-power/.

99. Dr. Brown was the "mad" scientist in BACK TO THE FUTURE (Universal Pictures 1985). *See* Philip E. Ross, *Loser: Why the Chevy Volt Will Fizzle*, IEEE SPECTRUM, Jan. 2010, http://spectrum.ieee.org/green-tech/advanced-cars/loser-why-the-chevy-volt-will-fizzle (satirizing "tech-minded people . . . who tile their roofs with photovoltaic cells, harvest the energy they expend on their StairMasters, or live underground in hobbit holes to conserve heat").

100. George Musser selected the company 1st Light Energy for his installation in New Jersey. George Musser, *What You Really Need to Install Solar: A CPA*, Solar at Home, SCI. AM., Jun. 4, 2009, http://www.scientificamerican.com/blog/post.cfm?id=what-you-really-need-to-install-sol-2009-06-04. 1st Light claims on its website that its five-year existence makes it "one of the most experienced solar companies in the Nation." 1st Light Energy, http://1stlightenergy.com/about.html (last visited May 10, 2010).

101. Musser, *supra* note 100.

NABCEP-certified professionals in the entire country.[102] Even using a certified professional is no guarantee of a smooth installation process.[103]

Home systems break and need repairs. If a homeowner cannot be guaranteed that a company will be around years later when service is needed, she might balk from the outset at making the installation. Few homeowners will relish going up on their roofs to check on malfunctioning systems. The classic cure for this, the word-of-mouth recommendation about reliability, is also difficult to find if large numbers of homeowners have not installed solar. This is a chicken-and-egg problem for which no existing state or federal incentive for renewables has a solution.

In many jurisdictions homeowners seeking to put solar on their roofs will also need lawyers, because they'll face NIMBY-like opposition from neighbors who will invoke state and local land use laws to delay or quash projects.[104] One person's good deed for the environment can be another's eyesore. This problem can be particularly acute in the numerous subdivisions governed by neighborhood covenants, some of which can be interpreted to prohibit renewable energy systems.[105] Some states have enacted laws that prohibit the most egregious forms of blocking renewable energy systems,[106] but even these laws allow wiggle room for neighborhood associations to bar solar installations.[107]

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102. North American Board of Certified Energy Practitioners, http://www.nabcep.org/ (last visited June 6, 2010).

103. *See, e.g.*, Musser, *supra* note 100. The title says it all.

104. *See* Michael L. Pisauro Jr., *Renewables and Land Use Law*, 23 NAT. RESOURCES & ENV'T 39 (Summer 2008); Rosenberg, *supra* note 6, at 640. The type of local control over renewable energy facilities varies widely from state to state. *See id.* at 673.

105. A typical story may be found in Paula Franzese, *Does It Take a Village? Privatization, Patterns of Restrictiveness and the Demise of the Community*, 47 VILL. L. REV. 553, 574 (2002) ("For example, in an Arizona planned community, one neighbor turned in another for installing a modest solar panel. The association declared the installation an eyesore and demanded its removal. A lawsuit erupted, generating more than $100,000 in legal fees. The resident won, 'but the association vows to fight on.'") (quoting Matthew Benjamin, *Hi, Neighbor, Want to Get Together? Let's Meet in Court!*, U.S. NEWS & WORLD REP., Oct. 30, 2000, at 57).

106. Rosenberg, *supra* note 6, at 673 (discussing these state prohibitions). At a symposium on renewable energy, Virginia state legislator David Bulova described how the Governor's Commission on Climate Change rejected a proposal for a state law to override existing covenants, due to the political difficulties involved. Del. David Bulova, *Discussion of House Bill 1994 and Virginia Initiatives, in* Annual Symposium, Diversify Your Portfolio: Regulating Energy Sources with Renewable Energy Portfolio Standards, WM. & MARY ENVTL. L. & POL'Y REV. (Jan. 29, 2010) (notes on file with author).

107. In Nevada, for example, "[a]ny covenant, restriction or condition contained in a deed, contract or other legal instrument which affects the transfer, sale or any other interest in real property that prohibits or unreasonably restricts the owner of the property from using a system for obtaining solar or wind energy on his property is void and unenforceable." NEV. REV. STAT. ANN. § 111.239 (Supp. 2007). *See* Debbie Leonard,

All of this is before considering a system's upfront cost. Unless there is an incentive in place to fully finance the system, this cost can run into the tens of thousands of dollars. The payback of a few dollars per month on an electric bill over the long term can appear too subtle or ephemeral. There is considerable research on why consumers do not adopt renewable energy systems and energy conservation measures, and much of it focuses on how consumers ignore long-term rates of return even when they are higher than market rates.[108] Asking Americans to consider the long term in purchasing a home improvement ignores the reality that we are a mobile society and many of us move every few years.[109] It is the genius of the cell phone pricing structure that carriers have effectively reversed the perception of cost: the upfront cost of the device is low, with carrier subsidies reducing the cost to essentially nominal, but the long-term cost of a two-year cell phone contract can be quite high.[110]

It is no wonder why all but those most determined to install solar on their roofs eventually give up. The situation resembles that of many homeowners who are interested in major home improvement projects but abandon them because of their expense and complexity. A solar installation is different in that promoting environmental protection will motivate some, but limiting residential solar to that subset of homeowners is too constraining. We need incentives that galvanize a large, latent and unexpressed demand in a simpler, better way.

IV. EXISTING INCENTIVES' POTENTIAL FOR PROMOTING DISRUPTIVENESS

Those incentives must do two things. First, they must streamline the purchase experience. Buying solar must become the equivalent of an impulse purchase, not a major home improvement project. Second, we

Legal Tools to Protect Access to Solar and Wind Resources, 17 NEV. LAW. 14 (2009). One person's "unreasonably restricts" can easily be another's "reasonably."

108. Sachs, *supra* note 4, at 309; Fuller et al., *supra* note 3 (noting that regulatory measures to promote renewables and conservation are typically aimed at making rates of return more favorable).

109. Jeffrey J. Kuenzi & Jason P. Schacter, *Seasonality of Moves and The Duration and Tenure of Residence: 1996* (U.S. Census Bureau, Populating Division Working Paper Series No. 69, 2002), *available at* http://www.census.gov/population/www/documentation/twps0069/twps0069.html#dor (demonstrating that the average American stays in the same house for less than five years, and that 70% of Americans spend ten years or less in the same home).

110. To take just one example, a simple search was performed on the Verizon Wireless website. Verizon Wireless, http://www.verizonwireless.com (follow "Phones & Accessories: Cell Phones: 3G Smartphones" hyperlink) (last visited June 6, 2010) (demonstrating that a 3G Smartphone may be purchased for $9.99 after rebate and two-year contract agreement); Verizon Wireless, http://www.verizonwireless.com (follow "Plans: Family" hyperlink) (last visited June 6, 2010) (demonstrating that two lines cost $120 a month, requiring a $2400 commitment with the purchase of the 3G Smartphone for $9.99).

must cut the upfront cost to the point where consumers will not be deterred by it. Companies that provide television service to the home understand this: get service in place at low cost and homeowners become reluctant to let it go, but make it expensive from the outset and they balk.

How well do existing state and federal programs and incentives address these issues? Not all that well, as it turns out.

A. *Tax Credits, Rebates, and Similar Financing Incentives*

For decades, both states and the federal government have offered financial incentives for the purchase of renewable energy systems.[111] States have offered rebates and tax incentives such as reduced or exempted property taxes and exemptions from state sales tax on purchases of renewable energy equipment.[112] The sheer variety of these incentives,[113] not to mention the paperwork burden associated with applying for some of them, can be enough to deter those unfamiliar with them.

Federal tax incentives have been in place inconsistently since the initial push to promote renewables in the late 1970s and early 1980s.[114] The Energy Tax Act of 1978 created tax credits for residential solar and wind installations, but the credits expired at the end of 1985.[115] The Energy Policy Act of 2005 reinstated a federal tax credit for residential

111. See DSIRE, *supra* note 11, for a complete summary of these and other incentives and programs that promote renewable energy.

112. *Id.* (searchable by individual state's credits and deductions). *See also* JASON COUGHLIN & KARLYNN CORY, NAT'L RENEWABLE ENERGY LAB., SOLAR PHOTOVOLTAIC FINANCING: RESIDENTIAL SECTOR DEPLOYMENT 15 (2009), *available at* http://www.nrel.gov/docs/fy09osti/44853.pdf (providing a map of states offering credits and deductions).

113. For an exhaustive collection of terminology, see A Solar Incentive by Any Other Name. . ., SOLARPOWERROCKS.COM, http://www.solarpowerrocks.com/solar-trends/a-solar-incentive-by-any-other-name. . . (last visited June 6, 2010).

114. Other federal incentives for a consumer's purchase of renewable energy technology include energy efficient mortgages (EEM) through various programs of the Federal Housing Administration, Department of Veterans Affairs, and Fannie Mae and Freddie Mac (for conventional mortgages not backed by a federal agency). *See, e.g.*, *Energy Efficient FHA Loans,* FHA.COM, http://www.fha.com/energy_efficient.cfm (last visited June 6, 2010). They also include loan grants and guarantees for farmers from the U.S. Department of Agriculture (USDA)'s Rural Energy for America Program ("REAP"). *See generally* USDA Rural Development, http:// www.rurdev.usda.gov/rbs/farmbill (last visited May 10, 2010).

115. This end to the tax credits had an obvious impact on solar installers, as one California-based firm discusses on its website. ACS, About ACS, http://www.avsolar.com/acsinfo.htm (last visited May 10, 2010) ("The solar glory days ended abruptly at midnight January 31, 1985 when the federal solar tax credits expired. Within 6 months, 90% of the U.S. solar industry expired as well.").

renewable energy systems.[116] A taxpayer may claim a credit of thirty percent of qualified expenditures for a residential renewable energy system.[117] The credit was initially applied to solar electric systems, solar water heating systems, and fuel cells, but the Energy Improvement and Extension Act of 2008 extended it to small wind energy systems and geothermal heat pumps.[118] The American Reinvestment and Recovery Act of 2009 (ARRA) expanded the availability of the credit by removing the maximum credit amount for all eligible technologies except fuel cells placed in service after 2008.[119] This is significant because the credit had been capped at $2000, and typical systems cost far more than the credit amount.[120]

The ARRA might lead to a more stable tax policy environment for renewable energy, though that is only guaranteed through 2013,[121] and a Congress concerned about overall federal revenue could easily choose to discontinue the credit. The on-again, off-again experience with the production tax credit for commercial renewables facilities,[122] and the inconsistency of residential tax credits since 1978, should give one pause for thought.

The number of homeowners who have taken advantage of tax credits and other financing incentives is still relatively small.[123] This should not be surprising. The amount of the credit can be substantial but still leaves the cost of a typical system at $10,000 or more, with a payback period that (even accounting for a break in electric rates through a feed-in tariff, as described below) is still long.[124]

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116. Energy Policy Act of 2005, 109 Pub. L. 58, 119 Stat. 594, 1033 (2005) ("Sec. 25D. RESIDENTIAL ENERGY EFFICIENT PROPERTY. "(a) ALLOWANCE OF CREDIT.—In the case of an individual, there shall be allowed as a credit against the tax imposed by this chapter for the taxable year an amount equal to the sum of—"(1) 30 percent of the qualified photovoltaic property expenditures made by the taxpayer during such year . . . .").

117. *Id.*

118. This Act was part of the Emergency Economic Stabilization Act of 2008 § 106, Pub. L. 110-343, 122 Stat. 3765 (2008).

119. American Recovery and Reinvestment Act, Pub. L. 111-5, § 1122, 123 Stat. 115 (2009).

120. *See, e.g.*, COUGHLIN & CORY, *supra* note 112, at 14 (examining incentives for a "4 kW residential system with an initial cost of $33,000").

121. Jeffry S. Hinman, *The Green Economic Recovery: Wind Energy Tax Policy After Financial Crisis and the American Recovery and Reinvestment Tax Act of 2009*, 24 J. ENVTL. L. & LITIG. 35, 57–58 (2009) (noting that the Production Tax Credit expires at the end of 2012).

122. *Id.* at 47–62 (featuring an excellent historical treatment of this issue).

123. COUGHLIN & CORY, *supra* note 112, at 27 (noting that "traditional methods of financing residential PV have been insufficient to drive material levels of installed capacity at the residential level").

124. *Id.* at 18–23 (examining several case studies and noting that only in New Jersey, with state SREC financing, was it possible to recover more than system cost over a twenty-year period).

Here is a sample analysis, using the new initiatives from utility DTE Energy Co. in Detroit:[125]

> To be on the conservative side, let's say we have a 5 kW system that costs $40,000, pre-incentives. (Unless you're in an especially aggressive, competitive region for solar, most installers will quote you $7.50 to $8 per watt for a non-utility-scale solar photovoltaic system, before incentives. If you've experienced differently, please let us know!) Here's how we would calculate the potential rebates:
>
> - Starting price: 5,000 x $8 = $40,000
> - Renewable Energy Credit (REC) Repayment: $2.40/watt x [5,000] watts = $12,000
> - Federal renewable energy tax credit, usually calculated as 30 percent of gross: $40,000 x 0.30 = $12,000
> - You pay: $40,000 – (2 x $12,000) = $16,000
>
> This figure is of course hypothetical, and your actual net cost would be even lower than this, thanks to Detroit Edison's ongoing $0.11/kWh repayment for the actual power your system generates, which will appear as a credit on your monthly electric bill for the next 20 years.[126]

In this case, *both* the utility and federal government have offered substantial incentives, but the system still costs $16,000. Most homeowners are unwilling to spend that much up front, no matter what savings they will see on their electric bills.[127]

Moreover, there is no "typical" system. It takes considerable legwork on a homeowner's part to work with a contractor to determine the system's size, the cost, and the credit's value.[128] Firms are willing to provide estimates, but they must survey prospective job sites to evaluate the numerous variables that determine what systems would be appropriate. By contrast, a consumer can determine the value of the federal tax credit for the purchase of a hybrid vehicle in a few minutes through a simple Internet search. A related problem is that a solar panel installation is a pure investment with no substitution possibilities. A prospective hybrid vehicle buyer can compare two price tags and decide whether the hybrid car is more affordable with the credit than a conventional one. Prospec-

125. Shining a Spotlight on Detroit's Solar Incentives, SOLARFEEDS.COM, Jan. 19, 2010, http://www.getsolar.com/blog/shining-a-spotlight-on-detroit%E2%80%99s-solar-incentives/3218.

126. *Id.* As a recent study by the NREL notes, the Detroit example is not unique: a residential PV project is only financially viable at present for a homeowner if a combination of financing tools is used. *See* COUGHLIN & CORY, *supra* note 112, at 18–23.

127. Fuller et al., *supra* note 3 ("The psychological burden of a large payment may also be significant, especially to reduce an expense such as a utility bill, which is often a small percentage of total expenditures for individuals and businesses.").

128. *See, e.g.*, SunRun Corp., *Get Started*, http://www.sunrunhome.com/get-started (last visited June 12, 2010) (describing the steps involved).

tive solar homeowners face the much more difficult calculation of balancing the discounted upfront cost against the savings on future electric bills.

This calculus is probably more like deciding to take on a home improvement project, with its cost likely to be evaluated against a different metric: whether it would affect the house's price at resale. A homeowner may perceive that she will recoup most of the cost of a remodeled kitchen on the resale market, but even with financial incentives, she may not feel the same about a solar system.[129] As a result, many homeowners will spend their money on projects other than renewable energy systems.[130]

B. *Feed-In Tariffs*

A different financial approach finding some recent support in the United States is the feed-in tariff (FIT), a fixed amount paid to a renewable power producer, established in advance.[131] Unlike the avoided cost approach established in the Public Utility Regulatory Policies Act of 1978 (PURPA),[132] anyone with a renewable energy system can receive a FIT payment, not just a "qualifying facility" (PURPA's term for a small power producer that meets statutory and regulatory criteria).[133] Under the typical FIT structure, modeled after that in place in European countries such as Germany and Denmark for a number of years,[134] renewable energy projects are guaranteed interconnection with the electricity grid, and project owners are paid an above-market rate locked in for a specific term of years (in Germany, twenty years). The rate can take one of several forms, such as a fixed amount defined in advance, or a premium over the wholesale price of electricity.[135] This prompts many to support the FIT idea for its potential to spur a boom in urban solar, as FITs can pay

129. Sachs, *supra* note 4, at 309 (noting that consumers ignore future benefits of renewable energy and energy efficiency improvements).

130. Fuller et al., *supra* note 3 ("Up-front costs can even cause individuals with access to capital to decline a project, as they may prefer to spend their money on higher-priority items.").

131. WILSON RICKERSON ET AL., FEED-IN TARIFFS AND RENEWABLE ENERGY IN THE USA—A POLICY UPDATE 1 n.1 (2008) ("The term 'feed-in tariff' derives from the German *Stromeinspeisungsgesetz* of 1990, which literally translated means 'electricity feeding-in law.'").

132. Public Utility Regulatory Policies Act of 1978, Pub. L. No. 95-617, 92 Stat. 3117 (1978) (codified as amended at 16 U.S.C. §§ 2601–2645 (2010)). The avoided cost approach is codified at 16 U.S.C. § 824a-3.

133. FERC Regulations Under Sections 201 and 210 of the Public Utilities Regulatory Policies Act of 1978, 18 C.F.R. §§ 292.101(b)(1), 292.204 (2010).

134. RICKERSON ET AL., *supra* note 131, at 2–3.

135. *Id.*

anyone for electricity generated from renewables, whether or not it serves any load.[136]

Efforts to establish FITs are underway in a number of states,[137] and there have been proposals for federal FITs,[138] although the main climate bills under consideration favor the RPS approach.[139] Unlike the FIT, which focuses on setting the right price for electricity generated from renewables, an RPS mandates how much of a utility's demand must be met with generation from its renewable energy facilities, or certificates that it purchases from another generator.[140] This basic difference in the regulatory approach has led to discussion about whether FITs are superior to RPS for promoting renewables,[141] including an ongoing debate between Professors Lincoln Davies and Jim Rossi.[142] Observers of the European experience conclude that the stability of FIT payments pro-

136. Glenn Harris, *Net-metering or Feed-in Tariff? Can They Co-exist?*, RENEWABLEENERGYWORLD.COM, Sept. 25, 2008, http://www.renewableenergyworld.com/rea/news/article/2008/09/net-metering-or-feed-in-tariff-can-they-co-exist-53618.

137. RICKERSON ET AL., *supra* note 131, at 2; KARLYNN CORY ET AL., NAT'L RENEWABLE ENERGY LAB., FEED-IN TARIFF POLICY: DESIGN, IMPLEMENTATION, AND RPS POLICY INTERACTIONS 1 (2009).

138. Slocum, *supra* 13, at 13 (describing the bills proposed by Rep. Jay Inslee (D-WA)).

139. The American Clean Energy and Security Act of 2009 (commonly known as "Waxman-Markey") would establish a "combined efficiency and renewable electricity standard" of 20% by 2020, with up to eight percent coming from efficiency measures and as little as twelve percent from renewable power sources. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. § 101 (2009).

140. CORY et al., *supra* note 137, at 8.

141. *See, e.g.*, Letter from Kellyn Eberhardt, Envtl. Defense Fund, to Fla. Pub. Svc. Comm'n, (Aug. 26, 2008), *available at* http://www.wind-works.org/FeedLaws/USA/EDF%20PSC%20Comments%2008-26-08.pdf ("Evidence is mounting that a REP [*renewable energy payment*] policy far outweighs other procurement models for the large-scale adoption of renewable energy technologies.").

142. *Compare* Lincoln L. Davies, *Power Forward: The Argument for a National RPS*, 42 CONN. L. REV. (forthcoming 2010) (advocating a national RPS) *with* Rossi, *supra* note 33 (opposing it). Other articles advocating a national RPS include Benjamin K. Sovacool & Christopher Cooper, *The Hidden Costs of State Renewable Portfolio Standards (RPS)*, 15 BUFF. ENVTL. L.J. 1, 9–10 (2008); Christopher Cooper, *A National Renewable Portfolio Standard: Politically Correct or Just Plain Correct?*, 21 ELECTRICITY J. 9 (2008); Joshua P. Fershee, *Changing Resources, Changing Market: The Impact of a National Renewable Portfolio Standard on the U.S. Energy Industry*, 29 ENERGY L J. 49 (2008); Robin J. Lunt, *Recharging U.S. Energy Policy: Advocating for a National Renewable Portfolio Standard*, 25 UCLA J. ENVTL. L. & POL'Y 371, 402–03 (2007).

One argument against a national RPS is that it is not the best means of reducing carbon emissions. A 2009 study by three Department of Energy researchers concludes that a national RPS would be an "imperfect substitute" for comprehensive climate legislation because it does not directly mandate reduced use of fossil fuels. AUDREY LEE ET AL., REGIONAL IMPACTS OF A NATIONAL RENEWABLE PORTFOLIO STANDARD (2009), *available at* http://www.usaee.org/usaee2009/submissions/ExtendedAbs/AudreyLee.doc. *See also* ELECTRIC POWER RES. INST., ECONOMIC ANALYSIS OF CALIFORNIA CLIMATE INITIATIVES: AN INTEGRATED APPROACH (2007), *available at* http://mydocs.epri.com/docs/

vides greater incentives than the RPS structure.[143] China is gradually moving toward FIT-like mechanisms for renewable resources,[144] which suggests that it is rethinking the wisdom of mandating the growth of renewables through RPS-like mechanisms.

A number of states have considered FITs, but by 2009, only California, Washington and Vermont had adopted them.[145] Vermont's law is the most like the German model, with different rates paid for different technologies and project sizes, and set at the cost of generation plus profit at a "reasonable rate of return" for long-term contracts.[146] Gainesville, Florida has perhaps the most aggressive European-style FIT, with its regional utility paying $0.32 per kWh for solar PV (about three times the cost of electricity in Florida as a whole).[147] FITs' slow growth is not surprising, as they are politically dicey. Their costs are passed on to all of a local utility's customers, who subsidize those who have taken advantage of the payments. This will inevitably lead opponents to tag FIT proposals as "anti-competitive."[148] As Professor Davies notes, the FIT takes on

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public/000000000001014641.pdf (reaching a comparable conclusion with respect to programs being undertaken in California).

143. *See, e.g.*, NICHOLAS STERN, STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE 366 (2006), *available at* http://www.hm-treasury.gov.uk/stern_review_report.htm (last visited June 6, 2010) ("Comparisons between deployment support through tradable quotas and feed-in tariff price support suggest that feed-in mechanisms achieve larger deployment at lower costs. Central to this is the assurance of long-term price guarantees."). This is popularly known as the "Stern Report."

144. Eisen, *China's Renewable Energy Law*, *supra* note 28.

145. Press Release, Cal. Pub. Util. Comm'n, CPUC Approves Feed-In Tariffs to Support Development of Onsite Renewable Generation, Feb. 14, 2008, *available at* http://docs.cpuc.ca.gov/word_pdf/NEWS_RELEASE/78824.pdf (discussing California's adoption of feed-in tariffs); Phil Taylor, *House Will Get Another Shot at Feed-In Tariffs*, N.Y. TIMES, Aug. 3, 2009, http://www.nytimes.com/gwire/2009/08/03/03greenwire-house-will-get-another-shot-at-feed-in-tariffs-70749.html (stating that Vermont, as of Aug. 3, 2009, was the only state to fully adopt feed-in tariffs). *See also* John Perkins, Comment, *Overcoming Jurisdictional Obstacles to Feed-In Tariffs in the United States*, 40 GOLDEN GATE U. L. REV. 97 (2009) (discussing U.S. FITs and proposals for additional ones).

146. VT. STAT. ANN. tit. 30, § 8005 (2010); *see* Paul Gipe, *Vermont FITs Become Law: The Mouse That Roared*, RENEWABLEENERGYWORLD.COM, June 1, 2009, http://www.renewableenergyworld.com/rea/news/article/2009/06/vermont-fits-become-law-the-mouse-that-roared.

147. GAINESVILLE, FLA., ORDINANCE 080566 (2009) (offering up to $0.32 per kWh). The average retail rate of electricity for residential customers in Florida in February 2010 was 11.53 cents per kWh. U.S. ENERGY INFO. ADMIN., AVERAGE RETAIL PRICE OF ELECTRICITY TO ULTIMATE CUSTOMERS BY END-USE SECTOR, BY STATE, February 2010 and 2009, *available at* http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html (last visited June 12, 2010).

148. Zac Anderson, *As Florida Shifts to Solar, a Fight Looms*, HERALD TRIBUNE, Mar. 22. 2009, at A1, available *at* http://www.heraldtribune.com/article/20090322/ARTICLE/903221081 (citing comments opposing a FIT proposal in Florida by utility Florida Power and Light).

"perhaps the heaviest burden in the American political lexicon—the moniker of 'tax.'"[149] The FIT can also have adverse distributional consequences. The payments will go to more affluent customers who can afford the solar systems, but the utility might raise rates on all of its customers, poor and wealthy, to compensate for the payments.[150]

If the FIT would ensure rapid growth in urban solar, then it would be worth countering these arguments. In Germany and Denmark, the payments have led to rapid increases in solar residential installations.[151] Germany more than doubled its national supply of electricity produced from renewables between 2000 and 2007, and met its 2010 target three years ahead of schedule.[152] However, like all government subsidies, the FIT depends on continuing governmental support, and the German subsidy is reportedly about to be cut substantially.[153]

The FIT also does not address the substantial upfront cost of the technology or the installation costs.[154] It is like offering a consumer a rebate on cellular phone service and expecting that she will purchase the phone. The FIT might be useful in combination with other policies, but on its own it is not a recipe for success. One possible solution involves rebates and tax credits working in combination with the FIT to make solar more attractive. They subsidize the equipment, with the FIT lessening the payback period.

As mentioned above, consumers will still balk at the upfront cost of the technology.[155] Assuming they are willing to go forward, they remain in the position of dealing with multiple entities: the utility that will purchase electricity from them, the local, state, or federal government that offers tax benefits or rebates, and the installer who will provide the hardware. Nothing about an FIT alleviates this problem.[156] Giving

149. Davies, *supra* note 142.

150. Rossi, *supra* note 33, at 8–9.

151. JOHN FARRELL, NEW RULES PROJECT, FEED-IN TARIFFS IN AMERICA: DRIVING THE ECONOMY WITH RENEWABLE ENERGY POLICY THAT WORKS 8–12 (2009), *available at* www.boell.de/downloads/ecology/FIT_in_America_web.pdf.

152. *Id.* at 12.

153. *Germany's Solar Industry Worried About Future in Wake of Subsidy Cuts*, DEUTSCHE WELLE, Jan. 21, 2010, *available at* http://www.dw-world.de/dw/article/0,,5153447,00.html.

154. CORY ET AL., *supra* note 137.

155. *See supra* Part IV.B.

156. Here is a comment on Britain's plan to implement a national FIT:

> Let me know the financial calculations of . . . . . .
>
> [T]he installation cost - the grant (if available) - maintenance & expected system life span (1 year manufactures [sic] warranty?) after which it's down to you to either foot the bill or take out insurance for repair.
>
> The end product in an ideal world is free energy and low carbon footprint.
>
> In reality a complicated home system like condensing boilers that cost a fortune to maintain and are beyond economic repair after 5 or so years. [sic]

homeowners money over the long term to generate electricity from the system does not relieve them of the responsibility of becoming general contractors.

C. *Property Tax Financing (PACE)*

Property tax financing (also referred to as "property assessed clean energy" or "PACE") is different in that it addresses the upfront cost. It allows local governments to provide property owners the option of installing renewable energy projects and paying for them over a period of years by adding specified amounts to their property tax bills.[157] Project funding comes from special tax bonds repaid through taxes collected on the property tax bills of participating owners.[158] California pioneered this approach,[159] and as of 2010, eighteen states had laws that allow their counties and cities to establish special assessment districts for energy financing.[160] These laws typically permit cities and counties to create energy financing districts, define types of projects eligible for financing, and give authority to the cities and counties to issue the bonds for financing.[161]

> This is idea is gonna cost you £££'s in the end unless you know how to design and build and maintain your own system.

Posting of Smugtory to GUARDIAN.CO.UK.COM, http://www.guardian.co.uk/environment/2010/jan/27/feed-in-tariffs-renewable-energy (Jan. 27 2010, 17:57 GMT).

157. THE WHITE HOUSE, POLICY FRAMEWORK FOR PACE FINANCING PROGRAMS 2 (2009), *available at* http://www.whitehouse.gov/assets/documents/PACE_Principles.pdf [hereinafter WHITE HOUSE FRAMEWORK] ("Property owners that benefit from the improvement then repay the bond through property assessments, secured by a property lien and paid as a part of the property taxes. . . . This local-government energy financing structure would allow property owners to 'opt-in' to attach up to 100% of the cost of energy improvements to their property tax bill."); *id.* at 6 ("Additional protections come from the year-by-year nature of the property tax lien if a borrower defaults.").

158. *Id.* at 2.

159. California's Clean Energy Municipal Financing Law was the first PACE statute. Fuller et al., *supra* note 3, at 2; *see generally* CAL. STS. & HIGH. CODE §5898.20–.32 (2010).

160. These states are California, Colorado, Florida, Hawaii, Illinois, Louisiana, Maryland, Nevada, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Texas, Vermont, Virginia, and Wisconsin. CAL. STS. & HIGH. CODE §5898.20–.32 (WEST 2010); COLO. REV. STAT. ANN. § 30-20-601.5 (West 2009); FLA. STAT. § 189.400–.429 (2009); HAW. REV. STAT. § 46–80 (2009): 65 ILL. COMP. STAT. 5/1-1-11 (2010); LA. REV. STAT. ANN. §33:130.790–.793 (2009); MD. CODE ANN. ART. 24 § 9-1502 (West 2010); NEV. REV. STAT. § 271.010 (2009); N.M. STAT. ANN. § 4-55C-1-8 (West 2009); N.Y. GEN. MUN. LAW. § 119-gg (McKinney 2009); N.C. GEN. STAT. ANN. § 153A-210.4–210.7 (West 2009); OHIO REV. CODE ANN. §1710.01–.13 (West 2009); OKLA. STAT. tit. 19 § 460.1–.7 (2009); OR. REV. STAT. § 223.387–.399 (2009); TEX. LOC. GOV'T CODE ANN. § 376.001–.008 (Vernon 2009); VT. STAT. ANN. Tit. 30, § 8002–8003 (2009); VA. CODE. ANN. §15.2-958.3 (2009); WIS. STAT. ANN. § 66.0627 (West 2009).

161. WHITE HOUSE FRAMEWORK, *supra* note 157, at 2.

In 2009, the ARRA removed one potential disincentive to property tax financing. Previously, the federal tax code prohibited individuals or businesses receiving "subsidized energy financing" from receiving federal incentives for renewable energy projects, such as tax credits. The ARRA ends this prohibition for home and business owners who finance their projects with taxable municipal bonds.

Property tax financing seems to eliminate the solar system's upfront cost, as a homeowner pays nothing up front and the city or county offers 100 percent financing. Because the debt is repaid through the property tax, if the homeowner moves before the system's payoff period, the debt simply continues to be repaid by the next owner. The obligation is meant to attach to the land, not the borrower, and to run with the land until paid off.[162] However, it is not clear that the obligation would transfer, as it depends on state servitudes laws.[163]

PACE could attract some homeowners, but the system is not "free," as its cost is recouped through a special assessment on the homeowner's property tax bill.[164] The question then becomes whether homeowners will object to that. PACE could provide the same perception to consumers that the upfront cost has disappeared because it has been amortized over time, like the practice of cell phone companies that spread the cost of a phone over two years or more.[165] This makes PACE inherently more attractive than tax credits and rebates. The PACE obligation is comparable to taking on a second mortgage, and because Americans move so often, homeowners might discount an obligation that spans decades into the future. This is what PACE proponents effectively hope for when they assert the obligation will run to subsequent homeowners.

Because PACE is so new, however, no evidence shows that a consumer would perceive spreading out the payments as painless. And while consumers may be willing to take on second mortgages to make home improvements because they perceive that housing is a good investment, they may be less willing to take on PACE obligations if the returns are not as obvious. Cell phone contracts involve one-time payments for hardware, while in this case the homeowner would see a reminder every time she sends in a property tax bill that she still owes on the obligation. On a typical 5 kW, $40,000 system, the extra taxes would be $2,000 per

162. *Id.* ("The assessment runs with the property at law and successor owners are responsible for remaining balances.").

163. *See* 1–60 R. POWELL, POWELL ON REAL PROPERTY § 60.04 (Michael Allan Wolf ed. 2009) (noting that servitudes are enforceable only if specific requirements met).

164. Chris Lynch et al., Berkeley FIRST, Presentation at UC Berkeley School of Law, Boalt Hall, Renewable Energy & Energy Efficiency Financing (Apr. 9, 2009) (copy on file with author).

165. This would be consistent with research showing the importance of net present value to consumers contemplating solar and energy efficiency improvements. Fuller et al., *supra* note 3, at 2.

year for 20 years, which is not an inconsiderable sum. Another possible concern is that some states would require homeowners to disclose the higher property tax obligation at the time of resale, which might give some prospective buyers second thoughts.

The limited experience with PACE to date suggests that the availability of full upfront financing prompts some homeowners to go forward with solar installations. In 2008, Berkeley, California became the first city in the nation to establish a property tax financing program. One year later, the program had funded thirty-eight solar projects.[166] By 2010, eleven cities and counties in California, and four others nationwide had established similar programs.[167] In March 2010, San Francisco's program launched with $150 million in funding.[168]

Extending the idea to a national scale, as Vice President Biden proposed in 2009,[169] would be extremely costly.[170] In addition, a form of regulatory commons problem seems likely to hamper widespread adoption of PACE beyond those states and cities where it has already begun.[171] PACE requires cities to proactively create new institutions. It requires state legislatures to empower cities to create special assessment districts, and it requires the cities to take action on their part of the two-step process.[172] They cannot rely on existing agencies and finance mecha-

166. The $1.5 million pilot phase of the Berkeley FIRST financing program sold out in nine minutes. Chris Lynch et al., *supra* note 164.

167. The eleven cities and counties in California with PACE financing programs are Alameda, Berkeley, Los Angeles, Palm Desert, San Diego, San Francisco, Santa Barbara, Santa Cruz, Santa Monica, Solana Beach and Sonoma County. Programs are in place or planned in Boulder, Colorado; Annapolis and Montgomery Counties, Maryland; Santa Fe, New Mexico; Athens, Ohio; and Babylon, New York. WHITE HOUSE FRAMEWORK, *supra* note 157, at 3.

168. *SF Green-Lights Country's Biggest PACE Program*, VOTE SOLAR INITIATIVE, Feb. 8, 2010, http://votesolar.org/2010/02/sf-green-lights-pace-program.

169. Vice President Biden announced a "Recovery Through Retrofit" initiative to create a national program based on the Berkeley model. Carolyn Jones, *Biden to* Model Solar Finance Plan on Berkeley's, S.F. CHRONICLE, Oct. 20, 2009, at C2. A set of policy principles and analysis of existing programs can be found in the WHITE HOUSE FRAMEWORK, *supra* note 157.

170. By one estimate, it would take $280 billion to fund "energy-efficiency and solar upgrades in fifteen percent of residential buildings in the United States." Fuller et al., *supra* note 3, at 10.

171. *See generally* William W. Buzbee, *Recognizing the Regulatory Commons: A Theory of Regulatory Gaps*, 89 IOWA L. REV. 1 (2003). Professor Buzbee uses the term "regulatory commons" to describe the lack of regulatory leadership that results when multiple levels and agencies of government have responsibility for addressing a particular problem. He observes that one result may be "predictable incentives in complex, multi-layered political-legal contexts for social ills not to be overregulated, but to remain unaddressed, to remain gaps in regulation." *Id.* at 5.

172. MERRIAN C. FULLER ET AL., UC BERKELEY RENEWABLE AND APPROPRIATE ENERGY LAB., GUIDE TO ENERGY EFFICIENCY & RENEWABLE ENERGY FINANCING DISTRICTS FOR LOCAL GOVERNMENTS 8 (2009), *available at* http://rael.berkeley.edu/sites/default/files/old-site-files/2009/FullerKunkelKammen-MunicipalEnergyFinancing2009.

nisms, but must create new ones. At both points in the political process, there are ample opportunities for opponents to claim that PACE is not an appropriate use of scarce municipal resources, particularly in tough economic times. As NIMBY-like opposition to local solar and wind projects shows,[173] there are plenty of opponents to these projects. Increasing the number of pressure points where opponents can take on proponents is not desirable.

PACE is far too complex for the average locality to administer. Its proponents note correctly that it relies on a bond financing mechanism with which cities are already likely to be familiar.[174] However, PACE special assessment districts are different from traditional improvement districts. They allow individual owners to opt into the program, rather than sharing the cost of an improvement among all property owners in the district.[175] This makes PACE more like a lending program and less like a one-time decision to assess a tax. A city would be required to make decisions on an ongoing basis about individual homeowners' suitability for participation in the program. This is a responsibility that not all cities will be willing to undertake, and it is therefore no surprise that cities like Berkeley with active environmental departments have been the first ones to adopt PACE.[176] Bring PACE to Peoria, and it may be a wholly different matter to convince local officials to devote municipal resources to the solar business. Many localities are fighting for their economic lives, and schools, libraries and other public facilities will be much higher priorities than PACE.[177]

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pdf (noting that "setting up and administering an Energy Financing District requires staff time on the part of local governments"). Not surprisingly, as of early 2010, no localities in the following states with state PACE laws had developed local financing programs: Florida, Hawaii, Illinois, Nevada, North Carolina, Oregon, Vermont, and Virginia.

173. Rosenberg, *supra* note 6, at 639–41.

174. WHITE HOUSE FRAMEWORK, *supra* note 157, at 2 ("Land-secured financing districts (also known as special tax or special assessment districts) are a familiar tool in municipal finance. In a typical assessment district a local government issues bonds to fund projects with a public purpose such as streetlights, sewer systems or underground utility lines. Property owners that benefit from the improvement then repay the bond through property assessments, secured by a property lien and paid as a part of the property taxes.").

175. CLAUDIA EYZAGUIRRE & ANNIE CARMICHAEL, VOTE SOLAR INITIATIVE, MUNICIPAL PROPERTY TAX ASSESSMENT FINANCING: REMOVING KEY BARRIERS TO RESIDENTIAL SOLAR 5–6 (2008), *available at* www.cleanenergyfortexas.org/downloads/vote_solar_initiative.pdf.

176. *See* City of Berkeley, Office of Energy and Sustainable Development, http://www.ci.berkeley.ca.us/sustainable.

177. *See, e.g.*, Susan Saulny, *Financial Crisis Takes a Toll on Already-Squeezed Cities*, N.Y. TIMES, Oct. 7, 2008, at A16 ("All over the country, parks are being sold, fees for routine services are going up and city workers are being laid off."). *See also* E-mail from Ronald H. Rosenberg, Professor, William and Mary Law School, to author, Jan. 25, 2010 (on file with author).

Assuming for the moment that cities do take to the PACE idea, one major hurdle remains. PACE addresses the issue of upfront cost, but not the transaction costs of installations. Cities with programs in place have no municipal installers. So while the city provides the funding to the homeowner, she is still required to handle legal and technical responsibilities.[178] If cities decided to tackle these obstacles to solar installations, many would find themselves in uncharted territory. Vetting equipment vendors and the like could easily exceed their competence level.

Any approach to urban solar will require municipalities' blessings. But cities should not shoulder primary responsibility for directing the process of marketing and distributing solar panels. If we had developed cell phone networks by asking each city to set up special districts for cell phone financing, it would have required policy innovations that localities would not have had the expertise to handle. Moreover, the benefits of standardization and economies of scale would not be available. PACE will not yield the large-scale installations that would make solar a disruptive technology because each new special assessment district has to be created according to the dictates of laws that vary from state to state, and even from locality to locality. The real innovation would be to find a different institutional structure that avoids piecemeal policies and addresses the transaction costs for prospective solar consumers.

D. *Solar Power Purchase Agreements*

A new model for deploying solar is finding more widespread use in the commercial setting: the solar power purchase agreement (PPA).[179] A PPA does not depend on direct financial incentives to end users to prompt them to purchase and install solar equipment.[180] Instead, it removes the upfront cost.

The solar PPA is a contract entered into between an electricity consumer (called the "host") and a company that is typically not the consumer's retail utility (the "developer" or "solar services provider").[181] The developer owns a renewable energy facility installed at the host's site.[182]

178. As an article by the developers of Berkeley's approach puts it, "[i]t is also important to note that the other barriers to adoption—information, transaction costs, and principal-agent barriers—still exist even if first cost is addressed." Fuller et al., *supra* note 3, at 9.

179. *See* Rachel Barron, *Power-Purchase Agreements to Spike*, GREENTECHSOLAR, Feb. 14, 2008, http://www.greentechmedia.com/articles/read/power-purchase-agreements-to-spike-591 (claiming that PPAs "will drive 75 percent of commercial and industrial solar sales in 2008 and 2009"); Michael Behar, *Selling the Sun*, ONEARTH, Feb. 27, 2009, http://www.onearth.org/article/selling-the-sun; *see generally* U.S. Envtl. Prot. Agency, Solar Power Purchase Agreements, http://www.epa.gov/grnpower/buygp/solarpower.htm.

180. U.S. Envtl. Prot. Agency, *supra* note 179.

181. *Id.*

182. *Id.*

Under the PPA, the developer owns the system, and the host pays the developer for the power produced.[183] The host also provides the developer access to the site to install equipment and perform maintenance, typically by granting an easement.[184] A number of large businesses, such as the retailers Kohl's and Wal-Mart, and a variety of institutions such as the Denver International Airport, have used PPAs. Whole Foods Market, the popular grocery chain, installed solar systems at some of its New Jersey stores in 2004 through PPAs.[185]

One report has predicted that, "PPAs will be established as the standard way that American businesses pay for on-site green power."[186] It is not difficult to see why, as the economic incentives are the inverse of those in a PACE structure. The developer incurs an upfront capital cost and is repaid by a long-term revenue stream over the term of a PPA contract that can last for fifteen to twenty years or more.[187] The developer/facility owner gets the benefit of tax credits and incentives, and might be able to sell renewable energy certificates (depending on whether it or the host retains them[188]) to utilities to satisfy obligations under an RPS.[189] Forecasting whether those combined revenue streams make a solar installation economically viable becomes the responsibility of a company that can presumably bring legal and business talent to bear on the problem.

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183. *Id.*

184. CHANDRA SHAH, NAT'L RENEWABLE ENERGY LAB., POWER PURCHASE AGREEMENTS 12 (2009), *available at* www1.eere.energy.gov/femp/pdfs/afo_ppa_pres.pdf.

185. Kerry A. Dolan, *Paying for Panels*, FORBES.COM, Aug. 16, 2007, http://www.forbes.com/2007/08/16/financing-solar-energy-tech-07egang-cz_kd_0816solarfinance.html.

186. JON GUICE & JOHN D.H. KING, GREENTECH MEDIA RESEARCH, SOLAR POWER SERVICES: HOW PPAS ARE CHANGING THE PV VALUE CHAIN 4 (2008), *available at* http://www.gtmresearch.com/report/solar-power-services-how-ppas-are-changing-the-pv-value-chain.

187. An interesting and as yet unaddressed question is whether an obligation under a PPA would run with the land to subsequent purchasers of the host site. Courts often disapprove of affirmative covenants to pay money to third parties but might view this obligation differently.

188. In *American Ref-Fuel Company*, 105 Fed. Energy Reg. Comm'n Rep. (CCH) ¶ 61,004 (2003), the Federal Energy Regulatory Commission declared that state law governs ownership of the credits generated by renewable energy facilities. Courts ruling on this issue often hold that renewable QF project attributes are conveyed to power purchasers. *See, e.g.*, In re Ownership of Renewable Energy Certificates, 913 A.2d 825 (N.J. Super. Ct. App. Div. 2007). *But see* Fershee, *supra* note 142 (discussing contrary decisions). Of course, this could also be resolved by contract.

Setting up proper accounting systems for RECs can also be difficult. Joel B. Eisen, *The Environmental Responsibility of the Regionalizing Electric Utility Industry*, 15 DUKE ENVTL. L. & POL'Y F. 295 (2005).

189. SHAH, *supra* note 184, at 4 (calling this a "double bonus" and "good alternative to purchasing RECs").

The host must assess whether purchasing power from the developer is financially advantageous, which does not require evaluation of a large capital investment. In the short term, rates might be slightly higher, but the PPA can serve as a hedge against long-term increases in electricity rates.[190] Like a fixed-term mortgage, the host locks in a rate that may be advantageous in the out years. In the typical PPA transaction, the host has an option to purchase the facility at some point during the length of the contract. If it believes the benefits of stable rates over a longer term would be desirable, it can capture them for itself in this fashion. There are some drawbacks for hosts considering PPAs. The negotiation process can be complicated.[191] Also, if the renewable energy system will not meet 100% of the host's needs, the host will have to continue service with its existing provider and pay two separate electricity bills.[192] As a new arrangement, the long-term viability of PPAs has yet to be proven.[193]

Why not simply extend this model to the residential setting? Some companies offering PPAs have years of experience in installing solar,[194] but very few offer a residential PPA.[195] As one observer puts it, "[s]mall projects lack the economies of scale that would make the uncertainties and transactions [sic] costs worth bearing."[196] Borrego Solar, which offers PPAs in commercial and nonprofit settings, "won't even touch projects smaller than 200 kW."[197] A residential solar system typically is in the 3–10 kW range,[198] so this limitation effectively restricts the PPA to the commercial setting. The "uncertainties" include the lack of pre-

190. IN OUR BACKYARD, *supra* note 4, at 13.

191. U.S. Envtl. Prot. Agency, *supra* note 179.

192. *Id.*

193. If a PPA developer failed, what would happen to "its" equipment located at the host's site? One can readily imagine a situation such as a bankruptcy proceeding where a successor in interest would be required to remove the solar panels. That state of affairs should be avoided.

194. *See, e.g.*, Borrego Solar, http://www.borregosolar.com/solar-energy-company/solar-contractor.php (last visited June 7, 2010).

195. Musser, *supra* note 1.

196. *Id.*

197. *Id.*

198. Calculating the required system size is no small matter. Many factors affect the size of a system designed to serve the electricity needs of a household, including the household's electricity demand, hours of sun it receives per day, and so forth. The 3–10 kW range is a synthesis of a number of estimates widely available on the Internet through multi-step calculators that attempt to empower homeowners to decide how large their systems should be. *See, e.g.*, Residential Solar Panels, http://www.residentialsolarpanels.org/plan-solar-system (last visited June 7, 2010). A New Jersey utility puts the average size of a residential solar system at 7 kW. PSE&G Solar Loan Program, Frequently Asked Questions (FAQs)—Residential, http://www.pseg.com/customer/solar/faq_residential.jsp#anchor5 (last visited June 7, 2010).

dictability in the subsidies that a PPA developer would receive.[199] Also, unlike universities and airports, homeowners move every so often, which might require renegotiation of a PPA deal with a new owner. But there is no reason why these and other uncertainties could not be addressed.

V. TOWARD PROMOTING DISRUPTIVENESS IN URBAN SOLAR

[S]omeone has got to do for solar installation what Apple did for the cellphone [sic]: make it so simple that even an astrophysicist could do it.[200]

If utilities are reluctant to scale up urban solar, and PPA developers generally eschew small installations, then who will market and distribute solar to households? There are no obvious candidates. Since the 1970s, renewables industries have always had an aspect of small scale. Many factors account for this, including owners' reliance on smaller companies to help them establish independence from utility companies (including those hardy souls who live "off the grid"). This has been a business with a pioneering decentralized ethic.

A. *A New Business Model: One Company Handles the Entire Process*

It is time for this business model to change. The present situation begs for a solar utility to take over the entire process of marketing and distribution in a wide geographic area, offering a comprehensive, streamlined solution to homeowners. There are no such options at present for residential users, except in the few states where companies offer PPAs or similar lease-type arrangements,[201] or where utilities themselves have embarked on distributed solar projects. Another intriguing solution is the Home Depot home improvement chain's service, which offers turnkey panel installing and "applying for and processing all permits, tax credits and coordination with your power company."[202] The entry of a major home improvement company into this market suggests the time is ripe for a solar utility to go even further and handle the entire process. In

199. If RECs are one component of the PPA developer's project revenue stream, any variability in their value could harm project viability. *See, e.g.*, Musser, *supra* note 1 (noting that PPA developers rely "heavily on tradable certificates of fluctuating value").

200. *Id.*

201. The SunRun company recently announced that it would enter the solar market in New Jersey, bringing its coverage to a total of five states. Nate Lew, *SunRun to Offer Residential Solar Energy Service in New Jersey*, COOLERPLANET, Jan. 21, 2010, http://solar.coolerplanet.com/News/19571903-sunrun-to-offer-residential-solar-energy-service-in-new-jersey.aspx; *see also* Mark Jaffe, *Dimming Solar Costs: Home Systems Are Becoming More Affordable With Zero-Down Leasing*, DENVER POST, Feb. 4, 2010, at B5 (describing SunRun's activities in Colorado).

202. Solar Power Installation—The Home Depot, http://www.homedepot.com (follow "Services: Installation" hyperlink; then follow "Solar Power Systems" hyperlink).

combination with a PPA-like financial model (which Home Depot does not offer[203]), turnkey installations would fundamentally change the nature of urban solar.

A solar utility would address the legal, financial, technical, and administrative tasks of solar installations and assuage homeowners' concerns. This company would have the ability and resources to overcome the "last mile" problem[204] and provide a comprehensive package including both the hardware and the other services required to support it (including, for example, maintenance of the panels). Using PPA-like financing and standardized technology, it could work out the engineering at host sites, gaining expertise as it engaged in more deals. This would also relieve homeowners of most of these responsibilities. Solar utilities might even bundle solar panel installations with other products, such as automakers might do with plug-in hybrids or a Home Depot might do with other home improvements.

The federal government should select solar utilities that have the expertise and resources to scale up to a nationwide basis. Many different kinds of companies could become solar utilities, and we should therefore be relatively agnostic about deciding which ones should qualify for government licenses.[205] There should be no requirement, for example, that the companies be stand-alone businesses; an existing company's business unit could take advantage of the company's strengths.[206] To provide an incentive for solar utilities, the federal government could offer them exclusive rights to provide installations in specific geographic territories. A comparable example would be the proliferation of cable television through governmental franchises. The structure in each market would be among the many details to be worked out; for example, it could be a

203. Another shortcoming of this approach is that Home Depot could not step into a homeowner's shoes to overcome legal opposition (*e.g.*, by doing battle with a homeowners' association wielding covenants to stop an installation). Rosenberg, *supra* note 6.

204. Of course, I use this term deliberately to echo the expansive body of literature on such familiar "last mile" problems as bringing the power of the Internet to consumers by bridging the "distance between main data lines and individual homes, businesses, and schools." James Fallows, *E-Mail Out of Every Plug*, THE ATLANTIC, June 2006, *available at* http://www.theatlantic.com/magazine/archive/2006/06/email-out-of-every-plug/4874.

205. Because utility companies have captured state PUCs and dominated the restructuring process (for example, by arguing successfully in many states that they were entitled to recoup billions of dollars in "stranded costs" despite controversy over their claims to entitlement), state legislatures and regulatory agencies might require solar utilities to compete with incumbent utilities. This does not make sense from a disruptiveness theory perspective, but may reflect political reality.

206. Danneels, *supra* note 12, at 256–57 ("When resource complementarities between the new venture and the mainstream business are crucial, and these complementarities require intracompany coordination, a more integrated approach may be advised.").

duopoly, as was originally done with cell phone companies.[207] The structure could also provide for disaggregation of the industry when specific performance benchmarks were met.

Any scheme this dramatically different from current practice will have its critics. One likely objection is that the federal government has a less-than-perfect track record of picking winners and losers. It often gets involved well after the technology is developed and can make decisions that hinder further technology development.[208] Contrast that, however, with the situation that exists at present, where no company has gained the legal and regulatory expertise, approvals, and technical know-how to be a full-fledged solar distribution company. A regulated structure may well be able to do what a fragmented, competitive industry cannot. It can overcome the regulatory instability and high upfront regulatory costs by offering one entry point to the regulatory process. Once a company handles the process of securing necessary federal, state, and local approvals to proceed with installations, it would incur fewer additional transaction costs. Given the difficulty of doing this at present, it is unlikely that any company would take on this task without governmental support.

Because creating unchecked monopolists leads to undesirable monopoly rent, a combination of state and federal regulation of this industry may be warranted, much as we regulate cable and telecommunications companies. It is already likely that solar utilities would be subject to state regulation as public utilities, unless existing state laws were amended. A number of state public utility commissions have considered whether PPA developers are public utilities because they sell electricity to retail customers. The New Mexico Public Regulation Commission ruled recently that PPA developers are not "public utilities" under that state's laws because they offer their services to specified individuals and not to the public.[209] The state's largest utility[210] and other rural electric cooper-

207. The regulator overseeing this process would need considerable resources to evaluate the applicants. *See, e.g.*, Fox, *supra* note 59 ("Between 1982 and 1986, the FCC planned to use comparative worth regulatory hearings to assign licenses [in the cell phone industry]. However, the FCC did not have the engineering resources to evaluate the many proposals, so the FCC awarded licenses for smaller cities and rural areas using a passive mechanism: lotteries. The lottery assignment mechanism attracted entrepreneurs with very little capability to operate a wireless phone carrier.").

208. In the cell phone industry, for example, the FCC's opening of additional spectrum that made the switch from analog to digital telephony possible trailed the development of the technology by years. *Id.*

209. Marjorie Childress, *Renewable Energy Gets a Greenlight from NM Public Regulation Commission*, N.M. INDEPENDENT, Dec. 23, 2009, *available at* http://newmexicoindependent.com/43552/renewable-energy-gets-a-greenlight-from-nm-public-regulation-commission. Other states reaching similar decisions include Nevada, Michigan, Colorado, Oregon, California, New Jersey, Maryland, Connecticut, Hawaii, and Massachusetts. Third-Party Arrangements for Renewable Energy Generation, Utah Pub. Svc. Comm'n, Docket No. 09-999-12 (Comments of Utah Clean Energy, Nov. 16, 2009, at 3), *available at* http://www.psc.state.ut.us/utilities/misc/miscindx/0999912indx.html.

atives had argued to the contrary. Their logic would apply more readily to solar utilities that would serve numerous customers and would almost certainly be public utilities in every sense of the word.

State monopoly regulation of this industry would also recognize our electricity system's uniqueness. When restructuring experiments in the 1990s allowed new companies to enter into part of the industry (electricity generation), the results were abysmal. Many states, including my home state of Virginia, have turned away from deregulation to traditional cost-of-service regulation or a variant of it.[211] Monopoly protection may also be required to subsidize the inefficiency of melding widely different skills of construction, property management (maintenance and repair), and regulatory analysis and compliance in a single company, or, to put it another way, to minimize consumers' exposure to the full risk of business failure.

Perhaps the most significant reason to regulate solar utilities as monopolies is to ensure their financial viability. They would depend on three revenue streams: state and federal tax credits and incentives (including the production tax credit or investment tax credit, as appropriate); revenue from the sale of RECs; and revenue from monthly electricity payments by homeowners. As noted above, the tax credits can be substantial, defraying as much as 50% of project capital costs.[212] One option for a company would be to finance the remaining amount with debt that would be repaid through a combination of the sale of RECs to utilities and the monthly electricity payments.[213]

An ambitious and detailed study in 2009 by the University of Delaware's Center for Energy and Environmental Policy explored whether this combination of revenue streams would support a "Solar Energy Utility" for the city of Newark, Delaware.[214] In this hypothetical scheme, the city would charter and operate a utility that would install and operate solar panels on a high percentage of city rooftops. This legal structure has some of the same drawbacks as PACE, in that it would require a city to become involved in the utility business when it may lack the expertise or inclination to do so. However, the financial analysis of the proposed pro-

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The Utah Public Service Commission is also dealing with the issue. *Id.* As of the writing of this article, it has not yet reached a decision.

210. Public Service Company of New Mexico.

211. *See Report of the State Commission Practice and Regulation Committee*, 30 ENERGY L.J. 765, 793 (2009) ("[A]fter six years in which only very limited interest was shown in this Virginia retail market by both end-use customers and competitive suppliers, in 2007, the General Assembly adopted legislation effectively re-regulating the market . . . .").

212. CREATING A SOLAR CITY, *supra* note 2, at 39.

213. *Id.*

214. *Id.* at 40.

ject is worth noting, because it would be the same for a private-sector solar utility.

The authors contacted two energy investment firms, which concluded that the project would be financially viable under the conditions proposed.[215] The study mentions two caveats. First, the number of RECs in a scaled-up solar market might exceed utility demand for them, driving the price down. One solution to this might be a national RPS with a national REC market, as the study assumes that RECs generated in Delaware could only be sold in the thirteen states of the PJM Interconnection regional market.[216] Second, the demand for federal tax credits could be substantial and pose a drain on federal resources. The authors call for federal support of tax incentives at higher levels than present.[217] In this Article's solar utility model, the federal government could conceivably take in revenue by creating and selling territory licenses, as it did with the cell phone industry, and use that revenue to fund added support for tax credits.

One assumption undergirding the Delaware study's financial analysis is that electricity prices would remain stable over the long term.[218] As in the commercial PPA setting, the contractual rate lock-in is necessary for debt financing. In the solar utility context, a state public utility commission could regulate rates to ensure that consumers were protected from excessive rates, while the utility could earn a reasonable rate of return. Of course, this idea is not new. Throughout our history, we have relied upon a "regulatory compact" that grants protection from competition to companies that serve the public, taking the risk to scale up and serve end users. In return, they agree to governmental regulation of the rates they charge (and rate of return) and services they offer.[219] This protection can dramatically increase the economic desirability of entering into an industry.

Consumers might view this financial structure more favorably than that of any other current incentive for solar power. There would be no upfront cost, and the monthly rate premium for green power would be substantially less than the added property tax increment of PACE (the only viable incentive that promises to eliminate the upfront cost). More research would be necessary to determine consumers' willingness to pay, but it seems plausible that small monthly premiums at the outset of a PPA-like contract would not deter consumers.[220] An analogy would be

215. *Id.* at 41–42.

216. *Id.* at 43–44.

217. *Id.*

218. *Id.* at 42 (using a "Price-to-beat" of $0.14/kWh increasing at 2.5% per year).

219. For a contemporary use of the term in this context, see Kathy Larsen, *Buffett and the Railroads: The 'Social Compact' Applies*, POWER LINES, Mar. 2, 2010, http://www.platts.com/weblog/powerlines/2010/03/02/buffett_and_the_railroads.html.

220. Sachs, *supra* note 4, at 309–10.

the purchase of a cell phone, where carriers subsidize the hardware and recoup those amounts during the contract period with fees for services. Those can often amount to more than the hardware cost, but this fact has not prevented millions of Americans from purchasing cell phones. Moreover, locking in the rate (as with a PPA) can make solar power less expensive than fossil fuel-generated power over the long term.

It is not clear what would happen if tax credits were unavailable because they were not renewed or not sufficiently large enough to support solar utilities. To be in business for the long haul, solar utilities must have a long-term guarantee that the funding stream will be less inconsistent than solar tax credits have been over the past three decades. This is no small matter. The history of this industry is rife with companies that thought they would succeed but did not. Between 1978 and 1985, when federal tax credits were in place, major companies (including some Fortune 500 companies) sold solar technology, but when the tax credits evaporated, so too did the companies.[221] It is also not clear that solar utilities would own RECs created by residential projects, which is currently a matter of state law and hardly settled uniformly. These are among many financial questions that remain to be addressed before solar utilities can become a reality.

B. *A Research Agenda*

Not surprisingly, given the comprehensive scope of this solar utility proposal, there are numerous financial, legal and technical issues to be worked out. With this in mind, it would perhaps be more appropriate to call the proposal a platform for a much longer analysis, and to group the major issues in a typology of sorts. A research agenda might include the following, with some issues depending on the resolution of others as noted:

1) *Economies of scale*: The proposal's eventual success rests on a notion that while individual installations might have low profit margins, a solar utility's economies of scale in installing multiple systems might be potentially lucrative. This in turn depends on whether there are in fact scale economies in various technical aspects of the business: for example, can a company create savings if it services multiple jobs in a small geographic area? Perhaps the greatest potential area of savings is regulatory. This of course would depend in turn on the contours of the regulatory approval process. Further research here should focus on the economics of the solar utility's business model bringing legal, technical, and business aspects of the transaction under one roof.

221. See *supra* note 115 and accompanying text.

2) *Company structure*: Regulatory design on this point must be careful. If an entrant knows nothing about the solar business, we will run the same risk of failure as in the late 1970s and early 1980s. Disruptiveness theory also tells us that incumbent electric utilities have shortcomings, but that should not completely preclude them from entering into the business. While this situation may not be directly comparable to that of restructuring (new entrant companies would not be required to share infrastructure with existing utilities, as was the case then), the possible side-by-side presence of new entrants and utilities would require careful consideration to ensure that the utilities do not use incumbent advantages to dominate the business.
3) *Monopoly regulation*: As noted above, if the industry is structured in a monopolistic (or duopolistic) fashion, companies might extract monopoly rents without regulation. This proposition requires testing, perhaps with a pilot program under the auspices of a state public utility commission. This pilot program should also examine whether consumers will be willing to pay the small premium in higher prices of electricity generated from solar power.
4) *Technology choice*: The consumer experience should be streamlined, but technology choice should not be overly constrained. Different solar designs work best on different homes, depending on such factors as roof shape, geography and orientation (whether the roof faces south, for example). Also, the entity offering the technology should have an economic incentive to change to new and better technology, at least for new installations, as that technology becomes available. Careful attention should be paid to deciding what technologies are to be made available at the inception of these companies and how best to promote continued innovation.
5) *Municipal approvals*: Comprehensive studies would determine what permits and licenses would be necessary to operate at the municipal level in each state. While this proposal would probably require less work on a city's part than establishing a PPA, it still would entail time and resources that could be spent elsewhere. More importantly, then, there should be incentives (perhaps financial) for cities to participate.
6) *State property law*: It is not at all clear that a "residential PPA" agreement would run with the land, and research into the law of covenants would be necessary. Also, it might take a federal law to cure the problem of neighborhood covenant resistance, comparable in some ways to what was done with opposition to television satellite dishes. Because land use policies are traditionally thought of as a predominantly local concern, any effort in this

direction would face federalism concerns (comparable to those faced by the energy efficiency provisions in climate bills). Still, as consumers currently bear all of the risk of action against them by their homeowners' associations, it would be more desirable to explore how a third party could step into the homeowner's shoes or how the problem could be resolved at the federal level.

7) *Legal authority*: Analyses of a wide variety of existing and (potentially) proposed legal authorities would be needed. One important question is whether it would take amendments to the Federal Power Act or state public utility statutes (or both) for solar companies to proceed.

This recital of challenges should not deter us from pursing the goal of making solar installations high-volume transactions instead of the equivalent of custom home building. Thirty years' experience with renewable energy has resulted in little progress. While some existing incentives (e.g., FITs) are of recent vintage in U.S., they are unlikely to address the most important issues preventing widespread adoption of residential solar technology.

In this fragmented industry, gains in disruption from adopting a different type of business model can be much more effective than relying on an existing one.[222] The utility's argument in the New Mexico case has been made in other states, and suggests that any proposal to create solar utilities would encounter stiff resistance. Opposition from incumbent companies should be no bar to adopting a disruptive technology. In many cases, in fact, it is the strongest signal that a new business model is warranted.[223]

As Professor Christensen explains, "[d]isruption can take decades if independent disruptive companies rely on other disruptive companies to put in place, piece by piece,"[224] their parts of a marketing and distribution network. Because there are a lot of moving parts in this system, we do not have time to waste while we try out other ideas that only address part of the problem.

Electricity generated from solar is still more expensive than conventionally generated electricity, but not by so much that it would make sense to wait to bring it to the masses. The delays in creating this comprehensive system of solar utilities outweigh the value of incremental improvements in technology. Working toward this result is preferable to following our current course, which would deter the average American consumer from adopting solar technology for many years to come.

222. CHRISTENSEN ET AL., *supra*, note 41, at 26.

223. *Id.* at xlvi ("Regulators must beware . . . of attempts by the leading institutions to outlaw business model innovation. Regulation should facilitate it.").

224. *Id.* at xxx.