Solar for Social Housing:
Elaborated using Pakistan's Case

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Housing development has a direct linkage to a number of Construction Material Industries (CMIs). In Asian countries that number is around 40-45; while Europe and America have been stated to have more than 70 CMIs. At the same time, development of housing and real-estate needs the support of utilities (water, electricity), as well residential infrastructure like sewerage, roads and public transport in addition to health and education facilities.

Since land availability and price are the critical and determining factor for "affordability", most of the low-income housing schemes in under developed and developing world emerge in the suburbs and the outskirts of the city. In the developed world, the poor live in the downtowns/slums, while the wealthy prefer to live in the suburbs. While in underdeveloped and developing world, the rich prefer dwelling close to center of the city in downtown areas while the poor find shelter in the suburbs.

Experience has shown that for a habitat to be accepted as livable by the poor and needy, electricity and water are the main deciding factors. Although access to water can be gained by digging local wells, there still needs to be some form of affordable and reliable source for lighting and energy. Since provision of electricity through national Grid (transmission lines), is capital intensive, it results in years of waiting for budgetary allocation. The more fundamental issue is the availability of surplus electricity which could be fed to the system for this un-served population. Most of the under developed and developing world is facing an acute shortage of electricity even to feed those who have access to the national Grid. Since a major portion of electricity production in these countries is "Thermal", rising fuel prices and rapidly depleting fossil fuel reserves (non-renewable resources), make it neither viable nor sustainable for the low income individual or even for the country's economy at large.

The following paragraphs aim to further elaborate on this state, through the situation and experiences in Pakistan, even though such scenarios are similar in other developing and under developed countries.

Social aspects

Like many developing countries in this world, Pakistan faces an acute shortage of electricity. The power generation capacity is largely Thermal and Hydro, with the following break:

Thermal (Public)	25%

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Thermal (Private)	40%
Hydro (Public)	33%
Nuclear	2%
Alternate Energy	Insignificant

The generation capacity is approximately 15,941 MW, out of which 14,263 MW is available in the summer and nearly 11,013 MW during the winter months, primarily due to a shortfall in the water level of the dams.

The demand estimate for the year 2007-08 was 17,398, while the actual supply was only around 12,442 MW. This means that the country is currently facing a shortage of around 4,550 MW, which is resulting in frequent power "shutdowns" for both residential and industrial consumers. With a growth rate of 10-11% p.a. in the recent past the electricity demand is projected to grow to 28,630 MW by year 2014-15 which will further widen the demand/supply gap. Unless new generation capacity is installed on war footing basis with a visible shift to Alternate Energy sources including Solar and Wind, the situation will severely affect socio-economic conditions.

The power consumption as per consumer category is:

Domestic	49%
Industrial	25%
Agriculture	14%
Commercial	7%
Otters	5%

More than two-third of the country's population lives in rural areas. Under the village electrification program, 132,569 villages have been provided with electricity (the number was 609 by year 1958). Although these villages have been provided with electricity transmission lines (connected to National Grid), due to frequent power shortages, they also become the first victim of power "shutdowns". Thus the "served" population becomes "underserved" instead. Another sizeable population living in remote/mountain areas remains largely "un-served" as well because the provision of electricity to these remote areas through the National Grid has its own budgetary constraints for the Governments. Thus, many such areas currently being served by the Grid are not economically viable due to a scattered population.

Economic aspects:

Rising fuel prices are making thermal electricity increasingly expensive and thus unaffordable for the general public. The difficult economic situation currently being faced by most countries is resulting in Governments withdrawing all "subsidies" previously on electricity tariffs available for residential users. The oil price hike during 2007-08 had demonstrated that the economies of countries with massive oil import bill are extremely sensitive to the fuel oil import bill. For Pakistan the Oil import bill constitutes nearly 25-33% of total import bill, and 40-50% of country's Export Bill. During the hike, the Forex reserves were getting wiped out, the Currencies were getting

depreciated and production costs were rising as well. During power shortages, power supply management and "shut downs" are essential. For political expediency the power cuts were made to affect primarily the industrial wheel. The production loss would result in further economic loss and unemployment.

Renewable and Non-Renewable Energy:

Non-Renewable energy resources include Fossil fuels like Oil, Coal, and Natural Gas. However its sources are fast depleting and can not be recouped. However, due to an increasing demand their prices are volatile and will inevitably rise. In addition, the use of Fossil fuels has environmental considerations which lead to the economic cost of "Carbon Credits'. The Government of Pakistan is considering a levy of Carbon Tax – similar to many other countries - to discourage use of Fossil Fuels.

Renewable energy sources include Solar, Wind, Bio-Mass, Hydropower, and Geo-thermal. The use of Nuclear has its own environmental and safety concerns; therefore a gradual switch to renewable energy is imminent. The viable and sustainable alternative would be a partial shift to Non-Renewable Sources of energy. For residential consumers in "un-served" and "under-served" areas, the practical and sustainable option would be Solar and Wind.

This paper focuses on the practicality and viability of Solar Energy for the poor and the needy- ideal candidates for Social Housing.

Solar Energy: The Kindness of Nature

The global demand of energy is 15TW, while the Sun, nearly Ninety-Three million miles away, blazes energy toward the earth, estimated at 89,000 TW- an enormous amount in relation to our need. The Sun produces light/heat energy by burning massive amount of Hydrogen emitted from its core- a kind of continuous and controlled Nuclear Reaction. According to an estimate - considering that the Sun is expanding 700 Billion Tons of Hydrogen every second - it is likely to keep burning another 4.5 Billion years. So the issue is neither its cost nor continuity, but of harnessing this nature's blessing as a valuable resource. The Solar Energy distribution pattern is:

Scattered and reflected back by clouds	20%
Scattered from atmosphere	6%
Absorbed by atmosphere and clouds	19%
Reflected by Earth's surface	4%
Absorbed by Earth	51%

Thus, nearly half of the energy emitted by the sun is available for us as Solar Energy, about 6,000 times more than our total energy needs.

Why Solar in Pakistan:

Pakistan is currently facing a power shortage of more than 4,500 MW. The Oil/Gas contributes nearly two-third of our power generation. The Oil requirements are mostly imported. In the recent years the oil import bill has been on the rise and it consumes a major part of our Forex earnings. Furthermore generating Thermal Energy is neither environment friendly nor sustainable for the economy
Solar energy, on an average, is available 8-10 hours per day in most of Pakistan, while wind energy at desired levels is available mostly on coastal areas. On the other hand, Soar/Wind Hybrid may work in most of Pakistan.

Market Segmentation:
Based on availability of electricity, the entire consumer market could be segregated into three segments:

Served Population:
These are mostly an urban population who have access to National Grid, and face intermittent load-shedding i.e., managed "Brownouts." This segment is more sensitive to comparative economics, reliability and quality of alternate energy sources. Although not the first victims of power shortages, they are the decision-makers when it comes to planning and policy issues.

Underserved Population:
These are the low income sections of the population/habitat living in Urban and Rural areas, which have a deficient and frequently interrupted electricity supply. While they have bare minimum requirements for light, fan etc, the tragedy is that they are the first victims of "Load Shedding'.

Un-served Population:
These happen to be people living in villages with no electricity or those living in remote areas that have either no electricity or a very poor supply. They are not served by the National Grid primarily for economic and budgetary constraints. This segment's electricity needs are also a bare minimum (light, mobile charger, and maybe the luxury of a running fan)

Solar solutions based on Income groups
To design and develop modules for "Solar for Social Housing;" the market has been divided into three segments while the solutions offered as mere suggestions, since many other options would need to be available as well.

Basic Module
(Low Income group)
Retail Solutions
DC System of 90W Panel, 4 Bulbs each equivalent of 75W, One DC Fan 22W, and a Mobile Charger. Cost estimate Rs 80,000 (US $ 1000). Electricity saving of 113 Units per month, which could be made available for the industry at a higher tariff, meaning an electric bill saving of Rs 800 ($ 10) per month to the Consumer.

If the Housing Finance Companies extend a subsidized loan of Rs 60,000 at LTV of 80:20 at 6% pa, the monthly mortgage payment would be around Rs 600 pm, which compares favorably with the electricity bill of Rs800 pm.
The Government could provide subsidized credit under the "Solar for Social Housing Program".
In the Basic Module for village Solar Electrification, a typical village of 30 houses (2 Bulbs of 8W plus Mobile Charger, a Worship Place and a School (2 fans 0f 60W,2 Bulbs of 14W, and a Community Center (Light plus TV) would cost about $15,000 . Even NGOs and Corporate could be motivated to come forward to support such a program.

Regular Module
(Middle Income Group)
Retail Solutions
AC System of 400W Panel, 6 Bulbs each equivalent of 75W, 3 AC Fans, and a Mobile Charger. Cost US $ 3,000. Similar economics as in case of Basic Module would be available in regular Module as well.

Community Module
(Community based Projects)
Wholesale solutions
200-1000KW AC System, supplied on Grid. The community solutions are more applicable to clusters of Low and Middle Income Groups. China is the main supplier of Solar Plants in this size range, and at very competitive cost, if one has technical support to verify quality. Initiatives for such community based solutions could be taken both by the Public Sector and Private sector power generation companies. For the wholesale community based solutions, both O-Grid and Off-Grid options may work.

Such retail solutions may also be applied for Street Lighting Programs as well as for Solar Water Heaters**.**

Solar for Social Housing, Cross Subsidy Model:

The use of renewable sources like solar energy is encouraged by providing subsidies in Capital and Interest cost. In view of the weak economic conditions faced by developing countries; a cross-subsidy model could be used to compensate for such subsidies.

*Industry would save on Economic Loss by providing cross-subsidy***:**
In Pakistan the power Tariff for Industrial Consumers is almost double as compared to Domestic Consumers. However, due to political expediency, the "Shut Downs"are applied mostly to the industrial rather than to domestic consumers. Such a policy has two adverse impacts on the economy:

- Economic Loss: a loss of industrial production causes an "economic loss" estimated at Rs 15/unit.
- Tariff Loss: since Industrial tariff is about Rs 10/unit while domestic consumer are charged subsidized tariff of Rs 5/unit.

Therefore, by keeping the industrial wheel on the move, the economy would gain more by saving of such an economic loss and earning additional revenue. A part of this

economic gain could be passed on to the domestic users using Solar Power. The Industry could finance/subsidize a part of Capital Cost, and the State could subsidize in the Interest Rate by Cross-Subsidizing the above gains.

Carbon Credits:

By switching to environment friendly sources of energy, the earned "Carbon Credits" could also be passed on to provide subsidies in Capital and Interest cost.

Carbon Tax:

The Government of Pakistan is considering a levy of "Carbon Tax" on industries using Fossil fuels as a source of energy. The revenue so collected should be used to subsidize the promotion of Renewable Energy like Solar.

Solar and renewable Energy Initiatives in India:

India has a population of 1,027 million people (2001) and a much bigger Energy issue but it has taken some very good initiatives to promote use of renewable energy, including Solar. Solar has a great promise for India, since India receives 5,000 trillion KWH of energy per year, a daily average of 4-7 KWH/SqM, and has 300 clear sunny days. The program covers the following sources of energy:

- Solar (In-Grid and Off-Grid Systems)
- Wind Energy
- Biomass/Biogas
- Small Hydro Power Plants

The program has been started at both Central and State Governments levels. Supported by the Central Government, 24 States have Village Electrification Program using Solar Energy. Under the program 5,259 villages were sanctioned, out of which 3,332 villages have been provided Solar Power, while 1675 villages are on their way to achieve the same. The Solar Photo-Voltaic (SPV) Home Lighting Program initially covered 4 lighting per House, and after 2005, it provides 2 Lighting per House. A two Lighting System is designed to provide 0.1 KWH/day, with a typical cost of IRs 13-15,000. The Central Financial Assistance subsidizes as follows:

Solar Home-lighting Model-1	IRs 6,000
Solar Home-lighting Model-2	IRs 11,000
Solar Street-lighting	IRs 20,000

Conclusion and Recommendations:

Providing housing to low and very low income household is a major "economic" issue, due to the challenge of "affordability". At the same time it is a "social" issue because this market segment constitutes nearly two-third of the population. In view of the issue of mismatch in Household Income and Property Cost, the market forces do not come forward to meet this massive potential demand. This makes this segment, the "Social Housing" segment. To make such real-estate projects "affordable", most of these developments take place in the outskirts of the city. Such areas are either un-served or underserved for Utilities and Residential Infrastructure, electricity being the most critical of these. Due to budgetary constraints the option of laying Grid Transmission is also limited.

Furthermore, due to power shortages, these underserved and un-served areas become the first victim of any cut down in power.

Renewable sources of energy are preferred on Environmental Considerations. The Solar option is economical on a long-term basis, needs less maintenance, is more handy and dependable.

The Cross-Subsidy models as discussed in the paper suggest that the financial burden on the State could also be minimized if not eliminated

Therefore it is high time to consider linking any Social Housing Project with the provision of solar energy. A few success stories on Solar for Social Housing will go a long way in promoting large scale housing schemes for low income people.