Chapter 2
Renewable Energy Technology: Market Development, Subsidy Policy and the Enlargement of Choice

Begin with the end in mind.
Stephen R. Covey
The Seven Habits of Highly Effective People, 1989

The introductory chapter lays out the theme, and more importantly, sets the tone for the ensuing portions of this book. In keeping with traditional wisdom the next chapter stresses that 'direction is more important than distance covered' and is intended to exhort policy makers to 'begin with the end in mind' so as to define and achieve the goals of positive development policy within prescribed time limits and within budgeted costs. Given the different approaches to market stimulation adopted for each, the Indian markets for solar photovoltaic (PV) and solar thermal (solar water heating systems: SWH) systems are compared. The conclusions relating to the delivery channels for product, service and financing, the incentive structures and most significantly, the overarching targets relating to consumer empowerment would, however, apply across technology options, market geographies and consumer segments.

Development is the enlargement of people's choices.[1] Government policy that restricts choice is, by extension, regressive. Governments might choose to subsidize certain sections of consumers for political reasons or as a part of development strategy. In most developing countries, politics often affect the continuance,

This chapter is largely based on Srinivasan, Sunderasan (2009) Subsidy policy and the enlargement of choice. Renewable and Sustainable Energy Reviews 13:2728–2733.

[1] The First UNDP—Human Development Report, 1990, http://hdr.undp.org/en/reports/global/hdr1990/.

S. Sunderasan, *Rational Exuberance for Renewable Energy*,
Green Energy and Technology, DOI: 10.1007/978-0-85729-212-4_2,
© Springer-Verlag London Limited 2011

distribution, geographic expansion and eventual termination, if at all, of subsidies [7]. Although discounted prices increase consumer demand for normal goods, they could lead to supply-side distortions, consequently restricting people's choices. A commodity or a service is deemed expensive simply because of consumers' low willingness to pay relative to substitutes, and subsidies could potentially end up compelling them to choose the less preferred alternative while simultaneously dissuading suppliers from serving such markets.

Even when launched with the most noble of intentions, inappropriately designed or untargeted subsidy programs could, thus, end up being counterproductive. Expanding and improving markets, therefore, involves not just assessing the potential for a technology package to contribute towards development goals, but also building efficient and locally appropriate service delivery channels and most importantly, accounting for political constraints [20]. The policy instruments employed are shaped by the political process that Jacobson and Lauber [11] refer to as the 'battle over institutions' involving among others, the parliament, advocacy coalitions, local governments, competing commercial interests and the like.

A product or service is considered expensive or otherwise when compared to its next best alternative. Power from central generating stations supplied through utility grids is subsidized, especially for residential users, in many developing countries. The penetration of renewable energy technologies (RET) in most developing countries is impeded by sub-optimal pricing for power, continuing cross-subsidies [6] and retarded power sector reform, attributed mainly to the instability of policy-makers, poor overall acceptance of the reforms, slow adaptation and poor transition management [3]. The savings accruing from investments into energy efficient gadgets or into decentralized RET are minimal in such situations. Rationalizing power tariffs is projected to encourage energy conservation behavior and investments in energy efficiency while favoring distributed generation [18]. Others argue that in addition to streamlining the power sector, a national renewable energy policy is a vital prerequisite to translate customer choice into a larger market share for non-conventional energy technologies such as solar photovoltaic (PV) and thermal applications [19].

Large volume offtake of RE Technologies such as solar Photovoltaics has been brought about by favorable tariff regimes as in Japan and Germany. Yet the market collapses as soon as the incentives are pared down, as in Spain in 2008–2009. Wind energy is considered competitive with centrally generated power but suffers from intermittency and the need for reliable transmission infrastructure to convey the power from the generation nodes to load centers. In addition to favorable policy, renewable energy technologies (RET), like other technological advances require a period of nurturing diffusion and scaling-up to attain the price/performance ratios required to appeal to larger segments of the market. On the demand side, clean energy markets progress through 'education', 'policy support', 'standards', 'demonstration' and 'industry involvement' stages [13] to eventually morph into demand-driven markets.

2.1 Donor Experiences with Market Making Programs

- Grameen Shakti, the energy service company floated by Grameen Bank of Bangladesh has exploited the accumulated business acumen, the branch network and existing client base to create a successful solar energy (solar PV home lighting systems) business. Grameen Shakti has accessed refinance and grants from the World Bank's Rural Electrification and Renewable Energy Development Project through the Infrastructure Development Company.[2] The grants help bring down the first costs while the refinance provides requisite liquidity to expand the availability of micro-credit for the solar energy systems.
- Rated "satisfactory", the highest rank awarded, by the Independent Evaluation Group of the World Bank [23], the ongoing Renewable Energy for Rural Economic Development in Sri Lanka,[3] provides refinance and a co-financing grants to privately owned financial intermediaries, who in turn, extend retail credit for the procurement of solar energy systems and other technology packages. The program prescribes technical specifications for components such as photovoltaic modules, batteries, etc., while vendors are at liberty to configure systems to cater to market demand.
- Alternative schemes to encourage intermediaries to extend credit in rural areas include grants and default guarantees, usually extended by third parties or donor agencies as those provided by the Global Environment Facility (GEF)/International Finance Corporation (IFC) under the Photovoltaic Market Transformation Initiative (PVMTI). The default offset is viewed as a risk mitigation measure, and thus helps expand the availability of credit for the procurement of solar energy systems.
- The government of India provides subsidies to enhance the competitiveness of solar PV and solar thermal systems, which have, over the years, conditioned the supply-side of the industry.[4] For instance, the Indian Renewable Energy Development Agency (IREDA) has employed the leasing model, wherein financial intermediaries commonly referred to as non-banking finance companies, are provided with long-term, low-cost refinance for leased solar energy equipment.

2.2 Attempts at Market Making: An Illustration

Experience from such programs leads one to conclude that to achieve a measurable impact on market growth and to reach a diverse cross-section of users, retail financing terms need to be flexible. It is often mentioned that for the median

[2] www.idcol.org.

[3] www.energyservices.lk.

[4] India is not isolated in this regard. Spurred by low power prices, South Africa's aggregate demand for energy is slated to double in a decade. Observing that close to 20–30% of electricity use is dedicated to heating water, Eskom, the national utility has initiated "aggressive promotion of solar water heating systems" through a Rand 2 billion subsidy program [17].

consumer of decentralized energy services, (Rupees) 10 a day is more affordable than (Rupees) 300 a month, even as most policy makers, consultants and traditional bankers might fail to appreciate the distinction. Private sector financial intermediaries functioning within an unbiased competitive environment are most suited to offering innovative product-credit packages. In general, subsidies should be phased out simultaneous with strengthening of the institutions involved which implies *inter alia* that strengthening the institutions involved should be a primary objective. The framework of incentives for the participants should be developed with a view to ensuring sustainability of the value chain so as to ensure prompt post-installation service and help service providers benefit from resulting network effects.

A characteristic feature of the electricity sector in India is the unreliability [14] and power cuts are an acknowledged "way of life", with the demand–supply gap progressively widening [8]. Consequently, unlike in other developing countries where solar PV systems generally make their way into unelectrified homes, in India, such systems are acquired in large measure by households *with* access to the grid. Here again, electrification is generally measured by number of households having access to the grid, irrespective of the actual supply of electric power to these households. This distinction is more than just statistical: in rural areas and tail-ends of utility grids stand-alone as well as grid-tied renewable energy technologies compete against more expensive alternatives viz., dry cells, candles, etc., as opposed to grid-supplied electric power (whose supply is often unreliable), and hence could be rendered viable with appropriately structured financing.

Similarly, the solar water heaters (SWH) are employed to reduce dependence on grid supplied electricity and hence, there is a substantial overlap in the target markets for the solar PV lighting systems and solar water heaters in smaller towns and peri-urban areas. To illustrate the differences in approaches adopted to promote renewable energy technologies, the capital subsidy provided to encourage the deployment of solar PV systems ('solar home systems: SHS'), and the interest subsidy provided to support the dissemination of solar water heating systems (SWH) are compared. This is followed by an analysis of the channels used to route such subsidies and of the reasons for the outstanding and sustained success of one scheme relative to the other.

2.2.1 Solar Photovoltaic Home Lighting Systems

Solar photovoltaic technology is considered to be ideally suited to illuminate and to pump water at remote locations and dispersed settlements, where extension of the utility grid or making other alternatives available could be technically infeasible or economically unviable [4]. However, low customer density in a given service territory makes sales, installation, service and payment collection expensive and difficult, giving rise to transaction costs which are in the order of 30% of the total system costs [24]. This reduces affordability, undermines sustainability of

Table 2.1 Year wise targets and installations of SPV systems

Year	2002–2003		2003–2004		2004–2005		2005–2006		2006–2007	
INR (crore)	53.00	41.24	37.00	28.65	23.00	12.12	25.00	23.55	29.50	47.66
SHS (no.)	50,000	28,430	50,000	11,870	0	34,844	42,000	9,727	60,000	23,033

systems and diminishes the effect of the progressive reduction in PV system prices. Further, provision of credit in remote and rural areas is often perceived to be expensive, even unviable, owing to high collection costs and on account of limited collateral security that can be offered in the context. Service provision is challenging, especially on islands and remote areas with restricted access.

In contrast, the Grameen experience and the resulting micro-credit revolution have illustrated that availability of credit provides a sustained improvement in the quality of life. Ostensibly, creation of viable and sustainable sources of consumer finance is vital for the sustainability of renewable energy projects [9]. The Indian SPV Demonstration and Utilization Program is implemented through the state nodal agencies of the federal Ministry of New and Renewable Energy[5] and through select non-governmental organizations. The program has been operational since 1993–1994 and serves to provide subsidies to facilitate the purchase/installation of solar home systems, street lighting systems, and similar SPV applications.

The Ministry has laid down detailed specifications of all SPV lighting and other systems and prototypes are tested and approved by authorized test centers. The five approved models are: 18 Wp PV module with one 9 W compact fluorescent lamp (cfl), 37 Wp PV module with two 9 W cfl or one 9 W cfl and a fan, 74 Wp PV module with four 9 W cfl or two 9 W cfl and a fan/TV, [15]. Subsequently, the capital subsidy payable on the 74 Wp model has been curtailed to the level of the 37 Wp model, lowering the incentive thereon. Further, the Ministry has imposed price ceilings on systems, to be packaged with comprehensive maintenance contracts for 2, 5 or 10 years.

Over the tenure of the country's tenth five-year plan 2002–2003 through 2006–2007, (Indian fiscal year: April–March) against a target of 202,000 solar home systems (SHS), the program has helped deploy a total of 107,904 systems, corresponding to a 53% accomplishment of targets. The budget estimates and actual achievement of targets for each of the years, as reported by the Ministry are as laid out in Table 2.1

2.2.2 Solar Thermal Water Heating Systems

Solar thermal water heating systems (SWH) replace electric or LPG geysers in urban settings and firewood or other fuels, appliances and techniques used to heat

[5] http://mnre.gov.in.

Table 2.2 Year wise targets and installations of SWH systems

Year	2002–2003		2003–2004		2004–2005		2005–2006		2006–2007	
INR (crore)	11.00	9.73	12.00	9.90	14.00	6.91	50.00	24.89	45.75	13.23
SWH (area m^2)	50,000	45,000	55,000	0	100,000	150,000	400,000	400,000	400,000	400,000

water in rural areas. The reduced consumption of such fuels as firewood, coal, furnace oil, etc., contributes to mitigation of carbon-dioxide emission and reduction in degradation of the environment. SWH have healthy monetary paybacks and with an LPG or electrical backup for non-sunny days, can provide heated water round the year. Large scale deployment of the SWH also helps reduce peak load demand for the electric utility [22].

The Ministry has encouraged a range of financial intermediaries (FI), including state-owned and private sector banks to participate in the low-interest ("soft-loan") scheme to extend loans of up to 5 years' tenure, not exceeding 85% of the project cost, at subsidized rates of interest. The Ministry compensates the implementing FI for the difference between prevailing commercial interest rates and the subsidized rates on offer. The subsidized rate of interest is available to domestic end-users, commercial establishments, cooperative societies and real estate developers [16]. Key attributes of the Solar Thermal Energy Program are: the absence of upper limits to the sizing of systems and the inclusion of the evacuated tubular collectors (ETC) under the soft-loan scheme.

In sharp contrast to the figures reported above in the context of solar home systems, over the same period, against a target of 1,005,000 m^2 of collector area, the program has contributed to the deployment of a total of 995,000 m^2, corresponding to a 99% accomplishment of targets. The budget estimates and actual achievement of targets for each of the past five years, as reported by the Ministry are as laid out in Table 2.2.

2.3 Quantitative Equivalence of the Two Subsidy Schemes

Chandrasekar and Kandpal [5] have computed the effective capital cost of solar energy technologies consequent to the fiscal and financial incentives provided by the government and have established indifference levels for various input parameters. For instance, they demonstrate that the provision of a low interest loan ("soft loan") at 2% annual rate of interest would be equivalent to a capital subsidy of 14.32% from the end-user's perspective.

In adopting an alternative view, in this section, subsidy provision is viewed from the government's perspective to help identify the indifference level between allocation towards the capital subsidy and the interest subsidy. Next, the *effective* cost to the end-user is computed using a larger set of input parameters, to establish

the equivalence between the two schemes. This discussion leads to an analysis of the restrictions imposed by the capital subsidy program and the enlargement of choices achieved through the implementation of the interest subsidy scheme.

One could view the difference merely in the modalities of implementation, as opposed to the design of the two subsidy schemes itself. Yet, it should be brought out that a subsidy scheme *where choices are made by agencies other than the end-user concerned are regressive* and efforts need to be made to empower the consumer make an informed choice. It is often overlooked that end-users routinely make purchase decisions relating to televisions and mobile phones and associated services, and are, for some reason, considered incapable of deciding for themselves, the number and distribution of light points they should have in their own homes!

The following notation is used to highlight the equivalence and the differences between capital and interest subsidies.

C_o	Capital cost of system (currency units)	I_t	Interest amount payable at time t (currency units)
I_b	Interest rate set by the commercial bank (%)	P_t	Amount outstanding at time t (currency units)
I_s	Interest rate subsidy buydown offered by the government as promotional incentive (%)	R_t	Principal amount repaid in time t (currency units)
I_g	Discount rate for government funds such that $I_g < I_b$ (%)	C_{is}	Discounted value of the interest subsidy paid by the government (currency units)
I_m	Market interest rate paid by borrower to access the net-of-subsidy amounts such that $I_g < I_b < I_m$ (%)	CF_{is}	Periodic payments by the government towards interest subsidy on the loan (currency units)
I_w	Weighted average interest rate paid by borrower such that $I_b < I_w < I_m$ (%)	f_{cs}	Fraction of capital cost paid as subsidy (%)
F_{cs}	Portion of capital cost paid as subsidy (currency units)	f_{sl}	Fraction of capital cost available as soft loan (%)
PMT_t	Periodic payments including principal and interest on outstanding balance (currency units)	CF_w	Periodic payments by the end-user towards repayment of the loan (currency units)
		C_w	Discounted value of end-user loan service (currency units)

As shown in result 1 of annex 1 to this chapter, purely basing on the direct subsidy expenditure per system, the government is indifferent between offering an interest subsidy to lower the rate for the borrower by I_s and providing a capital subsidy F_s equal to $C_{is,}$ where,

$$C_{is} = \sum_{i=1}^{n} (CF_{is})/(1 + i_g)^t$$

Table 2.3 Input parameters to compute the indifference between capital and interest subsidies

System cost	INR 20,000 (~ US$ 500)
Bank rate of interest	12%
Discount rate for government funds	6%
Market rate for end-user from informal and semi-formal sources	16%
Proportion of soft loan available	85%
Tenure of the loan	5 years

From the end-user's perspective, even as a capital subsidy of F_{cs} is made available, s/he is required to mobilize the net-of-subsidy amount ($C_o - F_{cs}$). This is mobilized at commercial rates prevailing in the markets, I_m, commensurate with the borrower's risk class. In the scenario where an interest subsidy is provided, the weighted average cost of the loan, I_w is given by:

$$I_w = (I_b - I_s)^* f_{sl} + I_m(1 - f_{sl})$$

The annuities payable by the end-user are computed and discounted at the prevailing market rate to arrive at the equivalent upfront payment, as perceived by her/him.

$$C_w = \sum_{i=1}^{n} (CF_w)/(1 + i_m)^t$$
$$= F_{cs}(\text{to establish the indifference level})$$

It is now possible to compute the indifference values for the government and simultaneously for the end-users, for a range of input values.

For the input parameters provided in Table 2.3 above, the interest buy down is 8.21% equivalent to a capital subsidy of INR 4,615 or about 23% of the capital cost. The net-of-subsidy amounts are mobilized by the end-user at the prevailing market rates. The similarity among the capital and interest subsidy schemes ends here.

2.4 Qualitative Divergence of the Two Subsidy Schemes

1. The principal difference between the schemes under discussion is the mode of delivery. The capital subsidy is delivered through nodal agencies and other qualified non-governmental organizations, while the interest subsidy is routed through the existing network of commercial banks and financial intermediaries. The not so insignificant indirect cost of routing the capital subsidy through parallel bureaucratic channels is not reflected in the computation above. In certain situations, as observed by industry watchers, subsidy management begins to justify the existence of the bureaucracy and reciprocally, enhances such entrenchment, simultaneously creating rent seeking opportunities.

2. The capital subsidy budgets are determined at the federal level and are drilled down to the state level implementing agencies by prescribing numbers of subsidy-eligible systems. The implementing agencies, further allocate, rather arbitrarily, quotas to select vendors. This leads to the creation of a supply-side dynamic where oligopolists market their wares in partially overlapping or non-overlapping intrastate markets, with fixed prices and identical product. In short, the oligopolists, almost inadvertently, end up acting as a monopolist. This is, however, a feature of the implementation process and not intrinsic to the design of the scheme itself.
3. Further, in order to standardize qualification for the capital subsidy, rigid eligibility criteria and technical specifications have been drawn up for the systems. This, by itself, curtails choice. For instance, in the above list of specified systems, a consumer is not permitted to acquire a 37Wp system capable of powering one lamp and one fan and to combine it with the 18Wp system to power an additional lamp. By restricting the modular expansion or contraction, the pre-designed quantity packages restrict the choices available to the end-users.
4. The one differentiator that could have emerged in this set-up is the quality of post-installation service, which is a function of the rigor of enforcement by the subsidy- implementing agency. It has been observed on several occasions that rural service providers scale down operations or completely go out of business upon the termination of capital subsidy programs, indicating that their businesses are only as sustainable as the subsidies themselves. The systems installed under the erstwhile programs, thus suffer from a lack of professional service provision for the remaining portion of their technical lives.
5. The net-of-subsidy price is low enough to eliminate all economic profits on non-subsidized systems, and hence deters entry and supply of systems with different technical specifications or the set up of service networks. This also ends up discouraging the provision of newer technology (evolving subsequent to the notification of technical specifications) or different component combinations that could help drive end-user prices down. It is virtually impossible for an individual in India to walk into a store, any kind of store, and walk out with a solar PV system of her/his, paid for in cash.
6. In contrast, the interest subsidy scheme on offer through commercial banks is not constrained by price, installation size or single borrower limits. The banks have demonstrated keen interest in offering the soft loans to promote the installation of the SWH. The evaluation criteria do not prevent the end-user from choosing a 5,000 liter-per-day (lpd) or a 10,000 lpd SWH over a 100 lpd installation. Further, the systems are installed and maintained by vendors whose systems and components are certified by the Bureau of Indian Standards (BIS).
7. Unlike the SHS vendors, the SWH vendors have aggressively invested in building brands and reputations through prompt and disciplined post-installation service. The quality of the system and the service, therefore, effectively sets vendors apart, who eventually earn premiums on such brand equity. This is not possible in a price constrained environment. In fact, at the most elementary

level, policy-makers should realize that price ceilings lead to shortages: in case of the system-service package, the intangible attributes such as (superior) installation-quality and prompt post sale service are found to be in acute short supply.

8. Further, the SWH vendors have also marketed evacuated tubular collectors (ETC), which represents a lower-priced technology variant, compared to the traditional flat-plate collectors. Being static in definition, the specifications for SHS do not allow for the inclusion of newer technologies viz., LED clusters to supplement the compact fluorescent lamps—as such designs would not be eligible to avail of the capital subsidy.

2.5 Choice and Inclusive Development

Arrow [1] asserts that a rational individual would choose an opportunity which helps achieve the highest level of utility, and that adding new opportunities cannot worsen the choice. Irrespective of whether the additional element is better than the originally chosen one, giving an individual more choice is per se valuable. In practical terms, the choice need not pertain to a range of goods: it would equally apply to quantities and qualities of a good supplied. Packaging goods in discrete quantities and pre-designed price–quality combinations adversely affects the poor. In most situations this is tantamount to fitting a solution to a problem, rather than the other way around. Quality standards prescribed by regulatory authorities could, thus, put goods out of reach of certain sections of society. Economic progress leads to the invention of higher quality products and this may include or exclude a larger proportion of the population, depending on concomitant changes in effective unit costs and price levels within the existing industry structure.

2.6 Subsidy Policy and the Range of Choices

In a market with a single quality of a good, firms compete exclusively through price strategies. In the SHS market, the quality and price are exogenously determined and hence the vendors behave as a cartel and barely compete. Where implementing-agency oversight and enforcement is weak, service support (and quality of the installation itself) is overlooked. The failure of a monopolist—or oligopolists acting in concert as in this case—to supply all the market and the prospect of a positive economic profit would attract entry. However, if the monopolist produces a superior product, as in the case of the specified solar home systems, while an entrant chooses to offer a product with a lower specification, at a lower price, the profit-maximizing response from the erstwhile monopolist would be to lower the price charged [2].

The level of profit for a monopolist supplying a commodity at price p, with a constant marginal cost c, per unit and a fixed cost of production k is given by

$$\Pi = (p - c)[1 - F(p/\lambda)] - k$$

where Atkinson [2] defines λ as a person's productivity-related, wage-influencing parameter. Further, λ_{max} and p_{max} are respectively, the quality and price of a superior (say prescribed technical specification) product and λ and p are the quality and price of a relative lower specification product, the market is segmented into consumers who can afford the superior product, those who can afford only the inferior product and those excluded. The pricing of the lower quality products by the same vendor needs to account for the revenue loss from customers who switch from the superior product ("cannibalization")—a common feature in the automotive industry, for instance. The profit from offering the two products is given by

$$\Pi = (p - c)[1 - F(w^*)] + (\rho - \gamma)[1 - F(w^{**})] - k - k_{max}$$

where $\rho = p_{max} - p$; $\gamma = c_{max} - c$ and w* is the threshold exclusion wage while w** empowers the purchase of the superior product. Since the two products in question are not perfect substitutes—though they may essentially perform the same function of lighting the household—the pricing strategy for the inferior product is considered independent of the superior product.

Suppose the incumbent supplies the superior product as prescribed under the capital subsidy scheme, a potential entrant could sell an inferior product at a lower price. An interest subsidy scheme can facilitate the purchase of such a system while the capital subsidy scheme accompanied by rigid technical specifications excludes it. The arguments posed by Atkinson [2] for two discrete commodity quality stipulations can thus be extended to cover a large number of variants assembled through mixing and matching quality certified components, maximizing choice and including a larger proportion of the population. Additionally, we relax the assumption relating to product indivisibility, to reflect the possibility of numerous combinations of system components.

Where the incumbent has the option to adjust price, a reduction in price by surrendering a portion of the monopoly rents is likely, in an attempt to ward off competition. If, on the other hand, the rival SHS is preferred to non-purchase, the entry leads to widening the range of systems and to reducing the income necessary to purchase each of the models available. Prices and availability of goods are determined endogenously by the decisions of suppliers faced with specified market conditions. Vendors supplying product under inflexible and exogenously imposed price-ceilings are tempted to compromise on the service component of the product-service package. As for the end-users, the monopoly price may exclude some customers at the lower rungs of society from the market and hence deprive them of the product.

If both, the superior and the inferior product are brought to the market by the monopolist—in this case the existing vendors—and given the assumption that the profit from the supply of both products is greater than that earned by

supplying either product alone, the price of the inferior product as defined by Atkinson [2] is:

$$p = \tfrac{1}{2}(\lambda w_{max} + c)$$

The price for the said inferior product when offered by the entrant is given by:

$$p = \tfrac{1}{2}(\lambda p_{max}/\lambda_{max} + c)$$

which is lower by

$$\begin{aligned}\Delta p &= \tfrac{1}{2}(\lambda w_{max} + c) - \tfrac{1}{2}(\lambda p_{max}/\lambda_{max} + c) \\ &= \tfrac{1}{2}\,\lambda(w_{max} - p_{max}/\lambda_{max})\end{aligned}$$

If the maximum wage endowment in the target market, $w_{max,}$ and price per unit of quality for the superior commodity, $p_{max}/\lambda_{max,}$ remain constant, the price reduction through liberalization of the market is a function of the quality chosen for the inferior product.[6] By relaxing the indivisibility assumption, we are able to fashion multiple variants at corresponding price points.

2.7 Sector, Segment and Market Neutrality

The European roof-top market has grown on the back of low-cost finance and high feed-in tariffs (FiT) offered and have helped advance an environmentally benign image for the power sector, especially in countries like Germany and Spain. Convergence with the utility grid in Japan has been driven by similarly structured subsidy programs (and comparatively high tariffs of grid-supplied power). In urban and sub-urban India, the PV systems would be filling the gap in the power supplied by the utility grid and would compete against other alternatives available in the urban context, viz., the ubiquitous diesel generators or inverter-based systems which draw power from the grid and typically use automotive batteries for storage. Most computers are connected through uninterruptible power supply systems (UPS), to bridge the gap during grid outages.

A diesel generator of equivalent capacity has a life cycle cost of almost twice that of a PV system, in some situations [21], viz, on island geographies, where transportation costs contribute substantially to the landed cost of fuels. Kolhe et al. [12] have worked on the economic viability of the stand-alone PV system as compared to the diesel-powered system and, given Indian operational parameters, have arrived at energy demand range of 15 kWh/day (worst case) to 68 kWh/day (best case) where PV-powered systems are cost competitive. Along similar lines, Hansen and Bower [10], opine that electricity planners have focused attention on

[6] In this context quality does not imply mediocre product or indifferent design, but lower wattage of lamps and the like.

lowering electricity costs at generation sites, while transmission and distribution losses and thefts have taken their toll. Further, subsidized tariffs on grid-supplied power reduce the incentive to look for alternatives. They believe that small scale generation technologies with power ranges as low as 5 kW (indicative range) are now in a position to compete economically with grid connected central generating capacity. This evolution in economics of alternatives opens up a world of possibilities for the production of electricity close to the point of consumption, thus reducing both technical and non-technical losses (power theft).

A rapid increase in volumes from a relatively "easy" market ("low hanging fruit") would help reduce prices for the market as a whole ("scale effects"). Additionally, higher installation density and a critical mass of systems help offset the higher costs of providing energy services in dispersed expanses ("network effects"). Appropriate banking channels could be identified to route the interest subsidy, as for instance, through rural branches of commercial banks, cooperative banks, etc. The policy intended for the promotion of a certain technology should be neutral to territorial demarcations, applications and classes of end-users.

2.8 Inferences

Financing mechanisms should be non-distortionary, inexpensive to administer and competitively neutral, enhancing allocative efficiency and not benefiting a few firms at the expense of others. Liberalized entry and competition encourage innovation and lead firms to generating a wealth of service, price and quality options to reach the target markets. The interest subsidy routed through banking channels is a superior option as it does not depend on quota or geographic allocation and merely requires that quality marked components be employed. Since the soft loan is linked to the capital cost of the installation, prepackaged system sizes and exogenously determined prices are not prerequisites. A competitive market enables innovation and the creation of brand equity, multiple price points and a range of robustly engineered quality options, while ensuring prompt and disciplined maintenance service for the systems. The end-users learn to discern product and service quality, over time. Additionally, the interest-subsidy schemes could be structured so as to ensure that product costs are progressively lowered through technology evolution (identical product at lower costs or superior product at identical costs), which would not be feasible under static capital-subsidy regimes.

The bureaucratic channels intent on controlling the distribution of capital subsidy could be put to better use in creating awareness among the target population and in encouraging vendors to use quality certified components. More generally, policy makers and their executive wings should abstain from replicating activities that could easily and more efficiently be carried out by non-state actors, specializing in such activities as banking, retailing, etc.

With the enlargement of the interest subsidy scheme, the systems, rather than the end-users are required to meet eligibility criteria. The consumer is at complete liberty to choose the vendor, the lender, the combination of sub-systems in the quality range between λ_{max} and λ and a price point between p and p_{max}, commensurate with his/her own endowment. At the end of it all, development is about empowering the masses and providing an enabling environment for people to choose for themselves.

2.9 Annex

$$\begin{aligned} PMT_t &= C_o[i(1+i_b)^n]/[(1+i_b)^n - 1] \\ I_t &= I_b * P_{(t-1)} \\ R_t &= PMT_t - I_t \\ P_t &= P_{(t-1)} - R_t \\ CF_{is} &= I_t * P_t \end{aligned}$$

Interest subsidy paid during the tenure of the loan is discounted at the rate of return on alternative use of government funds I_g

$$C_{is} = \sum_{i=1}^{n} (CF_{is})/(1+i_g)^t$$

The equivalent capital subsidy as a proportion of system cost is given by C_{is}/C_o.

The government is therefore indifferent between offering an interest subsidy to lower the rate paid by the borrower by I_s or a capital subsidy, F_s equal to C_{is}.

— Result 1.

Capital subsidy provided $= F_s$

Net-of-subsidy amount to be mobilized $= C_o\ (1 - f_s)$

$$C_w = \sum_{i=1}^{n} (CF_w)/(1+i_m)^t = F_{cs}$$

— Result 2.

References

1. Arrow KJ (1995) A note on freedom and flexibility. In: Basu K, Pattanaik P, Suzumura K (eds) Choice, welfare and development. Oxford University Press, Oxford
2. Atkinson AB (1995) Capabilities, exclusion, and the supply of goods. In: Basu K, Pattanaik P, Suzumura K (eds) Choice, welfare and development. Oxford University Press, Oxford

3. Bhattacharyya SC (2007) Power sector reform in South Asia: Why slow and limited so far? Energy Policy 35(1):317–332
4. Carlos JC (1997) Photovoltaic technology and rural electrification in developing countries: the socio-economic dimension. IPTS Report No. 19, www.jrc.es/iptsreport/vol19/english/ENE1E196.htm
5. Chandrasekar B, Kandpal TC (2005) Effect of financial and fiscal incentives on the effective capital cost of solar energy technologies to the user. Sol Energy 78:147–156
6. Chattopadhyay P (2007) Testing viability of cross subsidy using time-variant price elasticities of industrial demand for electricity: Indian experience. Energy Policy 35(1):487–496
7. Clarke GRG, Wallsten SJ (2003) Universal service: empirical evidence on the provision of infrastructure services to rural and poor urban consumers. In: Brook PJ, Irwin TC (eds) Infrastructure for poor people. The World Bank, Washington
8. The Economist (2005) India's electricity reforms: underpowering. The Economist, 22nd September
9. GEF (2001) Results from the GEF Climate Change Program—Evaluation Report # 1-02. Monitoring and Evaluation Unit, Global Environment Facility
10. Hansen CJ, Bower J (2003) The political economy of electricity reform: a case study in Gujarat, India. Report by Oxford Institute for Energy Studies, p 47. http://econpapers.repec.org/RePEc:wpa:wuwpot:0401006
11. Jacobson S, Lauber V (2006) The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. Energy Policy 34(3):256–276
12. Kolhe M, Kolhe S, Joshi JC (2002) Economic viability of stand-alone solar photovoltaic system in comparison with diesel-powered system for India. Energy Economics 24:155–165
13. Kumar A, Jain SK, Bansal NK (2003) Disseminating energy-efficient technologies: a case study of compact fluorescent lamps (CFLs) in India. Energy Policy 31:259–272
14. Makhijani A (2005) India should choose Iran, not US. www.rediff.com, 28 December 2005
15. MNRE (2005) Annual Report of the Ministry of New and Renewable Energy, 2004–2005
16. MNRE (2006) Annual Report of the Ministry of New and Renewable Energy, 2005–2006
17. Osterkorn M (2007) Solar thermal to score in SA? Renewable Energy Focus, pp 26–30
18. Pearce JM, Harris PJ (2007) Reducing greenhouse gas emissions by inducing energy conservation and distributed generation from elimination of electric utility customer charges. Energy Policy 35(12):6514–6525
19. Rader NA, III Short WP (1998) Competitive retail markets: tenuous ground for renewable energy. Electricity J 11(3):72–80
20. Radulovic V (2005) Are new institutional economics enough? Promoting photovoltaics in India's agricultural sector. Energy Policy 33(14):1883–1899
21. Sunderasan S (2006) Transforming solar thermal: policy support for the evolving solar water heating industry. Refocus 7:46–49
22. Taylor R, Abulfotuh F (1997) Photovoltaic electricity in Egypt. Renewables for sustainable village power. Project Brief, Department of Energy, NREL
23. World Bank (2006) New renewable energy: a review of the World Bank's assistance. Independent Evaluation Group
24. Yang H, Wang H, Yu H, Xi J, Cui R, Chen G (2003) Status of photovoltaic industry in China. Energy Policy 31:703–707

Springer

http://www.springer.com/978-0-85729-211-7

Rational Exuberance for Renewable Energy
An Economic Analysis
Srinivasan, S.
2011, XVI, 113 p., Hardcover
ISBN: 978-0-85729-211-7