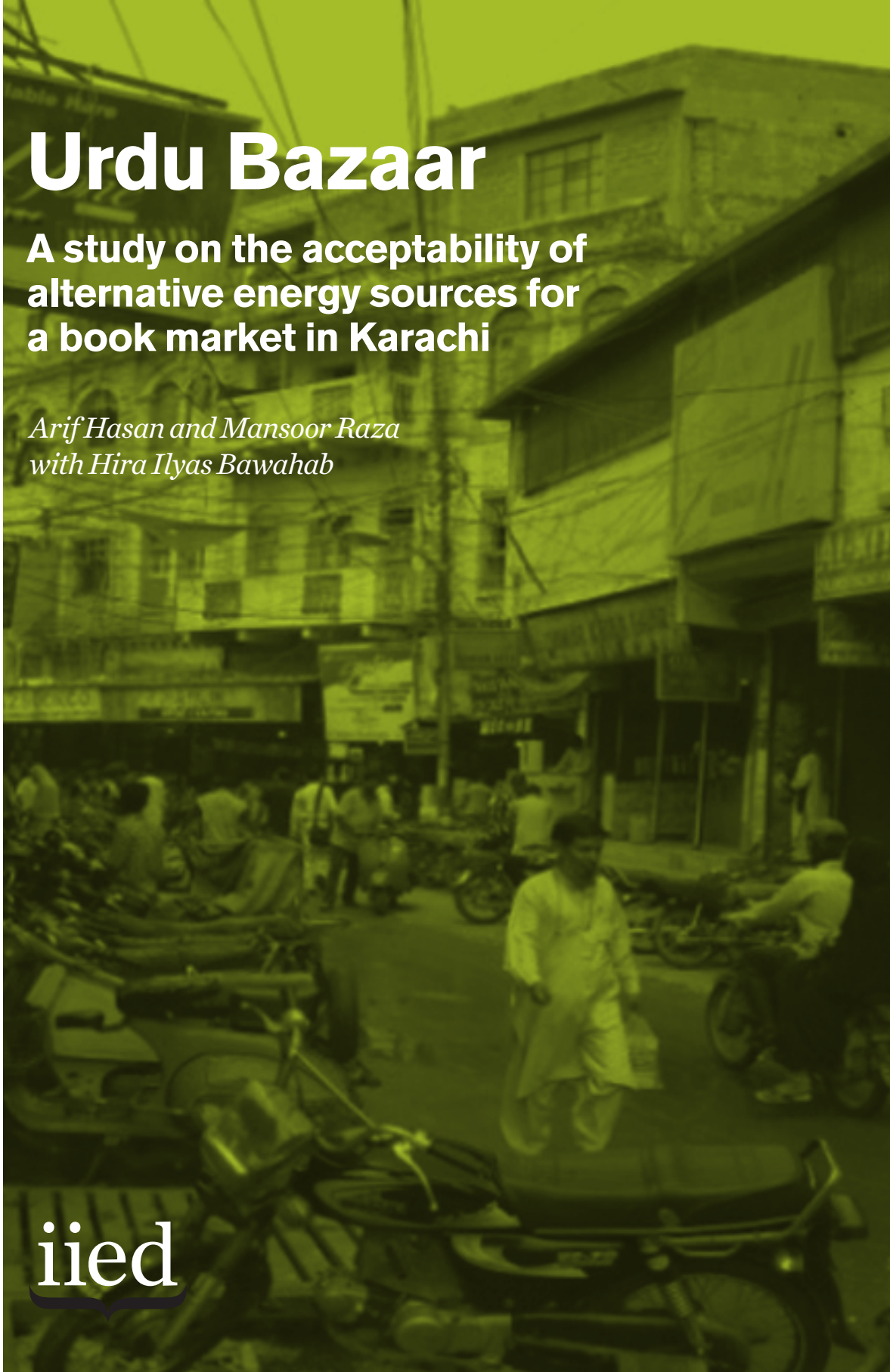
Urdu Bazaar

A study on the acceptability of alternative energy sources for a book market in Karachi

Arif Hasan and Mansoor Raza
with Hira Ilyas Bawahab



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About the authors

Arif Hasan is an architect/planner in private practice in Karachi, dealing with urban planning and development issues in general and in Asia and Pakistan in particular. He has been involved with the Orangi Pilot Project (OPP) since 1981 and is a founding member of the Urban Resource Centre (URC) in Karachi, whose Chairman he has been since its inception in 1989. He is currently on the board of several international journals and research organisations, including the Bangkok-based Asian Coalition for Housing Rights, and was previously a Visiting Fellow at IIED. He is also a member of the India Committee of Honour for the International Network for Traditional Building, Architecture and Urbanism. He has been a consultant and advisor to many local and foreign CBOs, national and international NGOs, and bilateral and multilateral donor agencies. He has taught at Pakistani and European universities, served on juries of international architectural and development competitions, and is the author of a number of books on development and planning in Asian cities in general and Karachi in particular. He has also received a number of awards for his work, which spans many countries.

Hira Ilyas Bawahab is an architect at the prestigious National College of Arts, Lahore, Pakistan. She is currently employed at Arcop Associates Pvt Ltd., one of the leading firms across Pakistan. She possesses a keen interest in urban design and development as a subject. The problems that Pakistan faces today in terms of population, land use, transport, road networks and sustainability are what drive her to learn and better understand the country and its urban fabric. Being part of the Urdu Bazaar research project provided a technical insight towards various aspects of viewing an urban environment.

Mansoor Raza is an electrical engineer and environmentalist. He is currently Deputy Director, Advocacy and Research at the Church World Service – Pakistan/Afghanistan, where he has worked since 2002 overseeing disaster response activities and mitigation plans for Pakistan as well as undertaking more strategic fundraising and managerial work. Prior to this he worked at the NGO Resource Centre in Karachi as a Field Coordinator, building the capacity of community-based NGOs and designing training packages for grassroots organisations. He has researched and published widely and has a special interest in the amendment and repeal of discriminatory laws and their misuse in Pakistan.

Abbreviations and local terms

KESC	Karachi Electric Supply Company
Kunda	An illegal electric connection taken from power distribution poles
kWh	Kilowatt hour(s)
OCT	Orangi Charitable Trust
OPP-OCT	Orangi Pilot Project (run by the Orangi Charitable Trust)
PKR	Pakistani rupee
UPS (units)	Uninterruptible power supply units

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A number of people worked on this study in addition to the main authors. Architects Furqan Khan and Hira Ilyas were responsible for carrying out and tabulating the questionnaire survey, Varda Nisar helped tabulate and prepare a related PowerPoint® presentation, and Israr Ahmad Rana pulled the study together.

Shahid Bhai, our contact in Urdu Bazaar, and Nasim Ahmad Sahib, the leader of the Urdu Bazaar Welfare Association, spent a lot of time with the team during and after the survey, and Nasim Ahmad Sahib subsequently arranged a well-attended meeting between shopkeepers from the bazaar, the authors of the study and the solar energy supply company.

The authors learned a good deal about the technical aspects of solar energy systems during the course of this study, and are now in a position to promote them in the teaching institutions to which they are affiliated, and among the communities where they and/or their organisations work.

The authors would like to thank Nikhil Jaisinghani of Value Development Initiatives and Emma Wilson of International Institute for Environment and Development (IIED) for reviewing the paper. IIED is grateful for the support of its Joint Framework donors Danida, SIDA and Irish Aid.

ARIF HASAN
January 2013

Executive summary

Pakistan has one of the lowest rates of power consumption in the world, with per capita consumption of less than half the average for developing countries. Power outages in Karachi have increased since the privatisation of the Karachi Electricity Supply Company (KESC) three years ago, and these are damaging industry and commerce. The energy crisis is starting to take a serious toll on the country's economy and its people's daily lives. Local communities are left to find their own solutions while they wait for the government to resolve the problem. Thanks to technological advances there are alternative power sources to choose from, but these are subject to a range of technological and social constraints and potential problems with governance.

This study explores attitudes to alternative energy sources in Urdu Bazaar, a typical commercial market in the centre of Karachi. After discussing the power generation situation in Pakistan in general, and Karachi in particular, it documents the initial conclusions of the research process, the actions taken following discussions with participants, and a follow-up review to assess the impact of the study and efforts to bring stakeholders together to resolve some of the issues identified during the investigation.

An initial survey conducted in July and August 2010 used observations, detailed interviews with leaders of the shopkeepers' welfare association, a questionnaire administered to 100 randomly selected shopkeepers, and interviews with solar energy companies and other experts. The authors met key stakeholders again in late 2011 and 2012 to determine the longer-term outcomes of the activities presented in the study.

The initial survey revealed that power outages in the market last for about three hours on a normal working day, but can go on for as long as six or seven hours. This means that shopkeepers cannot operate fans in summer, illuminate dim shops or provide lighting after dark. They use generators and uninterruptible power supply units (UPS) as an alternative to mains power, but these are far from ideal. Generators are expensive to buy and run, are noisy, and cause pollution and potential health hazards. Shopkeepers reported that customers do not like going into shops when they are switched on. UPS units are cheaper than generators, but do not store enough energy to cover long power outages and consume large amounts of power from the grid. The acid batteries also cause air pollution that is difficult to tolerate for long periods.

Some 90 per cent of the shopkeepers surveyed recognised the environmental advantages of solar energy, and said that they see it as a sustainable alternative power supply. They identified four packages that could meet their energy needs. The authors asked seven solar energy companies to provide technical details and a quote for one of the packages (consisting of two energy-saving light bulbs and a fan), and contacted two engineers to help them understand the proposed technologies. A company called WellBeingGreen was selected to proceed with the exercise, as it seemed keen to cooperate, was associated with a respected foreign head and had submitted the lowest estimate.

The authors presented their findings to the market's shopkeepers at a meeting hosted by the Urdu Bazaar Welfare Association. WellBeingGreen presented its package at this event, and the shopkeepers voiced some of their concerns about solar alternatives. They were worried that the government might impose a tax on solar power, which would compromise their investment, and that KESC might retaliate for the revenue it would lose if they opted for solar energy systems. There were also concerns about security, as the solar panels would be placed on roofs where they would be accessible to thieves; and fears that they would be left with worthless warranties if the company supplying the solar energy systems closed down. Another topic of debate was the advantages and disadvantages of individual and collective solar panels.

The representatives from WellBeingGreen explained that they face a number of constraints as producers of solar systems, such as the 50 per cent duty on cadmium batteries and 30 per cent tax on solar panels, which add 30 per cent to the cost of their final product. They argued that glass manufacturers in Pakistan are capable of producing the tempered glass sheets that cover photovoltaic cells, and that the government should offer incentives to manufacture them as this would further reduce costs.

After the meeting, one of the authors wrote to the Secretary of the Power Department in the Government of Sindh explaining the shopkeepers' concerns about governance and WellBeingGreen's observations regarding the duties on solar technology items. The letter also introduced the leader of the Urdu Bazaar Welfare Association and WellBeingGreen to the Secretary so that they could work together independently of the research project. The leaders of the Welfare Association shared the authors' presentation with their members and decided on a future course of action. This included keeping in touch with WellBeingGreen and, if necessary, with the authors.

Although the shopkeepers in Urdu Bazaar were keen on the solar option because it would make them less reliant on inefficient power supplies from KESC, they decided not to adopt it. There were several reasons for this. Firstly, the AC solar system would be relatively expensive as it requires power inverters to change from DC to AC current, while the more affordable DC option would mean replacing their existing equipment. They were also anxious about the security of solar panels on rooftops, given the current levels of unrest in Karachi. The final, major disincentive to investing in solar systems was the improved power supply from the national grid.

Representatives from WellBeingGreen were introduced to the Orangi Charitable trust (OCT), which ran the Orangi Pilot Project (OPP-OCT) in Karachi and has a major presence in rural areas of Pakistan. The intention was for OPP-OCT to introduce solar lanterns and fans to partner organisations in rural areas and small towns. WellBeingGreen held a number of discussions with OPP-OCT after the initial research was completed, but did not secure any orders from the OCT network. It has since had to scale down its operations and abandon the promotion of solar products due to financial difficulties.

A number of companies contacted the authors following the publication of a newspaper article about this work in February 2011. One of these companies, Smart and Renewal Energy Solutions Private Limited (SRE), set up a demonstration unit at Arif Hasan's office. This generated considerable interest, and led to several NGOs adopting solar energy in their homes and offices, and the introduction of solar-powered street lighting in a new tourist complex. SRE also worked with OPP-OCT to develop small 5W packages for individual households in rural areas, and the two organisations are now looking to further develop this market.

Although solar power could provide a solution to the energy problems in Urdu Bazaar, this study shows that there are technological, financial and social obstacles to the adoption of such technologies. It also reveals the challenges that companies face in promoting solar products, and the importance of adequate government support and incentives. The study also provides a valuable insight into how individual researchers and activists can convene and engage with key market actors to facilitate market development. The results may be unpredictable, but success can be achieved by persistence and by being open to opportunities as they arise. Local studies of all these constraints and opportunities are needed to determine whether such alternatives are really feasible, especially if they are to be scaled up from individual pilot projects and take advantage of emerging opportunities to develop the market for solar power.

1 Introduction

This study was undertaken in order to understand the reasons behind the hesitancy to use alternative energy to tackle the extensive power outages that plague people's lives and adversely affect businesses in Karachi's markets. It provides an overview of the power situation in Pakistan in general and Karachi in particular, documenting the research process, initial conclusions and actions taken following discussions with participants. It also presents the results of a follow-up review by the authors to assess the impact of the study and their attempts to bring stakeholders together to resolve some of the issues identified during the process.

1.1 Power supply in Pakistan and Karachi

Pakistan is defined as an energy-deficient country. Statistics show that it has one of the lowest rates of power consumption in the world, with per capita consumption of less than half the average for developing countries, about an eighth of the global average, a twenty-fifth of the average for developed nations, and a sixtieth of an average North American citizen's power consumption. The latest available figures (2007) put Pakistan's per capita consumption at 438kWh, while that of the world's top consumer, Iceland, is 31,147kWh (Nationmaster.com).[1] Massive power outages have crippled economic activities across Pakistan, hitting both medium- and small-scale industries and leading to a decline in jobs. Assuming that there is a positive correlation between power consumption and poverty (up to a certain level of consumption), these figures show the devastating effects of the energy crisis on the 182 million people estimated to live in Pakistan (Population Census Organization, 2013).

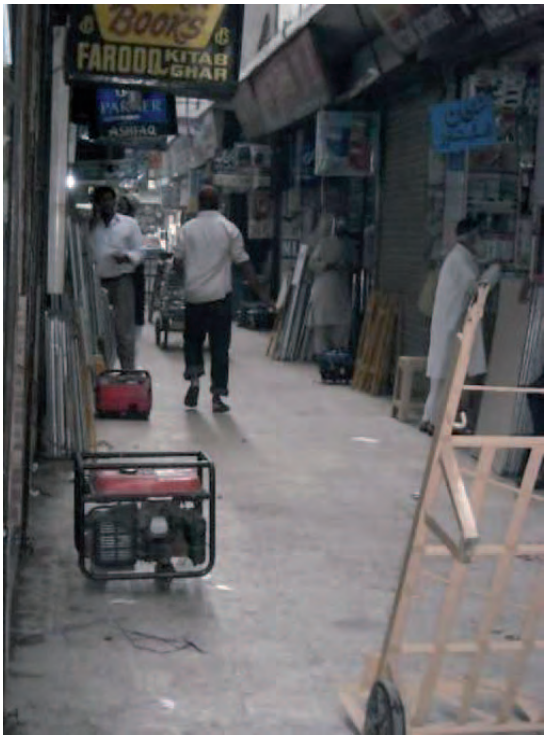
It is starting to take a serious toll on the country's economy as well as the daily lives of its inhabitants, who have to find their own solutions while they wait for the government to resolve the problem. Technological advances now offer various alternative sources of power, but they are subject to a range of technological and social constraints and governance-related problems. These constraints need to be studied at the local level if such alternatives are to become feasible solutions, and especially if they are to be scaled up from individual pilot projects to larger programmes.

Karachi is the business and commercial hub of Pakistan. Yet its residential, commercial and administrative areas are constantly plagued by power outages and load-shedding, which cause huge financial losses. Old systems and machines are unable to meet the city's demand for power, and 40 per cent of the electricity produced is lost to large-scale theft and obsolete distribution lines (Siddiqui, 2005). According to media reports, the city sometimes faces a shortfall of 600MW against demand for 1787MW. Prolonged periods without power often spark riots that last for many hours until electricity is restored. Tyre burning and stone throwing are common, and the offices of the Karachi Electricity Supply Company (KESC) have been torched on at least one occasion.

1 Figures are rounded up to nearest kWh.

KESC currently covers an area of 6000 square kilometres and has available capacity to produce 1400MW from gas and heavy fuel oil. This amounts to 55 per cent of the electricity generated.[2] KESC purchases the remaining electricity from independent power producers (IPPs)[3] such as the Water and Power Development Authority,[4] GulAhmed and Tapal. KESC is heavily criticised for not being able to satisfy consumers in its 'patch'.

When KESC is unable to provide a constant power supply, it stops delivering electricity to certain parts of the area it is supposed to serve in order to avoid a total blackout of the power system. This practice is known as load-shedding. At such times households and businesses have to rely on generators and uninterruptible power supply (UPS) units for their power.[5] The use of generators has escalated recently due to increasingly frequent power cuts.



Generators line the street outside shops in Urdu Bazaar

Heaps of rubbish on the roads near Urdu Bazaar

2 See: www.kesc.com.pk

3 Independent power producers (IPPs) are private companies that develop, own or operate electric power plants, and often sell power back to the National Grid. At present there are around 24 commissioned IPPs in the country.

4 The Water and Power Development Authority is a semi-autonomous body that was created in 1958 to direct the development of schemes in the water and power sectors. Its charter of duties includes the generation, transmission and distribution of power.

5 An uninterruptible power supply (UPS) unit is an electrical apparatus that provides emergency power to a load when the input power source (typically mains power) fails. UPS units provide instantaneous or near-instantaneous protection from input power interruptions via one or more batteries and associated electronic circuitry for low power users, and/or diesel generators and flywheels for high power users. They are not restricted to any particular type of equipment, but are usually used to protect computers, data centres, telecommunications and other electrical equipment where unexpected power disruption could cause injuries or fatalities, serious business disruption or data loss.

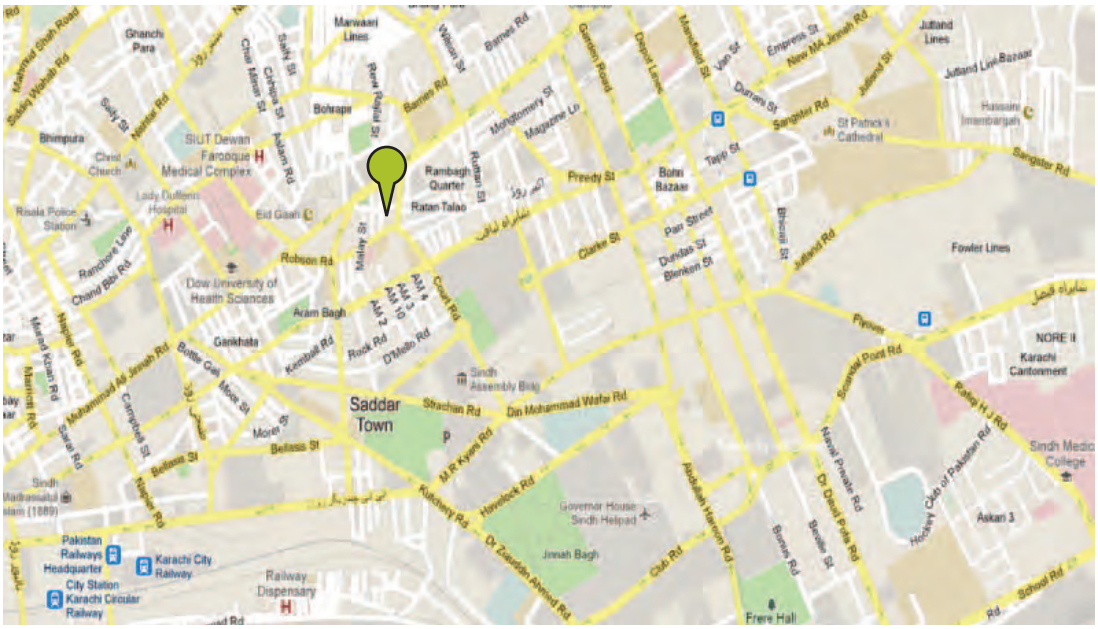
Some booksellers also own publishing, stationery or auto-parts businesses

Although generators are a good back-up as they supply uninterrupted power and are beneficial in emergency situations, their disadvantages outweigh their advantages as they contribute significantly to noise and air pollution, and require a considerable amount of space and maintenance. UPS backup power systems need to be charged regularly, do not last for long and also require maintenance, which means they are ineffective during extended power outages.

1.2 Description of Urdu Bazaar

Urdu Bazaar is a wholesale and retail book market in the centre of Karachi, the capital of Sindh province (see Fig 1). Radio Pakistan lies north of the market, Jamia Cloth Market to the southwest and the government College for Women to the southeast. Other important landmarks in the area include the Green Mosque, the Government veterinary clinic, the Aram Bagh garden and Sabiri Nihari House (a famous food outlet). All would benefit from

Figure 1:
Location of Urdu Bazaar in Karachi



Source: http://mayrapakistan.com/karachi-map.html

electricity systems powered by alternative energy sources.

Most of the 400 or so shops in this bazaar sell old and new books, although a few shopkeepers also own publishing, stationery or auto-parts businesses. The site includes a mixture of one- to four-storey high commercial and residential blocks. Their roofs would be a suitable location for solar panels, although the fact that most shops are at street level would make it more difficult for shopkeepers to access solar-powered electricity from the roofs. There is also the possibility that electricity may be diverted during transmission from the upper storeys to the ground floor, siphoned off into the jumble of overhead wires that feed informal electricity supplies and the countless illegal connections known as *kunda*.

Heaps of foul-smelling rubbish litter this densely built and populated area, and rains bring havoc to the market as the only drainage system is the natural gradient on the paved roads. Many shopkeepers operate on the ground floor but store their goods in *godowns* (storage units) on the first or higher floors. Our survey also revealed that there are no proper ventilation systems in the shops. Without electric fans, this creates a heavy, suffocating atmosphere during peak business hours, especially in the hot season.

Karachi experiences regular traffic jams caused by rain, inefficient traffic management and, most importantly, political events like rallies or protests. Urdu Bazaar is badly affected by these jams due to its proximity to the main arterial routes and the sites where protests take place. The disruption they cause, combined with the lack of electricity, air pollution and noise produced by generators are additional sources of stress for shopkeepers in the market.[6]

Jumbled overhead wires and *kunda* systems can be seen everywhere

Traffic jams are a regular feature of life in Karachi

6 See also the newspaper clippings in Appendix 3.

2
The Survey Process

Providing alternative sources of energy is not a simple undertaking. It raises a complex set of issues, including the governance of alternative power systems. Therefore, it is important to understand the existing and potential relationships between different actors in the alternative energy supply chain.

In view of the present electricity situation and the economic consequences of power outages, we decided to focus on one of the commercial areas of Karachi and study the possibility of solar energy as an option for electricity generation. A number of academics and alternative power suppliers told us that this is the first time such a study has been undertaken.

We selected Urdu Bazaar for the following reasons:

- It is an important commercial hub.
- It faces southwest and therefore receives the sea breeze, meaning that many west- or south-facing shops do not require power for electric fans.
- The narrow shops in this high-density area highlight the practical issue of the space required for solar installations.
- Most shops in the market are deprived of electricity for about three hours during the working day.
- This market is like many other retail and wholesale bazaars in Karachi in that it can be classified as middle-class rather than affluent. This means that conditions in Urdu Bazaar are comparable with those in most of the city's other markets.

The research process was facilitated by personal contacts in the locality.

2.1 Research methodology

The methodology was based on a range of information-gathering methods, such as direct observation, secondary data analysis, individual interviews and questionnaire surveys. A total of 100 randomly selected shopkeepers were surveyed, along with representatives from solar energy companies and other experts in this field. The shopkeepers, who mostly sold books or were in book-related businesses, were identified via a contact popularly known as Salam Bhai (Brother Salam), who sells books in Urdu Bazaar. Solar energy companies and individual experts were identified through personal contacts and readily available information on the Internet. Microsoft® Excel was then used to compute percentages accurately and filter and categorise the data from the surveys.

2.2 Research questions

The research team asked the following questions:

1. What alternative sources of energy do shopkeepers in Urdu Bazaar currently use during periods of load-shedding?
2. What are the monetary and environmental advantages and disadvantages of these alternatives?
3. Are shopkeepers willing to invest in a solar energy option?
4. What psychological and financial constraints might shopkeepers face in making such an investment?

5. What services can solar energy suppliers or companies provide for Urdu Bazaar shopkeepers, and at what cost?

The survey questionnaire can be found in Appendix 1.

2.3 Questionnaire survey

A questionnaire was designed and administered to 100 shopkeepers to establish the frequency and duration of power outages, their impact on businesses and the acceptability of solar energy as an alternative source of power. The survey was undertaken between 29 July and 11 August 2010.

The researchers discussed their initial observations on the use of generators and UPS units by vendors in Urdu Bazaar before they designed the questionnaire. They set up a three-member research team to conduct a set of pilot interviews, with a supervisor to coordinate and manage activities. The team was briefed about the research objectives, the ethical issues associated with such surveys and possible problems that could hamper the survey. After the first round of interviews, the questionnaire was modified in order to elicit more precise information. The survey findings are presented in Section 3.

2.4 Implementation challenges

Shopkeepers were contacted through an old acquaintance of one of the researchers, and interviewed in their business premises. The quality of their responses varied according to the number of customers in the shop when the survey was conducted. They were reluctant to provide precise information about electricity bills or the costs associated with generators, usually giving a range of figures that the researchers later averaged out. Expenses were reported at slightly inflated rates, reflecting the fact that many in the business community are suspicious of strangers, who may be undercover agents for the tax authorities.

The research team was under tremendous pressure to finish the survey phase before the start of the holy month of Ramadan, as past experience has shown that it is difficult to break the ice and ask strangers questions during this period. In addition to this, the city was brought to a grinding halt on 2 August 2010 by the high-profile murder of Raza Haider, one of the legislators of the Muttahida Quami Movement (one of the coalition parties of the current regime, which is led by the Pakistan People's Party). The ensuing violence disrupted business activities and made it difficult to conduct the survey.

The survey questionnaire served as an excellent reminder of the questions that needed to be asked in a systematic manner, kept the research team on track and also saved time, but proved to be a rather mechanical tool with little ability to capture the nuances of the broader issue. As the survey progressed, it emerged that a number of issues were not covered by the questionnaire. These are discussed in the next section, along with the responses to the questionnaire.

3
Research Findings

The survey data were analysed in order to determine the shopkeepers' capacity to establish an integrated system that uses solar power to supplement electricity from the national grid, rather than existing alternative power sources like generators and UPS.

The research findings can be divided into:

- on-site observations throughout the research period;
- findings and conclusions from discussions and informal interviews with shopkeepers in Urdu Bazaar;
- findings and conclusions from the questionnaire survey administered to shopkeepers in Urdu Bazaar; and
- findings and conclusions from interviews and discussions with solar energy suppliers and experts.

The aim of the analysis was to identify the gap between the current situation and the proposed solar energy ideal, and determine how it might be bridged.

3.1 On-site observations

Regular business hours in Urdu Bazaar are between 10am and 10pm. Load-shedding in the market lasts for a minimum of 3 hours per day, and can extend to 6 or 8 hours in the case of a KESC-related fault. The head of the Urdu Bazaar Welfare Association maintains that the average duration of power outages from the national grid is 3 to 4 hours a day. In the worst cases, which happen about twice a year, shops are left without power for 9 to 11 hours a day. He said that the average electricity bill for shops in the bazaar is 1800 Pakistani rupees (PKR) per month, equivalent to USD 21.[7] Shopkeepers complain that KESC bills them on an average tariff,[8] which is higher than average national tariffs.

The survey team noted that shopkeepers use generators and UPS during outages so that they can run fans to keep cool in the summer or provide lighting in poorly lit shops. Generators are expensive, costing about PKR 37,500 (USD 436) to buy and PKR 5882 (USD 69) per month to run. They cause undesirable levels of noise and air pollution, affect the quality of telephone and face-to-face communication, and can result in the loss of clientele. They are used on an individual and a collective basis.

UPSs are cheaper than generators, costing PKR 20,000 (USD 233) to buy and PKR 1000 (USD 11.6) per month to run. However, there are a number of operational issues associated with UPSs. One is battery-charging. Batteries are frequently not charged properly due to a combination of load-shedding and the fact that market's power supply is switched off at night. They cost between PKR 10,000 (USD 116) and PKR 12,000 (USD 140) each, are expensive to maintain and last no more than a year due to the

7 It is difficult to ascertain the exact amount as the shopkeepers gave contradictory figures, and the survey shows a broad range of expenditure on power utility bills. A couple of shopkeepers said that their quarterly bills were as much as PKR 3000.

8 The Karachi Electric Supply Corporation sometimes bases bills on the customers' average usage over last couple of months instead of their actual consumption in the preceding month.

frequent charge-discharge cycles. In addition to this, the lead-acid batteries used for UPSs emit acidic fumes that cause health problems.

Some respondents suggested that awareness about alternative sources of power should be developed through the media. Conversations with shopkeepers suggest that they would be willing to make an undefined 'reasonable' initial investment for a solar set-up, but would want to test-run a solar energy prototype before committing to this kind of investment. They said that people had invested in UPSs, which proved to be unreliable, and then when they turned to generators many found their daily fuel and maintenance costs unaffordable.

3.2 Findings from interviews with shopkeepers

The shopkeepers who participated in the survey raised a number of questions and concerns about the solar options. What would happen to the alternative power sources that they already use (UPSs and generators) if they switch to solar? What about potential conflict over collective solar panels, as some shopkeepers might consume more electricity than others? What would happen if the solar energy suppliers abandoned the site after installing panels? How could they stop rooftop solar panels and power cables from being stolen?

Another concern was whether solar systems could deal with heavy loads such as photocopiers, computers and printers, and what this would cost. Would solar cells work as well in cloudy weather and after dusk? Lack of faith in KESC was another factor: shopkeepers were worried that people who opted for solar power might be disconnected, and wondered whether KESC might agree to restrict load-shedding to daylight hours so that they would not be affected by the storage issues associated with solar systems.

They also discussed after-sales features like maintenance and warranties for solar systems, and payment models such as loans and monthly payment options. Some were concerned about the resale value of solar panels, and the risk of buying an expensive system whose market value would fall within a few years. Others worried that the government would start taxing renewable energy.

Respondents said that they wanted some control over the type of system they would be using, and the flexibility to use KESC or the solar system or a combination of the two. The electricity supply to the main market comes from more than one distribution zone, as configured by KESC. Power outages from these two zones happen at different times, and some shopkeepers have developed an ingenious mechanism that swaps their incoming supply lines from one source to another in order to maintain a continuous power supply for their businesses.

Vendors whose shops are outside the main buildings have enough sunlight to function and do not need energy saving light bulbs, known locally as 'energy savers'.[9] Shops that are located towards the main road get plenty of light and air and do not need fans during the day.

9 Energy savers or energy-saving light bulbs are also called compact fluorescent lamps (CFLs), compact fluorescent lights, energy-saving lights or compact fluorescent tubes. They are designed to replace incandescent lamps, and some types fit into the light fixtures formerly used for incandescent lamps. CFLs use a tube that is curved or folded to fit into the same space as an incandescent bulb, with compact electronic ballast in the base of the lamp. They use one-fifth to one-third of the electricity that standard incandescent lamps need to produce the same amount of visible light, and last eight to fifteen times longer. A CFL costs more to buy than an incandescent lamp, but can save over five times its purchase price in electricity costs over the lamp's lifetime. Like all fluorescent lamps, CFLs contain mercury, which means that they need to be disposed of carefully.

Box 1:
Interview with Nasim Ahmed, leader of the Urdu Bazaar Welfare Association

The head of the Urdu Bazaar Welfare Association reported that the market becomes stifling during power outages, and that people tend to avoid shops towards the centre of the bazaar. Most shopkeepers do not have generators due to their cost and the limited space in their shops, and some have started keeping glucose on hand as customers have been known to faint in the stifling summer heat. Generators cause asthma, allergies, sinus problems, headaches and short tempers. Their absence or presence affects businesses, as some customers do not want to have to shout over the noise they make, while others need artificial light to be able to see properly. Minimum requirements vary from shop to shop, but normally range from four energy savers and two small fans to two energy savers and one fan, or two energy savers and two fans.

The leader of the Association observed that offering shopkeepers the option of solar power would set up a trade-off between KESC supply and the various proposed combinations of solar power. The minimal maintenance requirements for all solar power arrangements, running costs and other maintenance cost-related factors will need to be considered. He suggested that there should be a formal agreement with KESC, as it stands to lose money if 400 shopkeepers switch to solar power for six to eight hours a day, and it may retaliate. Asking KESC to restrict load-shedding to daylight hours is not really an option because the bazaar is in the same electricity delivery system as nearby residential areas. However it would make the solar option much more attractive if it could be arranged, as shopkeepers would not need to buy and maintain storage batteries and would therefore make substantial savings on their outgoings.

Their only requirement is two energy savers at night time. This group of shopkeepers was not as interested in solar power options as those whose shops lie deep inside the market. We also found a few cases where four or five shopkeepers pooled the cost of power from petrol-fired generators, each contributing PKR 25 per day to get enough power for two energy savers and one fan.

A total of 100 questionnaires were administered to shopkeepers. The survey findings are presented in Table 1.

3.3 Findings from interviews with solar companies and experts

Between 16 August and 7 September 2010, the team interviewed two individual experts and six companies that are involved in the manufacture or sale of solar equipment. Their names and a brief profile are given in Table 2. Each meeting lasted for an average of 45 minutes, together totalling six and a half hours.

A number of technical and financial issues emerged from these discussions, such as economies of scale, how to break even in the long term, the provision of solar panels with or without storage capacity, and the user's choice of direct current (DC) or alternating current (AC). These points are summarised below.

Table 1:
Findings from the survey of shopkeepers

QUESTION	FINDINGS
Age/sex of respondent	All the respondents were male: 14% were aged between 15 and 24, 64% between 25 and 50, and 21% were over 50.
Nature of business	80% of respondents were in wholesale or retail business. Of these, 38% were wholesalers, 21% were retailers, and 21% were a combination of the two. The remaining 20% were publishers, stationers or dealers in automobile parts. 67% of shopkeepers had established their business in the last 25 years. Some people have been in business since Independence (1947), showing that this is a longstanding and well-established market.
Business hours	Usual business hours are between 10am and 9pm. Seasonal variations aside, 26% of the shops operate for 9 hours a day, 25% for 10 hours a day, and 18% for 11 hours a day. In total, 85% of the shops operate for between 9 and 11 hours each day.
Power provision	51% of the shopkeepers surveyed reported that they were left without KESC-generated power for a minimum of 3 hours a day. Some shops receive constant natural daylight throughout the day and therefore do not feel the need for a generator during load-shedding in daylight hours.
Generator ownership and maintenance	35 shopkeepers had generators. Of these, 28 had purchased them in the past 5 years (2006–2010). The maintenance cost of generators varies considerably, from PKR 2000 (USD 23) to PKR 80,000 (USD 930) per month. 65 shopkeepers did not have generators. Of these, 85% said that they could not afford the monthly expenditure they required, 16% thought generators create noise pollution, and 14% did not have enough space to store them.
Electrical equipment used in shops	On average, it was calculated that each shop had 2.5 fans and 7.31 energy savers. This is the bare minimum for bookshops. Photocopiers have huge power requirements. The extracted data also revealed that each shop had an average of 6.5 tube lights (40 watts).
Opinions on solar power	90% of respondents said they would prefer solar power to being reliant on KESC; 53% would be willing to have solar as an option provided it is more economical than their present arrangements. 20 of the 25 shopkeepers who work for 10 hours a day preferred the solar option, as did 16 of the 18 who work for 11 hours a day, and all those who work for 12 hours per day. 32 of the 35 respondents with generators preferred the solar option, along with 58 of the 65 respondents without generators. All those who said yes to solar power as an alternative source said that their monthly electricity bills were between PKR 275 (USD 3) and PKR 13,500 (USD 157).

Table 2:
Solar companies and experts interviewed for the survey

COMPANY	DETAIL
National Engineering Corporation (NEC)	NEC was founded in 1976. It currently works in all four provinces of Pakistan on irrigation, energy, groundwater resources, agriculture, public health, industry, urban and rural development, education, environmental management, highways and transportation, and renewable energy.
Hi-Tech Alternate Energy Systems Ltd.	This company works in the alternative energy sector, providing solar, wind and hybrid power solutions. In addition to winning the Achievement Award conferred by the Pakistani government's Alternative Energy Development Board, it is also ISO 9001 (quality management systems) and ISO 14001 (environmental management systems) certified.
Fusion Group	Based in Karachi, the Fusion Group carries out research and development to popularise product diversity, promote competitiveness and open up new markets in cutting-edge and cost-effective technologies in various fields. It is engaged in the development of alternative energy systems such as solar photovoltaic and solar thermoelectric systems.
Solar Line Adaptive Technologies Ltd.	This company provides a complete solution that includes the design, maintenance and installation of solar panels.
The Terminators Ltd.	Established in 2003, this company has worked in many fields including electrical, mechanical and civil engineering. Its proprietor has been involved in solar technology for the last ten years.
Systek Pakistan	This commercial organisation works with the Pakistani government and public sectors on renewable energy, solar, wind, thermal and hydro power, and in the industrial, medical and dental fields.
WellBeingGreen Company[1]	WellBeingGreen was established in 2007, with the aim of becoming Australia's leading provider of energy efficiency and Renewable Energy Certificates. It is involved in three programmes under the Clean Development Mechanism (CDM): two of these supply and distribute solar-powered lanterns to households in non-electrified rural villages in Pakistan and Bangladesh, and the third supplies and distributes compact fluorescent lamps to replace inefficient incandescent lamps in Pakistan.
Roland D'Souza	Mr D'Souza is a prominent electrical engineering consultant and human rights activist in Karachi. He also works on a voluntary basis for *Shehri* (Citizen), a Karachi-based non-governmental organisation that deals with civic issues.
Zafar Abbasi	Mr Abbasi is a well-established electrical and plumbing consultant.

10 For more information on WellBeingGreen see: www.whitepages.com.au/business/well-being-green/

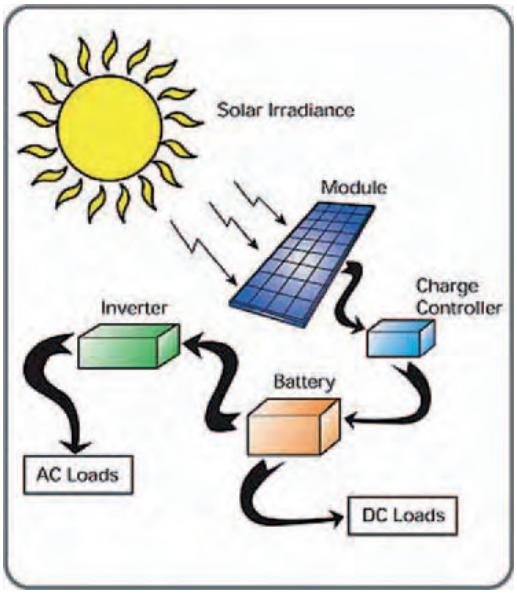
3.3.1 Technical issues

Solar power sources use quartz[11] and silicon to convert the sun's radiation (not heat) into electrical energy. The equipment required to generate solar power includes solar panels (which have solar cells), tempered glass sheets to cover photovoltaic (PV) cells, electric wires for transmission, inverters to convert DC to AC power (optional), storage batteries (optional) and DC or AC appliances. Panels are the most expensive items, followed by batteries and inverters. For safety reasons, it is recommended that power transmission should be alternating current (AC) rather than direct current (DC); the 'sinusoidal' or wave-like AC would repel someone making contact with it after the initial shock, making it relatively harmless up to 220 volts (DC does not behave like this and is considered dangerous in excess of 24 volts). For AC power, inverters would be needed. The suppliers and experts we spoke to emphasised the importance of having good quality inverters for fans as AC waves would otherwise cause damage.

Solar energy has several advantages: it is free to use, has low maintenance costs, avoids the nitrogen oxide and carbon dioxide pollution caused by burning coal and diesel, and generates very little waste, apart from replacement batteries. Solar panels last for approximately 20 years.

The total energy requirement for three fans, two 20W savers and one telephone charger amounts to about 350 watts.[12] The experts and suppliers we interviewed advised that 420W panels would be needed to support this, as businesses in the market operate for 9 or 10 hours a day and the sun is only expected to radiate for 6 or 7 hours a day.

Figure 2: The solar power system



Source: Invicta FX (2010) 'Invicta FX'. www.invictafx.com. Accessed March 2013.

For maximum efficiency, the angle of the sun needs to be calculated when determining the required surface area of solar panels. Their efficiency is reduced by cloudy weather, the angle of sunlight, shadow from taller buildings and dust particles on the glass panels. Moveable (motorised) solar panel brackets are recommended for proper and continuous voltage supply, although this would require extra space and increase the cost of the package. Solar panels that are connected to tracking devices generate up to 40 per cent more energy than fixed systems (Khan, 2009).

11 Fused quartz is an extremely important material as it both enhances the efficiency and reduces the cost of solar-powered devices. Its stability, chemical purity, light transmission capacity and heat resistance make it vital to the production of semiconductors. Quartz glass is used in many facets of photovoltaic (PV) cell manufacturing: light sources, reaction chambers and the tools used to produce solar cells, thin films and silicon wafers. Quartz is almost inert, durable and withstands the high temperatures associated with semiconductor fabrication and testing (adopted from material found on: www.solarpowerengineering.com).

12 The aging process and initial torque may bring the starting current up to 100 watts per fan.

Cloud cover in winter and during the monsoon season reduces voltage supply, meaning that it would be impossible to operate a solar system without batteries. Roland D'Souza advised that since batteries operate most efficiently at 25°C, it is best to avoid putting them on roofs, where temperatures are usually high.[13] Other issues that arose during the discussions with solar companies and experts included battery life (which is reduced by frequent charge-discharge cycles), the storage of acid batteries and the pollution they cause. Nickel-cadmium (Ni-cd) batteries were recommended as they have a longer life, are not polluting and can be safely disposed of, although they are more expensive.

On a more general level, the companies agreed on the advantages of installing demonstration units for their prospective clients, although they usually run them for three to five days, and were not willing to extend the demonstration period to one month. It should also be noted that solar panels are usually recommended for low density areas or places where the national grid is not available, and that Urdu Bazaar is in a high density area served by KESC.

Another issue that needs to be addressed is the cost of imported solar panels. Northern Pakistan has abundant supplies of the basic raw material for solar panels (quartz), but lacks the capacity to purify and process it to a stage where it can be converted into solar cells. This would require a one-off investment in imported equipment. The other raw material needed to manufacture solar cells is silica (sand), which is found in large quantities in the River Sindh.[14] There are many glass manufacturing factories in Pakistan that could produce tempered glass to the required specifications if they had the right facilities. Here too, there is a need to import the requisite machinery and install it in existing factories.

The comparative advantages and disadvantages of solar supply with or without inverters and with or without batteries are shown in Table 3.

3.3.2 Financial aspects

All the interviewees agreed that solar power has the potential to be an important source of energy in the future. Although it is expensive in the short term, it is cost-effective in the long run. A number of packages were identified as suitable for shopkeepers in Urdu Bazaar:

- Package 1 for low energy consumers (one fan and two energy savers).
- Package 2 for medium energy consumers (two fans and two energy savers).
- Package 3 for high energy consumers (two fans, four energy savers, computer and photocopy machine).
- Package 4, which covers two bulbs and one telephone charger point.

The expected costs of installing a solar system package were calculated on the basis of our discussions with the suppliers and experts. Package 1 (a 5'x6' panel with AC inverters) would cost PKR 98,000 (USD 1140) and allow shopkeepers to save an average of PKR 1800 (USD 21) per month on their KESC bills.

The Ni-cd batteries needed for the solar systems would have to be replaced every six years at a cost of PKR 36,000 (USD 419) each. Assuming that the shopkeepers save PKR 1800 (USD 21) a month on their KESC bills and spend PKR 500 (USD 6) a month on solar batteries, they stand to make a net saving of PKR 1300 (USD 15) a month, and will therefore recover their investment in a solar system in six years. As the solar systems are expected to last for a minimum of 20 years, their only expense for the next 14 years would be the cost of the batteries.

13 D'Souza is introduced in Table 2.

14 Although it is mixed with clay, and only available when water levels are low.

Table 3:
Quick comparison of solar supply with or without auxiliaries

	STORAGE/BATTERY		INVERTER	
	WITH BATTERY	**WITHOUT BATTERY**	**WITH INVERTER**	**WITHOUT INVERTER**
ADVANTAGES	Power back-up available in cloudy conditions, rainy season and after sunset Total independence from KESC	No annual expenditure on batteries No fire hazard No space issues No movable parts	Provides AC Can use existing fans, bulbs and telephone charger point	Much cheaper option
DISADVANTAGES	Hazardous acid fumes from lead batteries Higher maintenance Long payback period due to higher capital costs	No back-up in periods when efficiency decreases Supply fluctuates according to the rays captured	Additional space required near solar panels Security measures needed to ensure that inverters are safe, as solar panels are installed in open spaces Maintenance required	Obliged to use DC DC transmission above 24 volts constitutes a serious electric shock hazard Need to purchase DC fans and savers

The running costs of various options calculated on the basis of the questionnaire results and feedback from solar companies are shown in Table 4.

Without storage, solar option Package 1 will cost PKR 61,500 (USD 715) and incur no running costs. If the 50 per cent duty on Ni-cd batteries were waived, the cost of this option with storage would fall from PKR 98,000 (USD 1140) to PKR 80,000 (USD 930) per unit. If the 30 per cent duty on solar panels were waived too, the cost would be reduced by another PKR 15,000 (USD 175), bringing the cost with storage down to PKR 65,000 (USD 755).

The cost of the proposed packages is summarised in Table 5.

The shopkeepers' annual and five yearly expenditure on various power sources is shown in Table 6.

One supplier, The Terminators Company, claimed that the cost of the 120W solar panel could be reduced from PKR 50,000 (USD 581) to PKR 17,000 (USD 197) by using locally

Table 4:
Cost analysis of different energy sources and possibilities (in PKR)

	KESC	UPS (AVERAGE)	GENERATOR (AVERAGE)	SOLAR (WITH STORAGE – AVERAGE FOR PACKAGE 1)	SOLAR (WITHOUT STORAGE – AVERAGE FOR PACKAGE 1)
Running costs	1800 (bill)	1000 (cost of battery)	5882 (energy source)	500 (battery replacement/ 5 years)	No cost
Capital costs	–	20,000	20,000	98,000	61,500
Replacement in years	–	5	5–10	20	20
Annual capital cost	–	4000	2666	4900	3075
Advantages	No replacement cost	Automatic back-up system	Constant supply	No noise or air pollution Constant supply	No running costs
Disadvantages	KESC maintenance Load-shedding Perpetually increasing power tariff	Short battery life Pollution Unsafe for appliances	High running costs Noise and air pollution Storage space issues	High initial cost Storage requirements Theft Need to replace battery every 5 years	No energy during non-sunlight hours

produced solar panels – although this figure does not include the inverter, battery, charge controller and wiring, and would require a minimum order of 250 units to achieve the necessary economies of scale (according to Mr Zubair of The Terminators). As noted above, there was some debate about the pros and cons of DC and AC at the user end. The preferred option, AC, would incur additional expenses for converters. The final cost of the package would also be affected by the duration of the warranty, which varies from 15 to 40 years.

Table 5:
Cost of the four proposed packages for Urdu Bazaar (in PKR)

OPTION	PACKAGE ONE	PACKAGE TWO	PACKAGE THREE	PACKAGE FOUR
Appliances	One fan, two savers, one telephone point	Two fans, two savers, one telephone point	Two fans, four savers, one telephone point	No fan, two savers, one telephone point
Total load required from solar panels	150 watts	210 watts	250 watts	50 watts
Space required	Not known	7½ feet x 9 feet	10 feet x 12 feet	2½ feet x 3 feet
Cost of panel	50,000	70,140	83,500	16,700
Charge controller	3500	4000	4000	4000
Mechanical structure	Not known	10,000	10,000	5000
Total cost without storage and DC inverters	53,500	84,140	97,500	25,700
AC inverters	8,000	15,000	15,000	15,000
Total cost without storage and AC inverters	61,500	99,140	112,500	40,700
Storage with lead acid batteries	36,500 (dry cell batteries)	36,500	36,500	20,000
Total cost with storage and AC inverters	98,000	135,640	149,000	60,700

Other major considerations included the fact that the efficiency of solar panels varies with changing weather conditions and seasons, and the advantages and disadvantages of collective and individual use. The former would be more economical but would require a code of conduct to ensure that the power is used equitably; while the latter would involve installing panels for each of the 400 or so shops in Urdu Bazaar.

Table 7 illustrates the capital investment recovery period for Package 1.

Table 6:
Comparative cost of various modes of power used in Urdu Bazaar (in PKR)

TYPE OF COST	GENERATOR[15]		UPS		KESC		SOLAR ENERGY	
	Annual	5 yearly	Annual	5 yearly	Annual	5 yearly	Annual	5 yearly
Capital cost	7500	37,500 (average price)	4000	20,000 (average price)	4000	20,000 (meter cost)	19,600	98,000
Running costs	70,560[16]	352,800	12,240[17]	61,200	21,600[18]	172,800	6000	30,000
Total expenses	80,560	362,800	27,240	76,200	21,600	172,800	25,600	128,000

Table 7:
Capital investment recovery period for Package 1 (in PKR)

Average cost of KESC billing	1,800
Average cost of solar maintenance with storage	500
Monthly savings	1,300
Capital cost	98,000
Capital investment recovery period versus KESC billing	6 years

15 Health costs caused by the noise and pollution from generators cannot be calculated accurately.
16 Monthly outgoings of PKR 5880 (based on conversations with shopkeepers in Urdu Bazaar).
17 Lead acid batteries need to be replaced after one year. They cost PKR 12,000, plus PKR 240 per month for battery water.
18 According to respondents, KESC charges PKR 1800 per month for electricity.

4
Meeting between The Selected Solar Company and the Urdu Bazaar Welfare Association

Having met the energy suppliers listed in Table 2, the authors decided to continue the negotiations with WellBeingGreen as its representatives seemed to be most cooperative and willing to take the project further, and offered the most cost-effective options.[19] Representatives from WellBeingGreen were introduced to the Urdu Bazaar Welfare Association, and then discussed the options with its leaders independently of the study authors and visited the site to assess its suitability.

On 21 January 2011 WellBeingGreen joined the leaders of the Urdu Bazaar Welfare Association, a number of shopkeepers and the authors at a well-attended meeting at the Welfare Association office. The authors presented their study findings and circulated copies of the study (see PowerPoint® presentation of the study in Appendix 4), and the representatives from WellBeingGreen also made a presentation.

The shopkeepers were overwhelmingly (90 per cent) in favour of adopting the solar option as it was affordable and would make them less dependent on the inefficient grid supply from KESC. Some were even interested in a more substantial package than the one on offer. However, they did have a number of concerns and questions. They were afraid that their investment would be compromised if the government imposed a tax on solar power, and that KESC might disconnect them from the grid in retaliation for losing revenue when they switched to solar energy, as it had been known to resort to bullying and other tactics to make people pay their electricity bills. Some were worried that KESC would refuse to believe that the energy savers and fans were powered by solar energy, and pressure them to pay their bills in full.

Security was another concern. Because the solar panels would be placed on roofs there was some anxiety about them being stolen by thieves or drug addicts; and people were worried that the solar company might close down, leaving them with worthless warranties. There was also much discussion about the advantages and disadvantages of individual and collective solar panels.

The representatives from WellBeingGreen showed participants individual solar lanterns and fans that operate on a DC current. Solar lanterns cost about PKR 5000 (USD 58) with a solar panel, and a solar fan costs PKR 16,000 (USD 186). One fan and two savers would cost PKR 26,000 (USD 303), compared with PKR 98,000 (USD 1,140) for the proposed AC system.

The company representatives explained that they face various constraints in promoting their products, as there is a 50 per cent duty on cadmium batteries and a 30 per cent tax on solar panels, which increases the cost of the final product by 30 per cent. They argued that

19 A table showing the cost of the packages offered by each company can be found in Appendix 2.

the glass manufacturing industry in Pakistan is capable of producing the tempered glass sheets that cover the PV cells, and that the government should offer incentives to produce them as this would help further reduce costs. WellBeingGreen believes that solar energy can only be promoted through government incentives and subsidies, or by reducing all taxes on solar energy components.

The following actions were taken as a result of these discussions:

1. Arif Hasan (one of the authors of this report) wrote to the Secretary of the Power Department in the Government of Sindh, explaining the concerns that the shopkeepers had expressed about governance and the points that WellBeingGreen had raised with regard to duties on solar technology. In the letter he introduced the leader of the Welfare Association and WellBeingGreen so that they could pursue these matters with the Secretary independently of the research project. A copy of his letter can be found in Appendix 5.
2. The leaders of the Welfare Association shared the authors' presentation with other association members. They agreed to keep in touch with WellBeingGreen, and if necessary, with the authors.
3. WellBeingGreen was introduced to the Orangi Charitable Trust (OCT), which runs the Orangi Pilot Project (OPP-OCT) and has a major presence in rural areas of Pakistan.[20] It was felt that the project would provide a good opportunity to show the solar lanterns and fans to partner organisations in rural areas and small towns.

20 The Orangi Pilot Project was implemented in the 1980s in the squatter areas of Orangi Town, a low-income settlement of over 1 million people in Karachi. It aimed to help local residents solve their own sanitation problems, using innovative methods to provide adequate low-cost sanitation, health, housing and micro-finance facilities. The Orangi Charitable Trust was established in 1989 as an independent and autonomous institution whose main objective is to support local economic development efforts by providing credit in urban and rural areas.

5
Follow-up activities

The authors met key stakeholders again in late 2011 and 2012 to explore the longer-term outcomes of the research process and activities.

WellBeingGreen met OPP-OCT several times after the initial research was completed, to explain the technology and discuss the costs and advantages of solar options for project partners, especially in rural areas. The directors of OPP-OCT showed considerable interest in their products, had various follow-up meetings and introduced WellBeingGreen to their partners, but this did not lead to any orders. WellBeingGreen has since had to downscale its operations and abandon the promotion of solar products due to a financial crisis within the company.

The President of the Urdu Bazaar Welfare Association, Nasim Ahmed, reported that the shopkeepers of Urdu Bazaar were extremely interested in the solar option as it was affordable and would make them less dependent on the inefficient grid supply from KESC. In the end, however, they decided not to switch to solar power for the following reasons:

i) The solar option would be very expensive because they would need to buy inverters in order to use their existing equipment and appliances with the AC option. The DC option would be more affordable, but would mean replacing their existing equipment and fixtures, which they are reluctant to do.

ii) Urdu Bazaar is in a high-density area in the old city. Solar panels would have to be placed on rooftops three to five storeys high, and shopkeepers were concerned about their security given the current levels of unrest in Karachi.

iii) There has been a marked improvement in the electrical power supply from the national grid, which is a major disincentive to investment in solar options.

Nevertheless, Nasim Ahmed believes that some shopkeepers would be willing to use solar energy if insurance companies offered them packages that helped minimise the risk to their investment in solar panels.

A number of companies contacted Arif Hasan and Mansoor Raza after the Karachi Tribune Express published an article on this study in February 2011. One of them, Smart and Renewal Energy (SRE) Solutions Private Limited, set up a demonstration unit at Arif Hasan's office. This generated considerable interest among visitors to the office, and prompted several NGOs to switch to a partial solar option in their homes and workplaces. It also led to solar energy being used for street lights and some of the energy requirements in a tourist complex being designed by Hasan & Polak in Nagarparkar in the southeastern desert of Pakistan.

Arif Hasan and Mansoor Raza introduced SRE to OPP-OCT, which runs an extensive micro-credit programme involving small NGOs and community groups in rural areas of Sindh and Punjab. SRE set up demonstration units that power two lights and one fan at the OPP-OCT coordination office in Hyderabad. Although the initial response was very poor, research and discussions with the study team enabled SRE to reduce its costs considerably and offer small 5W packages for individual households in rural areas served by partner NGOs.

OPP-OCT recently purchased 50 units of solar panels and accessories from SRE Solutions, and installed ten of them as demonstration units at different locations in Sindh. Each unit supports two bulbs and one mobile charger, and costs PKR 7000 (USD 71.33). The Director of OPP-OCT reported that requests started pouring in as soon as they were installed. OPP-OCT has since met with Fakhar Khalifa of SRE Solutions to devise a future strategy, and the plan is to rent a warehouse in Hyderabad city to store the units. Hyderabad's central location within Sindh will be better for distribution purposes; Karachi is not so centrally located. OPP-OCT also plans to offer a larger unit consisting of a fan, two bulbs and a mobile charger, for more affluent groups.

SRE was introduced to another OCT partner, the Soan Valley Development Project, which operates more than 1500 kilometres from Karachi in the north of Punjab province. The project purchased 25 units, and individual households in its intervention zone have since bought a further 125 units. Demand is increasing, and SRE is also negotiating with micro-credit banks over the provision of loans for solar units.

One final significant development worth noting (although the researchers can take no credit for it) is the Pakistani government's decision to substantially reduce duties on solar energy products in the 2012–2013 budget.

6
Conclusion

The energy crisis in Pakistan is starting to take a serious toll on the country's economy and its people's daily lives. As increasing power outages in Karachi cause considerable financial losses to industry and commerce, people are looking for reliable and affordable alternative sources of energy.

Although solar power could provide a solution to the energy problems in Urdu Bazaar, this study shows that there are technological, financial and social obstacles to the adoption of such technologies. It also reveals the challenges that companies face in promoting solar products, and the importance of adequate government support and incentives.

The study also provides a valuable insight into how individual researchers and activists can convene and engage with key market actors to facilitate market development. The results may be unpredictable, but success can be achieved by persistence and by being open to opportunities as they arise. The media can also provide a timely boost to awareness-raising efforts.

This was apparently the first study on attitudes to alternative sources of power and factors affecting the adoption of solar energy systems in Karachi's commercial markets. It is to be hoped that the findings presented in this paper will help both consumers and suppliers address the problems faced by all those along the energy supply chain in Karachi. Local studies such as this, highlighting opportunities and constraints, are important as a way of sharing knowledge on whether such alternatives are really feasible. It is to be hoped that this study can contribute to increasing innovation and piloting of new approaches, and help to scale up from individual pilot projects to develop resilient markets for solar power and other alternative renewable and decentralised energy sources.

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Appendix 1: Survey questionnaire

Questionnaire for research on use of solar power as an alternative source of energy

Total questionnaires: 100

Number of this questionnaire:

Place where the interview is conducted:

Date:

1. Name of the respondent and the shop:

2. Male/Female/Transgender:

3. Age of the respondent:

4. Type of Business?

5. For how many years are you doing business here?

6. What are your usual business hours (from am to pm)?

7. On an average how many hours you are without national power supply?

8. Do you have generator?

Yes No

9. If Not why not? (Please provide reasons)

A. _____

B. _____

C. _____

11. If Yes, when you purchased the generator? (Year)

10. If Yes, then in how much you paid for it? (At the time of purchase)

11. What is your per month expense on the running of the generator?

12. What disadvantages of the generator do you see for your business?

A. _____

B. _____

C. _____

13. What disadvantages of the generator do you see for yourself?

A. _____

B. _____

C. _____

14. What are your bare minimum requirements for the shop? (In terms of bulbs and fans)

15. If you would get the option of getting the same, from solar energy, would you prefer solar option?

Yes No

16. If yes why and if not why not (Please narrate the reasons):

A. _____

B. _____

C. _____

17. How much money would you like to spend on the solar option (in Rs)?

18. What do you think, that how many businesspersons in this area will agree to the proposal?

Appendix 2: Cost comparisons

Estimated costs provided by different companies (based on 100 shops)

NO.	COMPANY NAME & DESCRIPTION	REQUIREMENT	WATTS	COST IN PAKISTANI RUPEES	AC OR DC
1.	National Engineering Corporation **For DC** 1-day option Quotation for 6 hours operation, solar power system with **180w/100Ah-12V**	1 fan, 2 energy savers, 1 phone charger **(124w)**	180	53,250	DC
	2-day option Quotation for 6 hours operation, solar power system and 6 hours back-up for next day **180w/180Ah-12V**	1 fan, 2 energy savers, 1 phone charger **(124w)**	180	60,250	DC
	4-day option Quotation for 6 hours operation, solar power system and 18 hours back-up for next day **180w/360Ah-12V**	1 fan, 2 energy savers, 1 phone charger **(124w)**	180	80,250	DC
	For AC 1-day option Quotation for 6 hours operation, solar power system with **180w/100Ah-12V**	1 fan, 2 energy savers, 1 phone charger **(124w)**	180	54,850	AC
	2-day option Quotation for 6 hours operation, solar power system and 6 hours back-up for next day **180w/180Ah-12V**	1 fan, 2 energy savers, 1 phone charger **(124w)**	180	61,850	AC
	4-day option Quotation for 6 hours operation solar power system and 18 hours back-up for next day **180w/360Ah-12V** One year warranty	1 fan, 2 energy savers, 1 phone charger **(124w)**	180	81,850	AC

NO.	COMPANY NAME & DESCRIPTION	REQUIREMENT	WATTS	COST IN PAKISTANI RUPEES	AC OR DC
2.	**Hi-Tech Alternative Energy System** Solar power supply system with 6 hours back-up operating solution: PKR 80,000 per shop for 100 shops, comprising: Operating solar panels, volt & current indication meter Batteries: deep cycle maintenance-free battery bank Charge control circuit Solar energy inverter 220 Volt AC Battery rack with inverter housing Maximum length of wiring from point of community-based solar power supply system to each shop should not exceed 30 feet. Any additional wiring will be charged at the going rate Wiring and installation within premises of 100 feet **Warranty:** **Battery 5 years, electronic system 2 years, solar panels 25 years**	1 fan, 2 energy savers, 1 phone charger (200 w)	200	80,000	AC

NO.	COMPANY NAME & DESCRIPTION	REQUIREMENT	WATTS	COST IN PAKISTANI RUPEES	AC OR DC
3.	**Fusions Group** Daytime system AC solution: 8 hours operation 60x3=180W panels, cost includes inverter and wiring Day and night-time system AC solution: 18 hours operation 60x6=360W panels, cost includes inverter, battery and wiring Day and night-time system DC solution; 18 hours operation 60x4=240W panels, cost includes battery and wiring	1 fan, 2 energy savers, (148w) 1 fan, 2 energy savers 1 fan, 2 energy savers	180 360 240	60,900 112,300 76,500	AC AC DC
4.	Solar Line Adaptive Technologies (PVT) LTD. AC solar power system ALT-150-AC 4-5 hours DC solar power system ALT-65-DC 6 hours for energy saver and 4 hours for fan	1 energy saving lamp (12W each), 1 ceiling fan (60W) and 1 TV (40W) 14 inch 2 energy saving lamps (12W each), 1 ceiling fan (30W)	150 65	97,500 40,000	AC DC

NO.	COMPANY NAME & DESCRIPTION	REQUIREMENT	WATTS	COST IN PAKISTANI RUPEES	AC OR DC
5.	TRDP TIED Imported from China. Charge controller will suffice if electricity is only required for daytime Battery will give 6-8 hours back-up at night-time 2½ years warranty for charge controller and battery, 20 years warranty for solar panels	1 fan, 2 energy savers		8000 12,000	AC
6.	**The Terminators** Cost does not include inverter, battery, charge controller and wiring Locally developed panels Minimum order of 250 units required to achieve this cost	2 energy savers 1 telephone outlet 1 fan	120	17,000	
7.	**WellBeingGreen** Cost of installation is not included 10 hours back-up per day Minimum order of 50 units required to achieve this cost Warranty varies for different parts of the package	2 energy savers 1 telephone outlet 1 fan	150	98,000	AC

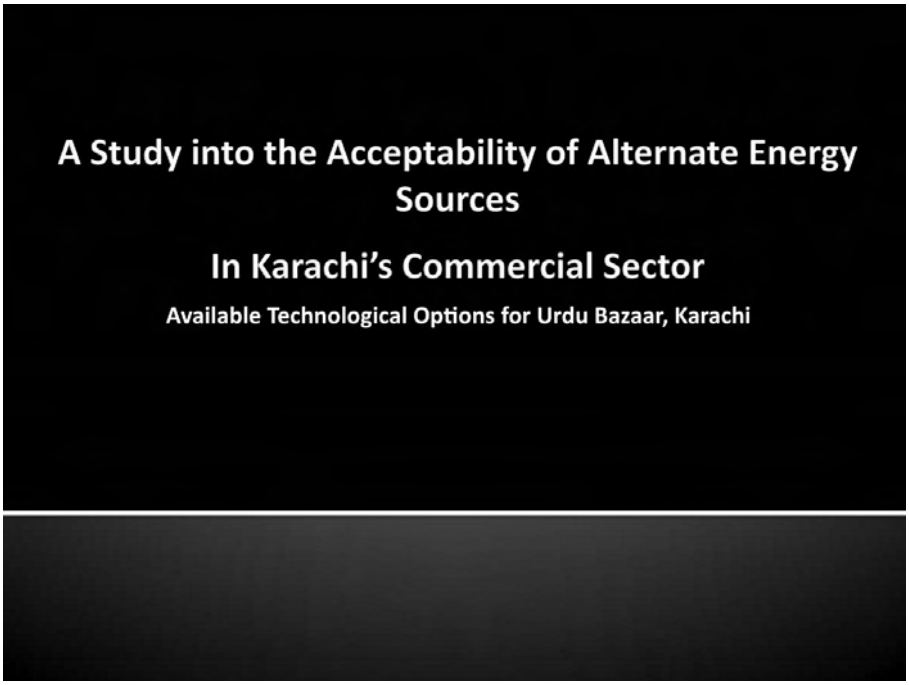
Appendix 3: Newspaper clippings

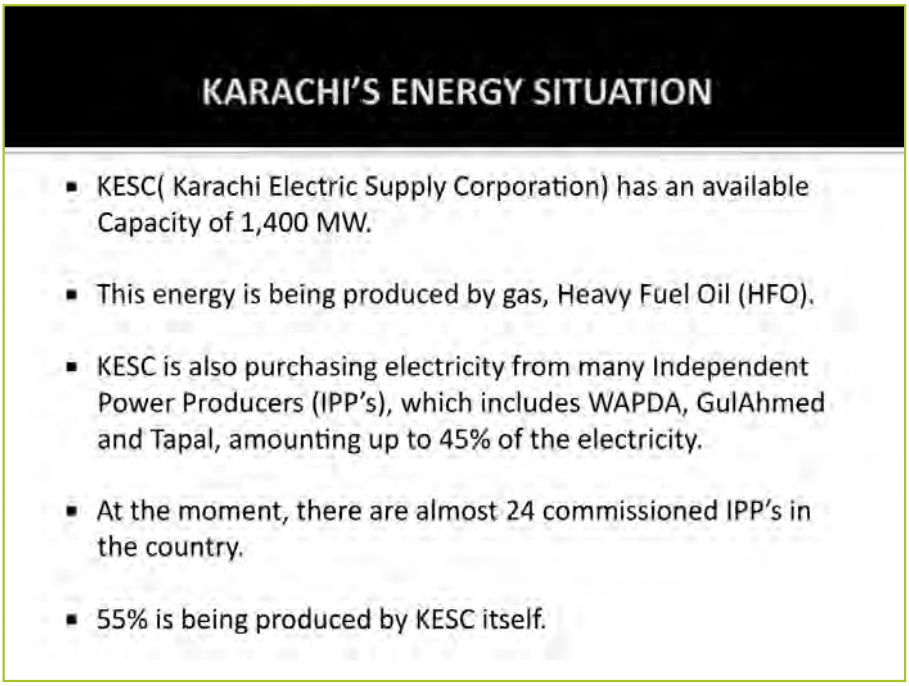
No let-up in Karachi load-shedding

With the mercury touching 37°C on Wednesday, citizens of Karachi suffered through yet another day of multiple power outages, which collectively lasted for six hours as the Karachi electric power supply company faced a shortfall of about 600MW in meeting the demand for 2,300MW (*The Dawn,* May 14, 2010).

As mercury shot up to 40°C with 46% humidity on Friday, the KESC unofficially increased power load shedding beyond 10 hours in 24 hours despite receiving an additional oil supply (*The Dawn,* May 15, 2010).

Appendix 4: PowerPoint® presentation of the study





ENERGY SITUATION'S REPERCUSSIONS

- The old systems and machines are unable to keep up with the demands of the city.
- 40% of the electricity produced is being lost due to large scale theft and obsolete distribution lines.
- In protests against electricity storages there are riots, burning tyres on the roads, throwing stones, and in even torching the KESC offices.
- These riots continue for many hours until the electricity has been restored.

ENERGY SITUATION'S REPERCUSSIONS

Protests against "load shedding" and KESC are becoming part of the city's routine

mqm.org/English-News/News-Archive/news-2009-archive.htm
thecurrentaffairs.com

ORIGINS OF THE PRESENT RESEARCH/PROJECT

- The project was taken up to understand the problems of a specific inner city commercial market with regards to the energy crisis.
- The advancement in technology allows us to seek alternative power sources.
- An understanding of the mindset of the prospective users towards these alternatives is necessary before they can become feasible solutions.

PRESENT SITUATION

- At the moment, an average of 2.5 hours of scheduled load shedding is being carried out for Urdu *Bazaar*. Unscheduled load shedding is in addition to this.
- To make up for the shortfall shopkeepers have installed petrol or diesel operated generators for electricity.
- Customers avoid entering a shop because of the noise of a generator when there is load shedding. This affects the business of many shopkeepers.
- Shops that are situated deep inside the *bazaar* are avoided by customers because of suffocation in the absence of fans and the presence of fumes from the generator.
- These conditions have resulted in serious health deterioration.

REASONS FOR SELECTION OF URDU BAZAAR

- It is a typical commercial market of Karachi, suffering from frequent electricity outages.
- Narrow shops with high-density, bringing to the fore the practical issues of space for solar installations, if agreed upon as an alternative by the shopkeepers.
- Personal contacts in the *bazaar* – which have made the research process easier – was also a reason.
- It is not an affluent *bazaar* like many other retail and wholesale *bazaars* in Karachi and thus provided the researchers with conditions that can be compared with the majority of other markets.

URDU BAZAAR: A GENERAL PROFILE

- Urdu *Bazaar* is a market of old and new books with shopkeepers involved in both wholesale and retail businesses.
- A minor percentage of shopkeepers own publishing, stationery and auto parts business.
- The area comprises of both commercial and residential blocks, some of which are more than two floors in height. The area most suitable for installing solar panels is the roof.
- Despite this ideal location, most shops are located below residential floors thereby hindering electricity transmission from the roof of the floors above to the ground floor.
- Theft of electricity from transmission from the roof to the ground floors is also seen as a problem.

URDU BAZAAR: LOCATION

URDU BAZAAR: LOCATION

A major issue is that while some shops have the roof space for the installations of solar panels, others will simply have to use the roof of the floors above.

CURRENT ALTERNATIVE PRACTICES: UPS (UNINTERUPTED POWER SUPPLY)

- The UPS system requires a certain amount of charging time, which is not possible during hours of constant load shedding.

Cost Typology	UPS	
	Per Year (Rs.)	*Per 5 Year *(Rs.)*
Capital Cost	4,000	20,000
Running Cost	12,240	61,200
Total Expenses	16,240(USD 189)	81,200 (USD 944)

- There is also perpetual emission of acidic fumes from lead acid batteries. In addition, the batteries are expensive to maintain.
- Maximum life of battery with such frequent charge-discharge cycles is one year and the cost of the battery ranges from Rs. 10,000 to Rs. 12,000 (USD 116 – 140)

Life of UPS is about 5 years

CURRENT ALTERNATIVE PRACTICES: GENERATORS

- The use of Generators has meant for many shop keepers high maintenance costs as well as the finding space for storing it in an already congested shop.

Cost Typology	Generator	
	Per Year (Rs.)	*Per 5 Year *(Rs.)*
Capital Cost	7,500	37,500
Running Cost	70,560	3,52,800
Total Expenses	70,860(USD 908)	390,300 (USD 4,538)

- The use of Generators also affects the quality of personal telephone communication.
- The fumes from the Generators has also resulted in causing health issues like sinus, asthma, and frequent headaches.

Life of a generator is about 5 years

RESEARCH METHODOLOGY

- The methodology of the research consisted of :-
- On-site observations made during the entire research period.
- Talks/informal interviews conducted with shopkeepers of Urdu *Bazaar*,
- Survey questionnaire served to 100 shopkeepers of Urdu *Bazaar* (conducted between 29 July – August 11, 2010)
- Interviews and discussions with suppliers and professional experts of the solar-energy discipline.

ON-SITE OBSERVATIONS MADE DURING THE ENTIRE RESEARCH PERIOD.

- Shopkeepers are irritated by the fact that they are billed on "average tariff" rule by Karachi Electric Supply Corporation (KESC), that from their accounts, is higher than the national power per unit rate.
- At times KESC resorts to average billing rather than monthly billing. In average billing it takes the average usage of last couple of months, instead of actual consumption of the preceding month.

FINDINGS AND CONCLUSIONS FROM THE INTERVIEWS CONDUCTED WITH SHOPKEEPERS OF URDU BAZAAR

Some of the points that were raised during this phase are: -

- If we opt for the solar alternative, what will happen to the already-in-use alternatives' such as UPS's and generators?
- If the solar panels will be installed for collective usage, some shopkeeper's may consume more electricity than other partners. How will this problem be solved?
- Will KESC agree to continue supplying electricity to shops that opt for the solar alternative?

FINDINGS AND CONCLUSIONS FROM THE SURVEY QUESTIONNAIRE CONDUCTED WITH SHOPKEEPERS OF URDU *BAZAAR* - 1

- 100 %of the all of the respondents are male. Age of respondents were categorized into three age brackets; 14% of the shop respondents fall between 15-24 years of age, 64% between 25-50 years and 21% are above 50 years of age
- 80 %are either in wholesale or retail. Of these 80 percent, 38 % are wholesale business, 21 %are retailers and another 21 %are the combination of the two. Remaining 20 % are publishers, stationers, and/or auto-part dealers.
- 67 %have established business in the last 25 years. The antiquity of the market is established by the fact that that some of the people are in business since independence.

FINDINGS AND CONCLUSIONS FROM THE SURVEY QUESTIONNAIRE CONDUCTED WITH SHOPKEEPERS OF URDU *BAZAAR* - 2

These survey findings are based on the 100 shopkeepers that were interviewed during the course of this research.

Average Yearly Expenditure		
For Electricity	**For Generators**	**For UPS**
Rs. 21, 600	Rs. 70, 560	Rs. 12,240

FINDINGS AND CONCLUSIONS FROM THE SURVEY QUESTIONNAIRE CONDUCTED WITH SHOPKEEPERS OF URDU *BAZAAR* - 3

These survey findings are based on the 100 shopkeepers that were interviewed during the course of this research.

	Reasons for not opting for Generators						
No. of people who don't have Generators	**Storage Problems**	**It is Expensive**	**Creates Pollution/ Smoke**	**Causes noise**	**Maintenance problems**	**Already Ventilated***	**None**
65% of the people interviewed	12%	22%	5%	14%	7%	3%	16%

* Shops getting the sea breeze do not need fans.

FINDINGS AND CONCLUSIONS FROM THE SURVEY QUESTIONNAIRE CONDUCTED WITH SHOPKEEPERS OF URDU *BAZAAR* -4

These survey findings are based on the 100 shopkeepers that were interviewed during the course of this research.

Disadvantages of Generators as stated by their owners

Loss of Customers*	Expensive	Storage	Pollution /Smoke	Noise	High Maintenance	Limited Appliances Operated	None
4%	6%	5%	16%	17%	2%	4%	7%

* Do not like entering noisy and polluted shops.

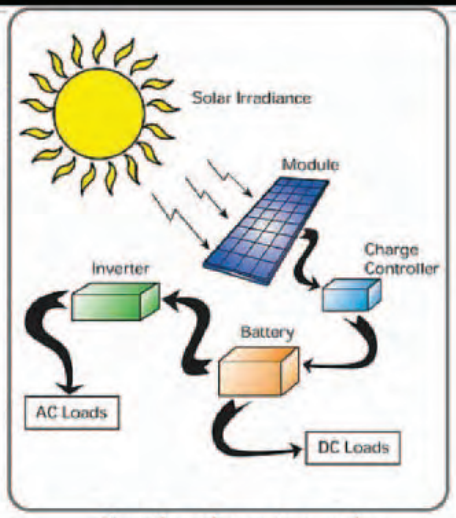
FINDINGS AND CONCLUSIONS FROM THE SURVEY QUESTIONNAIRE CONDUCTED WITH SHOPKEEPERS OF URDU *BAZAAR* - 5

These survey findings are based on the 100 shopkeepers that were interviewed during the course of this research.

Preference for Solar Panels

No. of shops who would opt for Solar Energy	Economical	Environment Friendly	Durable	No Load shedding	Beneficial
90%	53%	5%	14%	16%	2%

WORKING OF THE SOLAR SYSTEM



How the solar system works.

FINDINGS FROM SOLAR COMPANIES/EXPERTS - 1

A Brief Comparison of Solar Supply with/Out Auxiliaries

	Storage/Battery		Inverter	
	With	**Without**	**With**	**Without**
Advantages	•Power back up available in cloudy, rainy seasons and after sunset. •Total Independence from KESC	•No per year expense of battery. •No fire hazard •No space issues •No movable parts	•Provides Alternating Current. •Can use the existing fan, bulbs and telephone charger point.	•Obliged to use Direct Current. •Above 24 volts of supply hazard of serious electric shock •No movable parts.
Disadvantages	•Hazard of acid fumes (in case of lead batteries) •Increased maintenance •Long pay back period as it will increase the capital cost.	•No back ups in decreased efficiency periods. •Fluctuations in supply according to the availability of sun rays.	•Additional space required near solar panels. •As solar panels are installed in open spaces, therefore security measures need to be taken for the safety of invertors. •Maintenance required	•DC transmission beyond 24V is a hazard.

FINDINGS FROM SOLAR COMPANIES/EXPERTS - 2

- **Alternating Current** is defined as the current in which the movement of electric charge periodically reverses direction.
- **Direct Current** is defined as the current in which the movement of electric charge is only in one direction.
- **Inverter** is an electrical device that converts direct current (DC) to alternating current AC).
- **Charge Controllers** limit the rate at which electric current is added to or drawn from electric batteries, thus preventing against overcharging and overvoltage.

Source: wikipedia.com

NEEDS AS IDENTIFIED BY THE SHOPKEEPERS

The following needs were identified by the shopkeepers as minimum requirements for their shops

- 4 energy savers, 2 fans and 1 telephone charging point
- 2 energy savers, 1 fan and 1 telephone charging point
- 2 energy savers, 2 fans and 1 telephone charging point
- 2 energy savers and 1 telephone charging point

COST FOR THE PACKAGES

No	Options	Package 1	Package 2	Package 3	Package 4
1	Appliances 1 2 3	One fan Two savers One telephone point	Two Fans Two Savers One telephone point	Two Fans Four Savers One telephone point	No Fan Two Bulbs One telephone Point
2	Total Load	150 watts	210 watts	250	50
3	No of panels required	1	3	4	1
4	Space required	Not Known	71/2'x9'	10'x12'	2 1/2 'x 3'
5	Panel cost	50,000	70,140	83,400	16,750
6	Charge controller	3,500	4,000	4,000	4,000
7	Mechanical Structure	Not known	10,000	10,000	5,000
A	Total Cost without storage and without invertors (Direct Current)	53,500	84,140	97,500	25,700
8	Invertors of AC Current	8,000	15,000	15,000	15,000
B	Total Cost without storage and with invertors (Alternating Current)	61,500	99,140	112,500	40,700
9	Storage with lead acid batteries	36,500 (dry cell batteries)	36,500	36,500	20,000
C	Total Cost with storage and with invertors (Alternating Current)	98,000	135,640	149,000	60,700

** In case of Direct Current as output, cost of DC fans and bulbs will be added to above.*

NOTES

- One fan is 8- watts, one Energy Saver is 20 watts, and one telephone charger is 10 watts.
- A panel of 150 watts costs Rs. 50,000 per panel.
- All costs are in Pak Rs.

COST ANALYSIS OF DIFFERENT ENERGY SOURCES AND POSSIBILITIES

	KESC	UPS (Average)	Generator (Average)	Solar (with Storage- Average)	Solar (without Storage- Average)
Running Cost	1,800	1,000	5,882	500	No cost
Capital Cost	-	20,000	37,500	98,000	61,500
Replacement in years	-	5	7.5	20	20
Capital Cost/ year	-	4,000	5,000	4,900	3,075
Advantages/ Disadvantages	No replacement Cost KESC Maintenance Load shedding Perpetually increasing power tariff	Automatic backup system Short lived battery. Pollution Unsafe for appliances	Constant supply. High running cost. Noise and Air Pollution. Storage space issues	No noise and air pollution Constant Supply High Initial Cost Storage. Theft. Battery Replacement 5 years	No running cost No energy during non-sunlight hours.

RECOVERY PERIOD FOR CAPTAL INVESTMENT FOR PACKAGE 1 OF SOLAR OPTION

	(Rs.)
Average billing of KESC per month	1,800
Average Cost of maintenance of Solar package 1 (with storage) per month	500
Savings per month	1,300
Capital Cost of Package 1	98,000
Recovery of package cost	6 years
Life of solar panels/systems	20 years

CONCERNS/APPREHENSIONS OF SHOPKEEPERS

- If the solar panels are installed for collective usage, some shop keepers may consume more electricity than others.
- What happens to supply in cloudy weather and after dusk to electricity supply?
- Can the KESC be taken into confidence, and cater to the after-dusk demand of electricity of the market only, like that no storage for the solar option would be required?
- Can the companies first install a model for demonstration for a month at-least.

CONCERNS OF TECHNICAL EXPERTS

- Solar energy options work best for low density areas.
- Urdu *Bazaar* is a high density area. Shadows from surrounding buildings might adversely affect the functioning of the solar energy system.
- The environment of different areas relates differently to weather conditions. Therefore the study of weather related issues for Urdu *bazaar* is necessary.
- There will be power losses through transmission from the roof of high buildings to ground floors.

Appendix 5: Letter to Secretary of the Power Department

25 January 2011

Ms. Rabia Javery Aga
Secretary
Power Department
Government of Sindh
Barrack No. 91, Sindh Secretariat
Karachi

Subject: **Solar Energy Options for Urdu Bazaar Karachi**

Dear Madam

Further to my discussion with you on the subject, I am attaching a study on the acceptability of alternative energy sources for Urdu Bazaar Karachi. The executive summary of the report identifies the concerns and problems of both the Urdu Bazaar shopkeepers and of the solar company (Wellbeinggreen Company) regarding adopting the solar energy option.

The shopkeepers concerns are:

The KESC might disconnect them from the grid if they opt for the solar option.

The KESC might bully them by disagreeing that part of their appliances are operating on solar energy.

Their solar panels would be unsafe on easily accessible roof tops.

They would like to have assurances from the relevant government departments that they will not be subjected to retaliation by the KESC and also that the government would help in protecting their solar installations. In this connection, the Urdu Bazaar Welfare Association leader Nasim Ahmad Sahib will be getting in touch with you. I hope you will be able to meet with him and offer the safeguards his organisation is seeking.

The Wellbeinggreen Company's concerns are:

1. There is a 30 per cent duty on solar panels and a 50 per cent duty on cadmium batteries. If this is waived then the cost of solar energy products can be reduced by 30 per cent. This will make the products far more affordable to the public.
2. Given the advanced state of glass manufacturing in Pakistan, tempered glass sheets which cover Photo Voltaic cells can be manufactured in the country. This will further reduce costs. The government needs to offer incentives for producing them.

In this connection, representatives of the Company will be getting in touch with you.

With kind regards,

Yours sincerely

Arif Hasan

Copy to:

1. Mr. Nasim Ahmad, President, Urdu Bazaar Welfare Association, Urdu Bazaar, Karachi
2. Mr. Saim Aziz, Marketing Coordinator, Wellbeinggreen, Karachi

This study explores attitudes to alternative energy sources in Urdu Bazaar, a typical commercial market in the centre of Karachi.

Pakistan's frequent power outages are starting to take a serious toll both on the country's economy and its people's daily lives. Urdu Bazaar's shopkeepers, like many others in industry and commerce, are forced to use generators or uninterruptible power supply units, which are noisy, polluting and expensive, to shore up the daily gaps in provision from Karachi Electricity Supply Company (KESC). They would welcome reliable and affordable alternative sources of energy; and while solar power could provide a solution to the energy problems in the market, this paper shows that there are technological, financial and social obstacles to the adoption of such technologies. It also reveals the challenges that companies face in promoting solar products, and the importance of adequate government support and incentives.

Although the shopkeepers in Urdu Bazaar were keen on the solar option proposed in this study because it would make them less reliant on inefficient power supplies from KESC, they decided not to adopt it. Through questionnaires, interviews and group discussion, this study explores the obstacles encountered to the adoption of solar power in Urdu Bazaar. It also provides a valuable insight into how individual researchers and activists can convene and engage with key market actors to facilitate market development, as the follow-up to this research triggered unexpected opportunities to promote solar energy solutions elsewhere in Pakistan.

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The International Institute for Environment and Development is an independent policy research organisation. IIED works with partners in middle- and low-income countries to tackle key global issues – climate change, urbanisation, the pressures on natural resources and the forces shaping markets. IIED's work on energy aims to address poverty and energy security issues by supporting access to sustainable, affordable energy services for the poorest, as well as promoting responsible practice in larger-scale energy sector development, including biofuels, oil and gas, and stimulating debate around energy policy reform.

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