Institutions matter, but are they sufficient for enhancing all markets?

Examining the role of the state in promoting off-grid PV technology for productive uses in Punjab, India

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Abstract

Solar photovoltaic (PV) technology, a form of renewable energy, can embody environmentally sustainable development and bring electricity to thousands, particularly those in rural areas without access to the grid. Currently, policymakers are seeking ways to enhance markets for off-grid PV in productive uses, namely those that increase income generation and contribute to social development. PV offers a myriad of benefits to different users, and therefore this paper does not limit its analysis to expanding markets for the poor. It explores the central question: what is the role of the state in promoting off-grid PV market growth for productive uses? As a start, the state must improve institutions, such as promoting competition among providers and creating enforceable product standards-- thus echoing recommendations based in new institutional economic theory (NIE). However, NIE's market-oriented prescriptions may be insufficient for promoting all PV markets because the theory does not offer viable solutions to overcoming political barriers that contribute to technological path dependency. A case study in Punjab, India, where an agricultural PV water pumping program is in its third year of operation, illustrates how the NIE's shortcomings manifest themselves in practice. The program successfully penetrated market entry for PV pumps via competition between PV providers. However, the government of India achieved this feat by providing subsidies to wealthy farmers, a move that is frowned upon by the NIE school. Based on findings from the case study, states should look beyond NIE's framework to expand and improve PV markets in productive uses by accounting for political constraints, assessing how PV technology can improve development goals, and cultivating locally- appropriate service delivery models.

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Acronyms

FI	Financial Intermediary
IPP	Independent Power Producer
IREDA	Indian Renewable Energy Development Agency
LC	Leasing Company
MNES	Ministry of Non-Conventional Energy Sources
NIE	New institutional economics
PEDA	Punjab Energy Development Agency
PV	Photovoltaic
RET	Renewable energy technology
SEB	State electricity Board
SHS	Solar home system
SNA	State nodal agency

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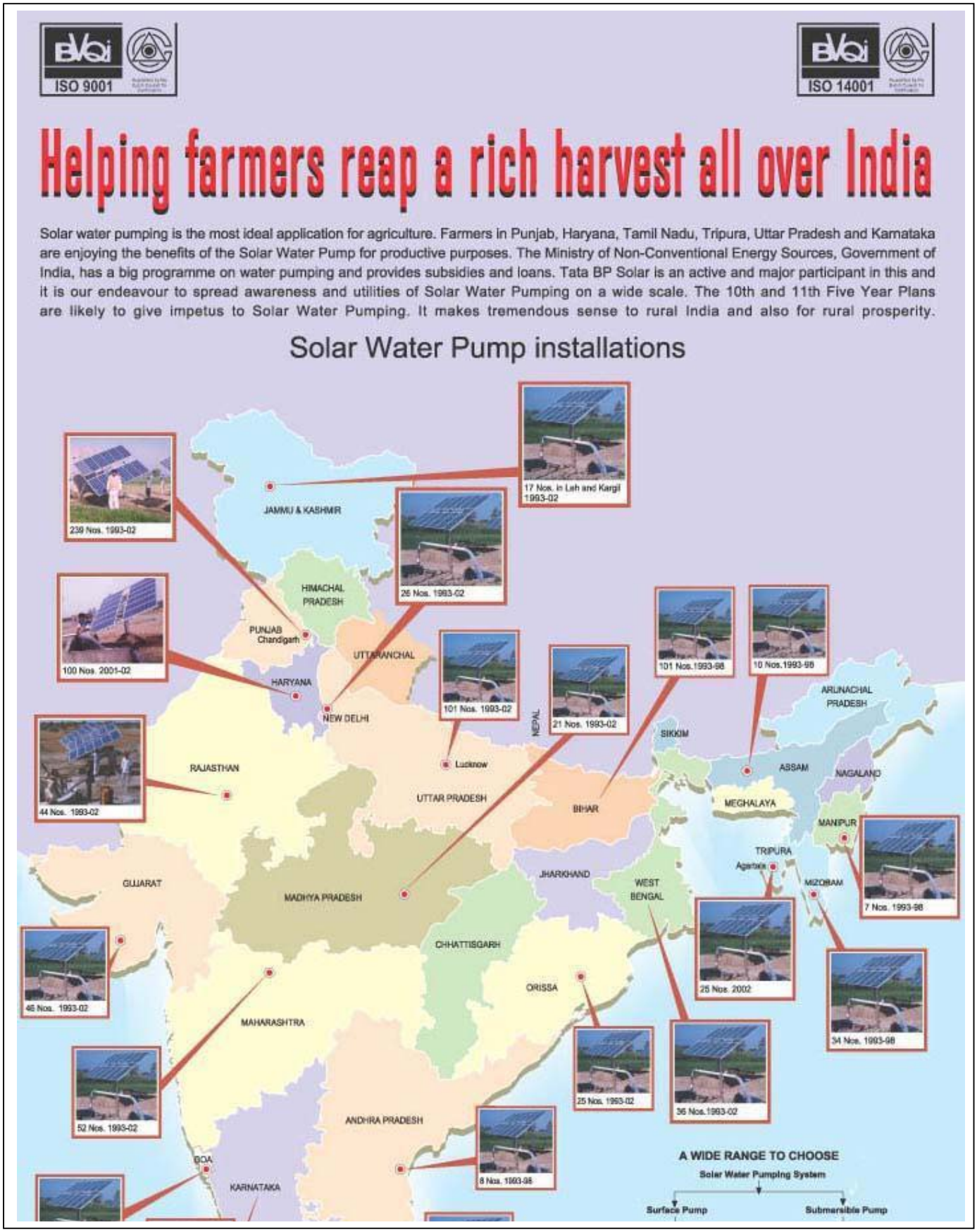
Note

This dissertation uses the Harvard referencing system.

Advertisement from Tata BP Solar for PV agricultural water pumping project across India.
Source: http://www.tatabpsolar.com/poster4.htm



1.0 Introduction

Despite decades of awareness on the merits of renewable energy, strengthening markets for new energy technologies remains a challenge. Solar photovoltaics (PV), a form of renewable energy, can embody environmentally sustainable development and bring electricity to thousands, particularly those in rural areas without access to the grid. Already, PV, which generates emissions-free electricity from the sun, has been used in numerous off-grid solar home systems (SHS) in developing countries to improve people's livelihoods. However, experiences show that for viable PV markets to emerge, successful entrepreneurial projects with strong sales or service delivery models are necessary. In recent years, policymakers, particularly in the international lending community, have begun to conceive of new roles for PV and have sought ways to enhance markets for off-grid productive uses in order to contribute to economic and social development.

Off-grid PV technology is a different entity than traditional, grid-based power systems. Therefore, off-grid markets may require different institutions and strategies if they are to find their way into productive uses on a larger scale[1]. Since PV is relevant to development efforts regarding energy restructuring, environmental protection and rural development, it faces pressure from different actors to be both a tool for sustainable development and a mechanism for poverty alleviation in the rural sector. Simultaneously, attempts are underway to shape a viable PV market amidst a sea of bias in favor of conventional, fossil fuel-based energy sources. Success on three fronts is a tall order and for a triple-win to emerge, a commitment from national governments is imperative to foster conditions that will expand PV's uses.

In this light, new institutional economics (NIE), a development economics theory promoted by the World Bank, examines what mechanisms should be reformed in order to make general markets operate smoothly. It finds the answer in institutions, or formal and informal rules that govern behavior. Align them on the side of competition with regulatory oversight and one's markets can be expected to improve. Complementary literature from renewable energy advocates, including those within the Bank, call for supply-side competition among providers, but recognize that subsidies may be necessary to enhance PV usage in poor regions. Often the poor are unable to secure credit to purchase PV systems, which remain prohibitively expensive.

The aim of this paper is to examine the question: what is the role of the state in promoting off-grid productive uses of PV? In seeking the answer, I critically examine how NIE, specifically the World Bank's use of the paradigm, applies to generating new markets for PV. In doing so, I also scrutinize criticisms of NIE, which point to how "getting the institutions right" glosses over the difficulties in reforming politically- influenced institutions that have become embedded in society. I use a case study from Punjab, India, where a PV agricultural water pumping program is in its third year of operation, to evaluate the role of the state in relation to different actors in one type of business model. I also show how the model emerged within a certain political context and examine the role of government subsidies – traditionally thought of as market destroyers– in carving out PV markets for productive uses. Within my observations, I

[1] On-grid enterprises have the luxury of a strong demand for grid-based energy and an existing delivery infrastructure. Policy changes center around whether, and to what extent, independent power producers (IPPs) can share access to the grid with other utility companies. Since off-grid markets rely heavily on entrepreneurship, rather than necessary negotiations with utilities, and work on a smaller scale for more targeted audiences, the barriers to its success will be different.

also discuss how previous electricity sector reforms and development strategies, particularly in India, failed to account for renewable energy, thus making market entry for PV potentially more complicated. Based on the lessons drawn from the case study, I then suggest where to improve government action to facilitate and increase off-grid PV's entry into the development framework via productive uses. This paper seeks to contribute to existing literature on suggesting effective, yet diverse, methods for enhancing PV markets in developing countries. It does not focus on promoting an array of business models; rather, it suggests *how* one should first approach finding solutions to market barriers.

Despite the fact that there are many forms of renewable energy, which include biogas, wind, wave, and mini hydro, I have chosen to focus on PV because it is younger and more sophisticated than other renewable energy technologies (RETs), and thus may require a different response from different actors. PV is also applicable in many parts of the developing world, due to the prevalence of tropical countries that receive ample sunshine throughout the year. I only focus on productive uses for PV, an emerging focus in development studies, instead of SHS, which is where the current bulk of experiences and lessons learned can be found. I also direct my focus towards the rural sector, which is where PV technology can enhance socio-economic development. However, I do not limit my analysis to the poor. Finally, despite the attention to renewable energy being used to achieve emissions reductions in climate change initiatives, due to spatial limitations, I will not address this aim of technology enhancement or North-South vs. South-South technology transfers.[2]

2.0 Methodology

This paper was written using primary and secondary research and is based in qualitative analysis. The theoretical underpinning draws principally on NIE which offers an analytical framework for assessing challenges raised by the case study. I conducted an extensive literature review on barriers to enhancing RETs in developing countries and examined criticisms of energy sector reforms. For the Punjab case study, I conducted a literature review of India's experience with advancing renewable energy and examined a report on the program. I then conducted interviews with the head manager of the program implementation team in the NGO sector as well as staff at the Energy and Resources Institute in New Delhi who were familiar with the program. I also conducted interviews with World Bank officials in the Bank's energy sector and the Global Environment Facility to learn firsthand about barriers to improving supply and demand for RETs in developing countries and why renewable energy has not been mainstreamed into the World Bank's lending or consulting practices.

3.0 Definitions

The terms PV, productive uses, conventional fuels, the grid, and institutions will be used throughout this paper. In addressing PV, I am referring to solar energy panels made out of silicon. For productive uses, I adopt the FAO/GEF working definition: "in the context of providing modern energy services in rural areas, a productive use of energy is one that involves the application of energy derived mainly from renewable resources to create goods and/or services either directly or indirectly for the production of income or value" (White, 2002). However, I extend the definition to a use that provides social services to enhance human development via health and education (Sen, 1999), despite the ongoing debate over whether or

[2] See Wilkins (2003) and Forsyth (1998) for further discussion.

not a project that is conceived for social benefits can generate economic development (White, 2002). By conventional energy sources, I refer to fossil fuels, large hydro and nuclear (Wilkins, 2002). The grid refers to a system of high tension cables by which electric power is distributed throughout a region. For institutions, I follow North's definition: "Institutions are the rules of the game of a society…the humanly devised constraints that structure human interaction. They are composed of formal rules, informal constraints, and the enforcement characteristics of both" (North 1995, p.23).

4.0 Why PV? Applications for productive uses and barriers to market enhancement

4.1 Why PV?

PV technology offers diverse uses and benefits. Stand alone solar PV panels can provide electricity where the grid is absent or act as an alternate source of power in circumstances where electricity generation is spotty and unpredictable (Foley, 1995, van der Plas and Hankins, 1998, Wilkins, 2002). Often utility companies, particularly those that have been privatized, lack incentives to extend the grid to rural areas, where consumers are either too poor or too sparsely located to make grid connection worthwhile (Foley, 1995, Williams, 2003). PV technology can also help combat vulnerability to oil price spikes, which is not a relic of the 1970s, but still a viable threat to net oil importers as seen in 1999-2001 (Wilkins, 2002). While many developing countries, namely in Latin America, Southeast Asia, and Africa, are oil exporters, a sizeable number of countries in those regions are net importers. Rural consumers remain particularly susceptible to price fluctuations in conventional fuels, particularly since they are often willing to pay high prices relative to their incomes for reliable and predictable energy (World Bank, 2000).

PV is also a flexible technology that can be rapidly installed, can supplement existing inter-regional supply systems, and lead to fewer energy losses than conventional transmission delivery (World Energy Council, 2000). With up to two billion people, mostly in the rural sector, still lacking access to electricity (World Bank, 1996), prospects for enhancing PV markets are ripe. Globally, PV and wind power contributions combined are growing at annual rates of 10-30 percent, depending on the location (Martinot *et al.*, 2002).

Yet, for PV to be an effective source of energy, it must be realistic about its limitations and therefore find its market niche. Realistically, the number of users in a community will often prefer conventional electricity since it has more load capacity and therefore offers limitless use options (Foley, 1995). For PV markets to work, they should seek areas with high existing demand for them and not try to replace other RETs, such as wind or biogas, that are better suited for certain functions. Already experiments with SHS have been underway for at least two decades. However, experiences show that PV overwhelmingly tends to serve as a backup to the grid to power appliances, such as televisions, in wealthier households, instead of meeting the needs of the poor (Martinot *et al.*, 2002). As a result, new literature is examining how to expand PV's consumer base by targeting it for productive uses rather than purely residential needs (Etcheverry, 2002).

4.2 Productive uses in rural development

Applying renewable energy to productive uses can assist rural socio-economic development. Specifically, PV can power cellular telephones and computers via solar batteries, provide electricity in health clinics so that vaccines can be refrigerated, provide electricity in classrooms, and generate electricity for water pumping systems either for agricultural purposes or

community drinking water (Gupta, 2003, White, 2002, Wilkins, 2002, World Energy Council, 2000). More broadly speaking, Gupta envisages expanding the uses of RETs to create "rurban" areas--rural communities with urban commodities—in order to mitigate the flow of rural to urban migration and enhance sustainable development (Gupta, 2003).

While generating PV markets for productive uses should continue to be viewed as a tool to enhance rural development, I raise the idea that productive uses for PV should not necessarily be limited to the lives of the poor. Different stakeholders might wish to enhance PV markets based on diverse goals. If the societal goal is poverty alleviation, then concentrating more specifically on the poor makes sense. However, in other instances some may wish to enhance PV's competitiveness with conventional, polluting fuels for environmental reasons. Such an approach would also include targeting wealthier segments of the rural population. These observations make room for analyzing what approach the state should adopt when determining where, when and how it should be involved in targeting and encouraging off-grid PV to flourish in productive uses.

4.3 Barriers to PV markets

Based on experiences with attempts to establish SHS in developing countries, renewable energy advocates and experts note a common set of key barriers across regions. While existing productive use projects contain little information on prospects for replication (White, 2002), renewable energy experts argue that many of the lessons from SHS are instructive for broadening PV's scope. Rather than needing an entirely new set of actors and institutions, PV advocates and providers should examine new strategies for deployment (White, 2002).

A significant barrier to PV market growth is the lack of inter-agency, or inter-ministry, dialogue and integrated planning over rural energy needs and energy provision (Gururaja, 2003, Wilkins, 2002). In most countries, the Ministry of Power deals with energy restructuring, the Ministry of Agriculture handles farming issues, the Ministry of Environment (where one exists) handles pollution matters, and so on. Yet, in order for PV to find its way into productive uses in rural communities, an interdisciplinary approach is imperative (Bates *et al.*, 2003). PV providers must be able to coordinate with rural and economic development specialists to enhance their markets in productive sectors. Previous project experiences also demonstrate that PV applications in productive uses are more likely to have a positive impact if other economic activity is available to make use of it (Martinot *et al.*, 2002). Yet, impacts of connecting poor communities to markets via PV, or other RETs, is largely absent (Kammen, 1999). Additionally, in many countries where electric utilities have been privatized, renewable energy has not been a component of restructuring efforts, nor have many countries enacted legislation to mandate its inclusion. As a result, communities expecting grid connection are unaware of other options available to them (Wilkins, 2002). In many cases, negotiating space and agreement between off-grid and on-grid providers to target certain areas remains limited (Martinot *et al.*, 2000a).

Other barriers to PV markets persist. Consumers' inability to pay for PV infrastructure and a subsequent lack of available credit or financing both hinder growth (Barnes and Halpern, 2000, Gururaja, 2003, Martinot *et al.*, 2000a, 2000b, Morse, 2000, Philips and Browne, 1998, White, 2002, Wilkins, 2002). Banks are often unaware of PV's benefits, and are therefore reluctant to offer start-up capital for a technology they view as risky (Wilkins, 2002). Worse, many PV projects spearheaded by donors in the last decade did not emphasize entrepreneurship and local capacity building (Bates *et al.*, 2003, Mulugetta *et al.*, 2001). Instead, a 'demonstration' project mindset often persisted, where donors set up PV infrastructure but did not promote a sustainable business model to enhance demand. According to Martinot, *et al.* (2002, p.330)

"donations without any cost recovery destroy markets." A lack of viable sales or service delivery and maintenance models as well as a lack of trained local personnel to administer repairs have also limited prospects for a healthy PV market (Martinot *et al.*, 2000a, 2000b, Morse, 2000, Philips and Browne, 1998).

Additionally, transaction costs and political manipulations constrain PV market growth. Difficulties in reaching and educating remote customers and dealing with multiple stakeholders increase transaction costs of setting up PV systems (Martinot *et al.,* 2000b). Access to the grid frequently becomes a political tool where politicians' promises of grid-connected electricity often leave rural communities reluctant to switch to off-grid energy (Martinot *et al.,* 2000b, World Bank, 2003a). In other instances, advertising that does not illustrate the limits of PV has left many consumers dissatisfied (Mulugetta *et al.*, 2000). Finally, inconsistent standards for PV technology fail to ensure quality in many circumstances and government-imposed import duties on PV systems increase final costs to consumers (Wilkins, 2002).

Given these constraints, how should governments respond in ways that can enhance PV markets?

4.4 Overcoming Barriers: Suggestions for state involvement

Current literature on enhancing PV markets almost unanimously agrees that a competitive business model is imperative for markets to grow and that regulatory oversight should allow entrepreneurial activity to flourish (Martinot *et al.*, 2002, Philips and Browne, 1998). The state's role is to act as a facilitator and coordinator in the realm of policy, legislation, training, and education (Gupta, 1995). As a start, the state can eliminate tariffs on PV-related imports, mandate that renewable energy be included in energy restructuring agreements, and support research and development (G-8, 2001, Morse, 2000). It can also remove implicit subsidies to conventional fuels (Gregory *et al.*, 1997) and can employ a cost-benefit analysis to the energy sector that accounts for environmental degradation (Jagadeesh, 2000). Both measures would allow renewable energy technologies to be more competitive with conventional, polluting ones. The state can also encourage involvement from civil society organizations, such as community groups, to spread awareness of PV's uses and ensure providers are meeting local needs[3] (Wilkins, 2002). Governments must also develop capabilities to enforce PV equipment standards in order to ensure quality and uniformity in markets. Additionally, PV entrepreneurs must know if the grid will be extended to certain areas in order to target consumers' needs (Morse, 2000, Wilkins, 2002). Therefore governments should cease making false promises to constituents and strengthen dialogue between ministries over energy planning. The purpose of ensuring these institutional changes is to increase transparency and predictability within the energy sector so that consumers understand their options and providers are clear on where the demand for PV technology rests, both of which are recipes for market growth.

Despite laying the groundwork for PV to flourish in productive uses, markets can fail to reach the poor. States may need to use subsidies to make equipment more affordable. However, subsidies should be 'smart,' or targeted to meeting specific rural needs and flexible enough to be

[3] I recognize that this particular suggestion is controversial. Many development practitioners call for community involvement but do not explicitly recognize that communities themselves often reflect wider social norms and are thus often politically biased and motivated themselves. As a result, community oversight may not lead to transparency and equity, but may further promulgate inequalities. It is, however, beyond the scope of this paper to engage in a detailed discussion of the role of civil society in building institutions for markets. See Harriss (2001) for an introduction. My motive for incorporating the suggestion is to recognize that in some instances, where community groups and NGOs are active, they may be able to play a valuable role in promoting PV markets.

removed. Experiences have shown that in some countries "well-meaning government subsidies for PV have undercut the existing private PV industry, so that while an individual program may be successful, the sustainability of the overall PV market is damaged" (Philips and Browne, 1998, p.7). Subsidies can also be harmful to market growth because they give incorrect market signals and are often difficult to administer (Gururaja, 2003). Additionally, there will never be enough subsidy money in developing countries to "out-compete other energy sources" (Philips and Browne, 1998, p.5). Smart subsidies would focus on fostering demand-inspired growth and would provide assistance for up front capital costs, rather than subsidizing consumption-- the latter of which has had deleterious effects on markets growth in previous experiences (Barnes and Halpern, 2000). Moreover, governments should encourage private sector involvement wherever possible (G-8, 2001, Morse, 2000, Philips and Browne, 1998).

The government-imposed remedies for PV markets cited above reflect a particular type of state involvement, one that reflects a recent theory that has been applied to development studies: new institutional economics (NIE). Below, I examine how NIE provides a framework for state involvement to improve market performance and present contrasting critiques.

5.0 Theory: Examining the NIE Paradigm

5.1 Get the institutions right

During the 1990s, a new framework in development economics emerged to nuance its neoclassical predecessor. Unlike the neoclassical assumption that humans are rational actors and that markets clear if we 'get the prices right,' NIE focuses on 'getting the institutions right' (North, 1995). Instead of markets clearing because it is in their intrinsic nature to do so, markets are revered to work if only everyone would behave in rational and transparent ways. However, since people rarely do so naturally, the correct institutional checks and balances must be present. NIE considers market limitations to be a result of transaction costs from inadequate information, incomplete definition and enforcement of property rights, and barriers to entry from new participants (North, 1995, Nugent, 2002, World Bank, 2002). If institutions, both formal and informal, were governed by participatory mechanisms to ensure accountability, the correct incentives would emerge and market discrepancies would melt away. Additionally, since imperfect information increases transaction costs between individuals, transparency is necessary in order to smooth market imperfections.

In a marked departure from neoclassical thinking, the NIE school does not presume that the state will automatically antagonize functional markets via bungled bureaucracy. Instead, NIE sees the state as an integral player that must create the proper institutions to promote competitiveness, thus leading to the most efficient maximization of scarce resources (North, 1995). Competition forces organizations to invest in innovative skills and knowledge to remain afloat. New skills and knowledge will shape future choices and further alter institutions (North, 1995), thus adding new players to NIE's roster of market-enhancing organizations. Getting the institutions right is critical because getting them wrong can lead to path-dependency, whereby inefficient economic systems persist. Certain political groups may actively seek to maintain institutions that benefit them (North, 1995, Nugent, 2002) and may resist advancing institutional change where the transaction costs--often political transaction costs-- of implementing reforms outweigh the costs of retaining them (Khan, 1995). Societal networks also do not stay stagnant with inefficient institutions in the marketplace. They build up social and physical infrastructure to accommodate these institutions, thus making changes even more costly.

The focus on improving institutions is evident in recent World Bank reports[4]. The 1997 World Development Report (WDR) *The State in a Changing World* recommends that states develop strong regulatory mechanisms to encourage legal accountability, minimize corruption, and foster competition among goods and services via privatization (World Bank, 1997b). The report operates under the framework that privatization will allocate resources effectively, efficiently, and at the lowest marginal cost to society—thus freeing up state funds to provide for the poor (World Bank, 1997b). The 2002 WDR *Building Institutions for Markets* further advocates institutional reform via selective state involvement. States should promote open information flows, particularly to connect communities, and should again encourage competition among jurisdictions, firms and individuals. Moreover, governments should exercise neutrality when developing incentive structures, since competition should weed out the unsuitable competitors. "Market development and private business," the Report notes, "flourish when the behavior of those who govern is not arbitrary…a strong state that respects the law itself and refrains from arbitrary action is a critical factor" (World Bank, 2002, p.7).

It is important to note that even though the World Bank opposes biased state activity in shaping markets, it does make one exception. It acquiesces that subsidies may be necessary where markets fail to benefit the poor (World Bank, 2002). However, subsidies often encounter two main dilemmas. First, as mentioned earlier, they are often difficult to administer. Second, they can be difficult to remove (Barnes and Halpern, 2000). In both cases, subsidies risk becoming a mainstay if elite capture crowds out intended beneficiaries. As a result, just as the literature on renewable energy suggests, subsidies must be tightly administered and carefully targeted to reach those who need them most (Barnes and Halpern, 2000, World Bank, 2002).

5.2 Criticisms of 'get the institutions right'

While the NIE is able to explain institutional change in hindsight and why institutions are different in diverse societies, critics claim that it is a static theory (Nugent, 2002, Toye, 1995). The NIE's paradigm for making institutions work does not offer more specific analyses of the political landscape of a given country, which may explain why the same economic institutions can have varied consequences in different contexts (Harriss 2002, Sindzingre, 1998). "Power," Harriss notes, "is missing from the NIE" (Harriss, 2002, p.9). NIE, particularly how it is used in the 2002 WDR, advocates 'getting politics right' in order to 'get the institutions right.' Nevertheless, it fails to analyze the intense difficulties of doing so[5]. According to Bhardan (2000, p. 267), "institutional arrangements of a society are often the outcome of strategic distributive conflicts between different social groups." Moreover, instead of tackling politics head on as the force that drives economics, the NIE school and the World Bank attempt to soften it; otherwise, politics risk thwarting institutional change from the beginning, thus making theory irrelevant to practice. Fine (1999, p.403) terms this the "colonization of the social sciences by economics," where "non-economic or non-market relations [are treated] as if they were economic" (2001, p.8). Politics and power are analyzed in a neutral economy-enhancing or inhibiting lens of institutions (Fine 1999, 2001).

In dealing with politics as a peripheral issue, rather than placing it at the theoretical center, NIE risks underestimating the dynamic influence that politics can exert on markets. Advocating that states set up the correct institutions to spur market growth implicitly assumes

[4] While the 1997 and 2002 WDR encompass many topics and themes, I have only chosen to focus on key, broad components that apply to my further analysis of PV markets in India.

[5] The World Bank's predicament lies in its mandate, which forbids it from becoming involved in playing political favorites in developing countries. As a result, it almost has to recognize politics as an afterthought.

that once these are in place, markets are secure. This approach does not account for the politics that lurk beneath the surface, which may seek to subvert those institutions in the future. NIE advocates would most likely counter this argument by calling for implementing institutions that safeguard markets from political crosswinds in the first place! The tension between the two arguments persists because neither can be applied in absolute terms.

The NIE's analysis on the role of the state, as echoed by the World Bank, advises governments against behaving arbitrarily toward markets. However, this prescription ignores previous experiences in once-developing countries, where states shaped robust institutions and market growth via heavy-handed involvement in selecting and disciplining firms.[6] Although the World Bank recently acknowledged this practice in regard to East Asia's economic growth, it continues to advise other states against attempting such tactics.[7]

Despite recognizing that inefficient institutions are difficult to surmount once they become path-dependent, NIE fails to explain—with foresight, rather than in hindsight—how to overcome this path dependency. This dilemma becomes more evident as efforts to bring new technologies into the market encounter a technological and institutional co-evolution that has already locked-in previous technologies (Thompson, 1997, Unruh, 2000).[8] As a result, according to Jacobsson and Johnson, the emergence of a new technology, particularly one that replaces, rather than complements rival technologies, "is a painful and uncertain process" (2002, p.630) that usually faces highly organized actors from competing systems. New technologies must compete from a weaker vantage point, where their networks and dissemination strategies are not fully formed. It is unclear whether setting up institutions, such as a transparent rule of law or even policies favoring new technology, will always be able to penetrate the existing social and physical infrastructure without active and arbitrary state involvement.

Finally, the 1997 and 2002 WDR reports deem privatization as a solution to rent-seeking behavior of corrupt officials. In response to bureaucracy's drain on public resources, competition, it is argued, will raise the transaction cost of seeking protection and subsidy from the state, and henceforth promote efficiency between firms. The World Bank often assumes the existence of a strong private sector, or at least assumes that one will emerge given the correct institutions (Cornia, 1998, Hilyard and Wilks, 1998, Martinussen, 1998). However, absent from analysis is how the private sector may not always be ethical or operate according to quality standards (Bayliss and Cramer, 2001).

Below, I describe how the government in Punjab is promoting off-grid PV in agricultural uses. Then in section 7.0, I critically examine how the NIE framework and the critiques of it

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[6] See Woo-Cummings (1999) and Wade (1990) for further discussion.

[7] The 1997 and 2002 WDR both call for states to act within their capacities. Weak states should focus on the bare minimum, such as enforcing property rights, and only stronger states should attempt to exercise sharper controls over their manufacturing sector, or fill in the gap of missing markets. Given space constraints I will not discuss this approach, despite its importance to all developing countries in promoting PV markets. It raises the question, what should governments do if they lack allocated funding for subsidies, or if they are unable to attract a solid manufacturing base of PV providers? These are crucial questions for further research, however, the project in Punjab, India, which I examine later, does not have these concerns at present. For a brief discussion of how matching state capability to action can be problematic see Bayliss and Cramer (2001) and Mkandawire (2002).

[8] In the case of energy, Unruh (2000) explains how previous choices to use conventional fuels generated a 'carbon lock-in' characterized by increasing returns to scale which hinders energy-efficient technologies from penetrating the market, despite their economic and environmental benefits.

described above apply to Punjab's case in order to evaluate the role of the state in enhancing PV markets.

6.0 Case Study

6.1 Background: India's experiences with electricity restructuring and renewable energy

The political economy of energy provision in India provides the initial framework for understanding how different actors confront barriers to PV dissemination in Punjab. Both electricity sector reforms within the last decade as well as state-led initiatives to promote renewable energy affect prospects for advancing PV markets for agricultural uses in Punjab.

India's two attempts at reforming the electricity sector during the 1990s failed to make provisions for renewable energy. Poor public management, rampant corruption, and spotty collection of fees rendered most state electricity boards (SEBs) defunct and in desperate need of reform after fifty years of government control. The first reforms, implemented in 1991, opened utility companies to private competition. Yet, instead of implementing new regulations to insulate the sector from political influence and grant the SEBs further autonomy, the reforms were pushed ahead with immediate liberalization. In expedient efforts to attract independent power producers, the Ministry of Power waived environmental clearances (Dubash, 2002) and failed to provide avenues for renewable energy to fill in the gaps where utility companies and independent power producers (IPPs) would not provide access to the grid.

The second set of reforms began in 1993, where this time the World Bank stepped in to advise on restructuring for greater demand-side management. Again, the process only paid spurious attention to environmental and social issues. Even when they were acknowledged, the reform process was not structured to accommodate them (Dubash, 2002). After the reforms were underway, PV, in particular, still accounted for a small fraction of energy provision (Gupta, 1998). In 1998, the Bank conducted an electricity study of the environmental effects of electricity reform (World Bank, 1998) that focused on costs and benefits of different energy technologies rather than examining how institutional changes could affect the market viability of renewable energy, particularly off-grid technologies. Moreover, there is little evidence that the study impacted the design of reforms on the ground (Dubash, 2002). Likewise, in 1999 the Bank released the report, *Meeting India's Power Needs: Planning for Environmentally Sustainable Development,* which focused on on-grid power generation, instead of also examining how integrating off-grid and on-grid energy delivery plans could fulfill the needs of various uses. Finally, in its limited involvement in lending specifically for renewable energy projects in India, the Bank rushed the loan process and demanded that loans go through private sector developers instead of involving and strengthening public sector rural credit agencies (Miller, 2000).

A further constraint on electricity reforms is India's farmer lobby. During India's Green Revolution that began in the middle of the 20th century, farmers received free electricity and low-cost diesel in order to spur production (World Bank, 1999). Yet, after the Revolution ended, the subsidies remained, draining state resources. Old practices had become entrenched as these subsidies became a tool of populist politics (Dubash, 2002). Not only was this arrangement financially unsustainable, but since larger farmers could chase the water table more than small ones could, subsidization often disproportionately benefited the wealthy (Dubash, 2002). The scars of providing free electricity to farmers have yet to be erased as many still do not expect to pay for it, despite recent government attempts to begin phasing out the subsidies (Chaurey, 2003b).

However, despite India's shortcomings in incorporating renewable technology into its sector-wide reforms, it is in a far better position than most countries to accelerate off-grid PV market penetration. Since 1987, India has had a Ministry for Non-Conventional Energy Sources (MNES), a central government body responsible for targeting and financing renewable energy initiatives. The Indian Renewable Energy Development Agency **(**IREDA), MNES's soft-loan financing mechanism, provides subsidies, often administered at the state level to both providers and consumers (Bakthavatsalam, 1999). Currently most states have a state nodal agency (SNA) that administers the loan. Surprisingly, despite the corruption and bureaucracy found in India's government, synergy between the MNES and its state nodal offshoots is often robust, particularly in Punjab (Chaurey, 2003b). IREDA employs various instruments for accelerating markets for RETs which include, but are not limited to, debt financing, lending through financial intermediaries, and equipment financing (Bakthavatsalam, 1999). Since IREDA's headquarters are in New Delhi, it has adopted a decentralized management approach to reach clients and communities throughout India, namely via rural cooperatives, SNAs, commercial banks, NGOs, and RET manufacturers (Bakthavatsalam in World Energy Council, 2000).

Yet even this structure is not without flaws. Little dialogue and few integrated policy measures exist between the Ministry of Power and the MNES (TERI, 2002) or between the MNES and rural development initiatives. Thus, creating a niche for PV and targeting rural needs remains a dual challenge. Rural consumers must deal with two separate and competing entities for their basic needs. Additionally, in the past, MNES offered little advisory support for designing business models and, until recently, also encountered difficulty attracting private sector involvement in RETs (Ramana and Sinha, 1995). Experiences in the last decade with promoting renewable energy markets also show that IREDA was biased in favor of providing capital subsidies to larger corporations, with the presumption that over time markets would trickle down to the rural sector (Miller, 2000). IREDA officials often felt that penetrating rural markets was difficult due to problems in recovering loans and high transaction costs from working with multiple stakeholders that require time and resources (Miller, 2000). Despite IREDA's integral role in promoting RETs, it lacks sufficient finances to propagate all RET markets (Chaurey *et al.* 2003a). Government-allocated funding for renewable energy still remains a fraction of the funding available for conventional options (World Bank, 1999.) Moreover, India is missing strong private financial mechanisms that are willing to undertake risks associated with emerging RETs (Jagadeesh, 2000).

In 2001, the central government passed new energy legislation that called for the increased provision of renewable energy in order to meet rural energy needs and provide decentralized off-grid energy supply for the agricultural, industrial, commercial, and household sectors in rural and urban areas (Renewing India, 2003). According to Dubash (2002, p.62), the central government is leading "a broad trend away from acceptance of electricity provision as a purely commercial enterprise and more willingness to reinsert social and economic development goals within a broad framework of fiscal responsibility." Currently, it is too early to determine the effects of this emerging legislation on improving PV markets. Despite the potentially good news, there is still a need to be cautious since pre-existing biases towards conventional energy may prevent off-grid PV markets from infiltrating productive uses. Current reform efforts also call for more competition within the energy sub-sector, a move toward market-determined pricing (TERI, 2002). Since India's central government lacks a holistic approach to market enhancement across all energy subsectors (TERI, 2002), certain policies could potentially crowd out RETS, especially PV, in favor of more conventional fuels.

In sum, current barriers to successful RET market entry, particularly for productive uses, include (but are not limited to) a risk perception of RETs which makes it difficult to mainstream the technology past demonstration models; lack of capital at affordable cost since most banks are themselves unfamiliar with RETs; distorted energy markets due to established networks that can access conventional fuels; lack of rural awareness of PV's uses; and a dearth of trained professionals to administer routine maintenance (Bakthavatsalam in World Energy Council, 2000).

6.2 PV water pumping program in Punjab, India[9]

Punjab, a north-Indian State, is the prime agricultural bastion of India. Farmers use extensive canal-based irrigation systems and pump water to the surface via boreholes. They use a mix of stationary diesel pumps, electric pumps, and tractor-driven pumps to irrigate their land. The pumps are between 5-10 horsepower (HP). They also receive free electricity and subsidized diesel from the government, remnants from the Green Revolution, to power their conventional pumps (van den Akker and Lamba, 2002).

It is against this framework that the Punjab Energy Development Agency (PEDA), a state nodal agency of MNES, began introducing large scale solar PV pumps to replace conventional ones. Between October 2000 and March 2002, 1000 systems were installed. Since late 2002, 700 additional large scale pumps have been adopted by farmers in the region. Despite the fact that the PV pumps are only 2 HP and that PV market enhancement for pumps in this region must compete with free electricity, the program continues to expand. Below, I examine the role of the central and state governments in cultivating this ongoing process.

How do farmers first learn about solar PV pumps? PEDA uses the media to generate awareness by placing advertisements in the local newspaper, emphasizing the subsidies. After curious farmers agree to an initial deposit, PEDA officials visit the site to determine the size of the borehole. Due to high initial skepticism, farmers often opt to have a new borehole constructed, rather than dismantle the conventional pump's infrastructure (van den Akker and Lamba,2002, Lamba, 2003).

Why is the PV pump attractive to farmers in the first place if they already receive free electricity? Despite the farmers' initial disappointment that the 2HP pump does not deliver as much water as the 5-10HP pump, they appreciate the PV pump's benefits. The PV pumps are well suited for more efficient water pumping systems, such as drip irrigation or microsprinklers, they incur only a one-time low cost so they are not seen as a financial burden for these farmers, and farmers can use their tractors in the field while the water is pumping-- unlike their previous diesel and tractor-driven pumps which must remain stationary while pumping. The farmers also avoid the (albeit small) costs of additional diesel for the tractor (van den Akker and Lamba,2002, Lamba, 2003).

In order to make the PV-driven pumps cost-competitive, MNES itself provides a capital subsidy to the manufacturer to reduce the cost of equipment for the end user. Smaller programs

[9] This entire section is based on personal communication with Hemant Lamba (Lamba, 2003), project leader for AuroRE, a non-governmental organization commissioned by private firms to install PV pumps in Punjab; van den Akker and Lamba (2002); and personal communication with Akanksha Chaurey (Chaurey, 2003b) of the Energy and Resources Institute in New Delhi.

have been running since 1993, but it wasn't until 2000 that funding for larger scale projects accelerated. IREDA, which receives funding from MNES, also offers soft loans at 2.5 percent with repayment options extending up to 10 years with a two year moratorium on payments. From 1993-2002, four parties were involved in the financial architecture: MNES, IREDA, a leasing company (LC), and the manufacturer. MNES provided two sets of incentives which were routed through IREDA: a direct subsidy or combined grant and soft loan. Previously, loans were routed through the LC, which served as a financial intermediary (FI), although sometimes it was available directly to farmers themselves. The FI could also be a bank, PV manufacturer, or any other such company. Since farmers could not provide the necessary guarantees required by IREDA's strict financial requirements it was more convenient to route the loans through LCs or other FIs (Lamba, 2003).

Leasing companies had incentives to serve as the financial coordinators for these loans. First, they received a 100 percent depreciation benefit on holding a renewable energy asset. For example, if the asset was worth 100 Rupees and the income tax on it was 45 percent, the LC would deduct 100 Rupees from its taxable income. If the LC has an income of 100 Rupees, then by having an asset worth 100 Rupees they did not have to pay the tax, which would have amounted to 45 Rupees. Second, the interest rates during the mid 1990s were as high as 18 percent per annum. This would often translate to an average 15.5 percent interest differential between the IREDA loan and market interest, benefiting the LC. Third, farmers were only to pay a one-time lease rental up front, which avoided headaches in collecting lease rentals from financially unpredictable consumers (Lamba, 2003).

The farmers also benefited from this process because they received the PV pumping systems for about 10 percent of the original costs after the loans and subsidies were administered. Of all the parties involved, the MNES was the financial loser. However, since its aim was to promote a market niche for solar PV pumps, the government was willing to undertake losses (Chaurey, 2003b, Lamba, 2003).

Yet, by 2002, this process ceased. A crash in India's non-banking finance company market removed key FIs. After the crash cleared, only large, conservative banking players remained and declined to participate in complex financial arrangements with PV manufacturers, since they perceived PV as a risky emerging technology. Furthermore, no subsequent efforts materialized to educate banks and other private creditors on the benefits of PV. The second reason for the collapse of the IREDA-LC-farmer arrangement was that the central government's tax department terminated depreciation claims based on corruption from a few leasing companies. Finally, the fall in interest rates from 18 to 9 percent by 2002, further diminished incentives for LCs and thus dissolved the financial architecture (Lamba, 2003).

Since the beginning of 2003, two financial routing mechanisms have been in place for the solar PV pumping program: open market or the SNA (which in this case is PEDA). In an open market, the financial transactions operate similarly to their predecessor. However, instead of an LC, the FI is the manufacturer itself, which takes both the loan and the subsidy from IREDA and can reduce the cost of the equipment to the end user by 70 percent (Lamba, 2003).

In the SNA approach (see Box 1), which is the prominent model among Punjab's farmers, the MNES gives an additional subsidy of Rs. 25 per watt peak if the state government also provides an additional subsidy routed through the SNA. In the case of Punjab, PEDA provided an additional Rs. 50,000 subsidy. Due to the bulk tendering of 700 additional pumps in 2003, PEDA is able to reduce the price from Rs. 392,000 to Rs. 325,000.

Box 1: SNA financial approach

Cost of System:	Rs. 315,000.00	*approx.***	US$ 6,900.00
MNES Subsidy:			
@Rs.135 per Wp	Rs. 243,000.00		US$ 5,300.00
SNA Subsidy	Rs. 50,000.00		US$ 1,100.00
Cost After Subsidy	Rs. 22,000.00		US$ 480.00
End User Pays	**Rs. 35,000.00 ***		**US$ 770.00**

***End user also pays for plumbing & civil works. The price to an end user in open market approach includes both these items, which cost approximately Rs.10,000 or US$ 220.00**

** Based on bank exchange rates from August 24, 2003 from Oanda.com Fx converter

Source: Lamba (2003)

Despite the large subsidies, firms are engaged in a competitive bidding process for the lowest subsidy to discourage dependency on state handouts. In addition, PEDA awards several contracts to divide the work among firms to encourage more competition. The plan is for PEDA to evaluate and compare performances, and thus allocate future contracts only to companies that demonstrate optimal results in the field for PV quality and maintenance. Companies are bound to maintenance contracts for the first 5 years of the pumps, which have a projected life span of 20 years (van den Akker and Lamba, 2002, Lamba, 2003) .

Further decentralization and deconcentration of activity occurs to spur division of labor and incorporate more actors into the PV dissemination process. In this case, the companies subcontract and pay AuroRE, a non-governmental organization based in Auroville, Tamil Nadu, to carry out the installation, local training and capacity building, and maintenance tasks. AuroRE coordinates the five-hour installation process, including arranging for transportation of the materials to the farmers, and trains local farmers via demonstrations and written instructions on necessary maintenance features in both the local language and English. It has set up field offices in the district capital town to be available to repair faulty equipment. Despite the pumps' durability, basic accessories such as foot valves will inevitably need to be replaced after years of use. At this point, all stakeholders aim to avoid a collapse in demand for PV systems due to lack of end-user maintenance, particularly since PV acquired a maintenance-free reputation from previous experiences (van den Akker and Lamba,2002, Lamba, 2003).

Finally, despite the subsidies' drain on public resources, the government has designed them to be withdrawn gradually. Already, the 2003 round of subsidies were slightly reduced from the previous year's expenditures to send a signal to manufacturers that financial assistance will not be permanent (Lamba, 2003).

6.3 Program strengths and weaknesses

A weakness in Punjab's program is its unsustainability without state support (Chaurey, 2003b, Lamba, 2003). Presently, both the central government and PEDA have allocated funding to support it, but this type of market cultivation is susceptible to external financial shocks that could undermine or endanger public funds. It is too early to determine whether or not these government subsidies will stifle future market development. If they prove to be truly 'smart' subsidies and are gradually removed, the market stands a good chance of flourishing. If they become entrenched due to political pressure, as did free electricity from the Green Revolution,

PV markets that are not propped up by state funds will flounder. In addition, at present farmers are not given a choice in pump manufacturer. The goal is that as the market becomes more robust, different manufacturers can compete independently, thus allowing farmers more choices in products (Lamba, 2003).

There is also the danger that if the state does not enforce quality standards for equipment, the largest and cheapest products will edge out smaller and higher quality competitors. At this time, equipment cannot afford to be faulty or appear unreliable, as it has yet to be mainstreamed into productive uses. PV must overcome a substantial obstacle, a perception of risk from consumers, future creditors, and venture capitalists, who will hopefully replace IREDA/PEDA subsidies in the future. Pricing that is too aggressive to capture subsidies may also affect service provision. If the company skimps on money for maintenance and repairs and small components, future demand will plummet. Thus far, most of the problems have been related to the pump which is susceptible to mechanical failure due to negligence by the owner or standard wear and tear of pump components such as carbon brushes or mechanical bearings. Since the parts for these particular pumps are not yet widely available in local stores, specialized service stations with trained technicians are necessary to reduce maintenance problems in the field. One suggestion that has been put forward to improve service delivery is to have the farmers pay most of the up-front equipment costs, but save a remaining portion to be paid to companies in installments per maintenance visits. If the manufacturer does not deliver repairs (or do so via an NGO), it doesn't get paid (Lamba, 2003).

Finally, this particular approach may be insufficient for targeting poor farmers. Additional rural loans, perhaps from microcredit or rural credit agencies, would have to be available so that the poor could afford the cost of the subsidized pumps. In theory, this approach might not endanger market development any further since poor people would not be gifted the technology, but would come to view it as an investment for which they would still need to borrow money. The program in Punjab targeted wealthy farmers-- there aren't many poor ones in the region. The benefit of this approach is that by targeting prosperous regions and having the rich demonstrate a shift in mindset and use, the equipment could lose its stigma and thus achieve faster mainstream acceptance. According to Wilkins (2001, p. 134), "social acceptance of renewable energy technology is very important, as its absence can be a major barrier." If other farmers see that their wealthier and more prosperous counterparts are switching to PV pumps, they are less likely to reject PV technology and may be more likely to follow suit. Moreover, should PV technology become more popular, its initial costs would decrease, thus making it more affordable to less wealthy consumers.

The program's strengths lie principally in that it has allowed the testing of different designs and methodologies for pumping systems as well as service delivery models (Lamba, 2003). Since viable business models will ultimately spur market growth, testing them under the protective guise of government intervention allows for a stronger approach to emerge once enough demand and independent financing mechanisms enter the fore. Competition between manufacturers also exists because subsidies hinge on the lowest bidder and can be revoked if quality is not ensured (Chaurey, 2003b, Lamba, 2003). However, most of all, as hypothesized above, farmers *are* acquiring trust in the technology, thus overcoming a major initial hurdle to PV market penetration (Chaurey, 2003b, Lamba, 2003).

Most importantly, the program is appropriate for Punjab because it is designed to respond to pre-existing, historically-specific, institutional barriers as it tries to incorporate the private sector into building a PV market. While the overdependence on subsidies is seen as a market deterrent, in this case subsidies also act as a market stimulator. In the Punjab model,

community groups have greater involvement and more jobs have been created through training and maintenance servicing. Moreover, the project demonstrates the birth of new institutions, or organizing mechanisms for service delivery. Despite its shortcomings, Punjab's program exemplifies a multi-layered state-supported business model that is changing local attitudes toward energy use and allowing for PV markets to enter productive uses in the agricultural sector.

7.0 NIE Revisited: Refutations from Punjab?

The NIE's analysis for improving institutions and the Bank's adoption of policies to 'build institutions for markets' are both relevant and useful starting points for boosting PV markets in developing countries. In many respects, in Punjab, the central and state governments are working towards key institutional changes that can benefit off-grid PV market growth. Their efforts include incorporating RETs into a new energy bill, seeking to remove subsidies for conventional fuels, and promoting competition between manufacturers. However, in many ways PV market takeoff in Punjab has occurred against the NIE paradigm and has ignored the World Bank's warnings against subsidizing the rich. Thus, Punjab's project illustrates how criticisms of the NIE manifest themselves in practice. Below, I argue how building institutions alone is not always a sufficient solution to enhancing PV markets in universal contexts. I focus on three points where Punjab's case challenges the NIE: incorporating politics into developing market-enhancing strategies, overcoming technological lock-in, and de-romanticizing the private sector.

7.1 Politics and the social electricity contract

Markets for PV pumps in Punjab must overcome the political power of the farmer lobby that secures free electricity in agricultural operations. This is why Punjab resorted to the unorthodox practice of providing subsidies for the wealthy. To further illustrate this point, I use Heller *et al.*'s (2003) analysis of the social electricity contract to demonstrate why subsidies were necessary to counter both a backlash from farmers and create a space for PV markets to penetrate productive uses. Carving out a market for PV in productive uses in Punjab involves capturing the elite to override pre-existing institutions.

Electricity reforms in developing countries have often failed in practice because they have not accounted for maintaining the implicit social contract between electricity providers and consumers. In other words, reforms often gloss over the complex political arrangements that some groups have with energy providers. According to Heller *et al.* (2003, p.2),

> the standard model for reform has been crafted without attention to political economy; many of its prescriptions, such as releasing tariffs to the whims of the market, are particularly difficult for democratic politics to implement…any theory of market restructuring must properly take into account the organizational and political realities associated with electricity reform.

Therefore, if the old system benefited certain groups and the new one does not, previous beneficiaries may seek to undermine reforms by manipulating the social electricity contract in their favor. Heretofore, India has had particular difficulty in phasing out subsidies from the Green Revolution (Barnes and Halpern, 2000). How can PV compete with free electricity, in a context where the political grasp on implicit subsidies for conventional fuels remains firm? In Punjab's case, the government is collaborating on a central and regional scale to foster competition among PV providers behind the scenes, but presents a very low-cost energy substitute to farmers. As a result, the farmer doesn't feel as though he is losing a major benefit

because he only pays a low one-time cost for equipment. Additionally, the PV pump only needs minor servicing and generates free energy from the sun.

7.2 Overcoming technological lock-in

In addition to tackling politically-charged subsidies, PV markets in India must overcome institutional path-dependency, due to previous decisions that led to a technological lock-in of conventional fuels. According to Heller *et al* (2003, p.10**)**, "whereas in industrialized countries the debate over the social contract has focused on environmental measures (including renewables and energy efficiency), in developing countries environmental issues generally have not figured prominently in the process of recasting the social contract." This is evident in India where RETs have not been incorporated into meeting diverse rural energy needs in both electricity restructuring or integrated development planning (TERI, 2002, Phadke and Rajan, 2003). As Dubash (2002, p. 68) notes "[the] history of agricultural subsidies and the IPP debacles should teach us how expedient choices in the present constrain our collective future."

PV networks in India, as well as in Punjab, are emerging, but they must still face larger and stronger networks- both market actors and physical infrastructure— based around conventional fuels. In this context, Jacobsson and Johnson (2000, p. 231) state,

> potential customers may not be able to articulate their demands and meet the supplier in the marketplace. Markets therefore need to be created in a process where fragmented potential customers can formulate and articulate their demand.

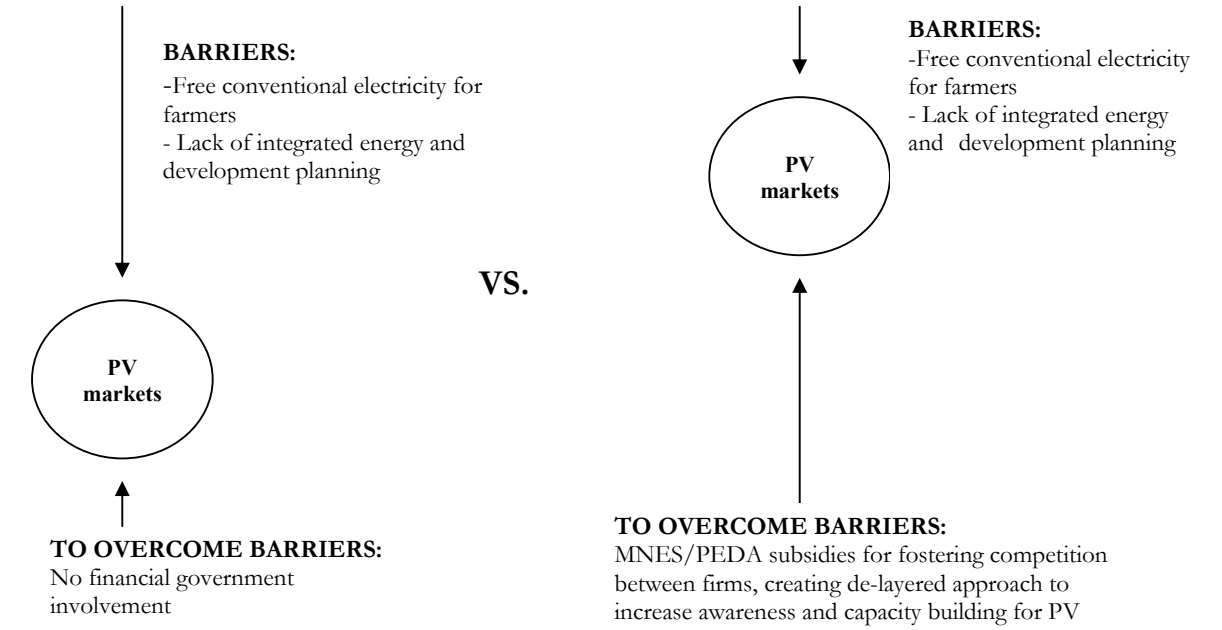
MNES and PEDA's joint approach to disseminating PV allows the manufacturers, community groups, consumers, and at one time, other private financial intermediaries to strengthen their networks to disseminate information. Also, high connectivity does not arise just from markets, but from trust (Jacobsson and Johnson, 2000). And trust in PV pumps, in this case, is cultivated under the watchful eye of state subsidies until the networks are strong enough to sustain a market.

As shown above, if politics shape markets, they can also inhibit them via the social electricity contract and decisions that lead to path-dependent institutions in favor of conventional fuels. In this light, "markets do not spring up by themselves- they are a social construct[10]"(World Energy Council, 2000). In this case, off-grid PV markets need active state commitment and involvement as they expand to reach new consumers via productive uses. Figure 1 demonstrates how the government is actively shaping PV growth in new niches, despite existing barriers.

[10] Quoted from Griffin Thompson, Executive Director of IIEC, on Panel 3: *Policies for accelerating renewable energy* in World Energy Council (2000).

Figure 1: Government strategy for enhancing PV

Source: author



7.3 De-romanticizing the private sector

Despite the NIE's belief that competition will maximize efficiency, it may not always lead to quality. In Punjab, PV providers have been guilty of cutting financial corners on servicing smaller parts or providing poorer quality models to reduce costs *in order to be competitive*. Indeed, as noted by Jackson, if PV is left to the market too quickly, it will experience pressure to achieve cost convergence (Jackson, 2000), thus potentially eliminating costlier, but better quality PV systems. In order for off-grid PV markets to expand to, and flourish in, productive uses, it may be imperative that companies' feet are held to the fire in the first few years of operation so that consumers do not lose faith in the equipment. Consumer perception, not just competition between firms, matters substantially for PV market growth.

To the NIE's credit, as shown above, institutions that can determine and enforce industry standards and rules are important for PV growth. Regulatory frameworks, enforcement mechanisms, and industry standards are important for encouraging consumer trust in PV technology and developing transparency and uniformity across firms. Yet often previous electricity reforms failed to provide enough attention to institutional design and authority, particularly the role of independent regulators, who often do not have the human resources or information needed to regulate firm activity (Heller *et al.*, 2003, Phadke and Rajan, 2003). While this statement applies generally to on-grid restructuring efforts, off-grid markets may also require regulation and enforcement of standards, albeit different, to develop consumer trust and private sector accountability. In the case of Punjab, both PEDA and MNES use subsidy allocations as a form of enforcement and quality control. Carrots instead of sticks are used, where if firms fail to provide proper maintenance or if the quality of pumping systems sold deteriorates, they also fail to secure future subsidies. The government already revoked a lucrative depreciation claim – or tax holiday—once when corruption endangered public funds. Punjab's case study demonstrates how quality enforcement mechanisms are not limited to legislative activity or fines. Instead, firms face active market barriers if they limit their commitment to quality for the consumer.

The private financial sector can also experience unpredictable shocks which may affect PV market growth. Both IREDA and PEDA responded in a flexible manner to the unforeseen crash in the non-finance banking sector as well as the drop in interest rates. Without government subsidies to replace previous creditor or financial incentives, the PV market could have easily floundered. While unpredictability in the private financial sector is problematic, even more troubling is the lack of private creditors in the first place-- which is the case in India for financing PV initiatives. According to Juma, "in developing countries, private venture capital is not yet developed, leaving governments to take the lead" (2001, p.634).

8.0 Broader lessons learned: Suggestions for enhancing PV markets in productive uses

While the government's strategy examined above may work well in Punjab and the neighboring states of Haryana, Rajastan and Uttar Pradesh, which are introducing similar programs, a carbon copy may not be transferable to other developing countries, or even other states in India. As a result, what general lessons can the case study teach us about the role of the state in advancing PV for productive uses in developing countries?

8.1 Add politics: Building the right institutions is imperative for markets to flourish. However, as I argue here, this solution is not always sufficient depending on the pre-existing politically-charged barriers that may inhibit the emergence of new markets. Sometimes, as in Punjab, states enhance off-grid PV markets by actively pushing them in a certain direction and assessing niches they can appropriately occupy. The word 'distortion' is anathema in economics, however sometimes distortions are necessary to overcome other pre-existing distortions, namely subsidies for conventional fuels. No new institutions emerge from a vacuum or a white slate, and thus, cultivating PV markets must be adapted accordingly. Instead of seeking to fulfill a standardized set of institutions that should act as market incentives, states should apply a more historically nuanced assessment of how and where political barriers affect PV when trying to stimulate markets for productive uses.

8.2 Focus on technology: The Punjab program illustrates more general trends in development planning and off-grid PV dissemination, where a communication chasm exists between rural development, energy, environment, and finance planners. A lack of inter-ministerial coordination has resulted in policy measures that fail to recognize the benefits of PV. India's experiences also demonstrate how creating a niche market for PV can encounter institutional and political barriers due to previous decisions in energy planning. Thus, in order for PV to find its way into productive uses in rural communities, an interdisciplinary approach is imperative (Bates *et al.*, 2003, Mulugetta *et al.*, 2000, Wilkins, 2001, World Bank, 1981). One solution that has been put forward places technology in the center of development discussions (Juma, 2001, TERI, 2002). For example, instead of approaching PV from a technology-push perspective, i.e. "how can we diffuse PV in rural areas?" the approach should be, "what are rural needs and how is PV best suited to meet those needs?" As a result, when seeking to "get the institutions right," governments can coordinate bodies that facilitate inter-ministry dialogue and planning (Juma, 2001). Within this structural framework, officials can assess how and where PV technology should be targeted at certain niches (World Bank, 2001)[11].

[11] While the state's coordinating role cited above is critical to enhancing off-grid PV market, parallel action from the World Bank could facilitate this process. I focus on the World Bank because, in general and in India, it has failed to incorporate RETs into mainstream energy sector lending. Just as with ministries in most countries, the World Bank's programs are also compartmentalized thematically, allowing for little overlap and dialogue between sectors

8.3 Design appropriate service delivery models: Punjab's PV program illustrates how one model emerged out of a given political and institutional context. Just as each state will need to address different barriers to promote off-grid PV markets in productive uses, each market will develop according to the social dynamics and capabilities of existing actors. Punjab's model employs a delayered approach where government subsidies are divided between the central and state agencies. SNAs, firms, and NGOs participate in education, dissemination, and maintenance efforts. The project also employs a sales model, where farmers pay a one-time fee to own the systems- although it is moving in the direction of a partial fee-for-service approach. The arrangement works well in Punjab because there are already numerous indigenous manufacturers, a nongovernmental sector that firms can subcontract to install and repair PV equipment, and farmers who are wealthy enough to afford the pumps up-front. Yet, this model might not be appropriate for other countries given their varying circumstances. For example, where entrepreneurship is missing, governments may wish to undertake measures to attract foreign companies or employ a concession model, where the government awards one company a contract for servicing a particular region. Likewise, rental models or fee-for-service models, instead of direct equipment sales, may be more appropriate for seasonal workers or poorer communities[12]. Governments should resist seeking a panacea, and instead adopt models to local conditions.

9.0 Concluding remarks

As off-grid PV moves beyond household electrification into productive uses, governments will most likely need to remain active in cultivating its niches. Too often electricity restructuring and rural development initiatives have failed to account for RETs and implicit subsidies for conventional fuels continue to hinder off-grid PV markets. NIE and the World Bank's prescriptions for market growth via 'getting the institutions right' provides a starting point for state action to overcome barriers. However, it fails to provide a sufficient antidote for confronting India's political landscape that has led to technological lock-in, and hence PV lock-out. In looking at Punjab' approach through a strict NIE lens, the state used an arbitrary, and thus inappropriate, approach to PV market growth by employing subsidies for the wealthy. However, in doing so, it achieved its goal of enhancing PV markets for agricultural uses, raising

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(Feinstein, 2003). A lack of integrated energy planning is also evident in its different reports. For example, the 1997 report *Rural Development: from Vision to Action* does not engage in rural *energy* needs, particularly in the agricultural sector. Additionally, the 2003 World Development Report, *Sustainable Development in a Dynamic World,* despite its emphasis on building institutions and fostering local participation on fragile lands, lacks an analysis of how different energy sources could meet rural and environmental needs (World Bank, 2003b). As the Bank struggles to bring new technologies into the development process (The World Bank, 2001), the World Bank's loan-approval structure also presents obstacles to mainstreaming RETs into both energy and rural development programs. Task managers are reluctant to prepare smaller projects, as the Bank's internal incentives structure still rewards larger scale projects (Miller, 2000) (Martinot, 2001). To its credit, however, the Bank does possess a strong, albeit small, energy team within the Energy Sector Management Assistance Programme, Asia Alternative Energy Programme, and the Global Environment Facility that understands how RETs can be incorporated into productive use. Recently, Bank teams have begun to approach projects differently, focusing on development goals, not just targets for technology dissemination (Feinstein, 2003). Nevertheless, pressure on the Bank must be sustained to push for integrated energy and development planning as well as reforming internal incentives that would not regard preparing smaller projects— such as PV initiatives-- as cumbersome. For a deeper analysis of the Bank's difficulties in integrating RET into energy sector loans see Martinot (2001). See Wade (forthcoming) for a historical analysis of tensions between Bank operations and environmental protection.

[12] For a detailed explanation of different sales and service delivery models and payment schemes for off-grid PV, see Gregory *et al.* (1997) and Martinot *et al.* (2002, 2000a).

awareness among future users, and fostering competition between firms. As Bayliss and Cramer (2001, p.60) argue, "protection and subsidy may be a critical part of successful productive growth."

Yet, it is too early to determine whether Punjab's program can be touted as a success, whereby markets can flourish without the state's financial support. Whether India truly integrates RETs into future energy planning and rural development efforts will affect Punjab and other state-level renewable energy initiatives. Should the off-grid PV market continue to grow in productive uses, it will be interesting to see what new institutions and organizational networks also emerge. Here is where further testing of NIE, particularly via World Bank recommendations, can continue. However, ultimately, Punjab's test will not be whether the government can continue to capture the elite, but whether it can insulate itself from elite capture, which may turn lobbying efforts onto maintaining PV subsidies should they rapidly diminish. It is here where the NIE's institutional analysis is likely to fall short of providing remedies unless it incorporates politics into its theoretical center.

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