EXPANDING ENERGY ACCESS BEYOND THE GRID

Five Principles for Designing Off-Grid and Mini-Grid Policy

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EXECUTIVE SUMMARY

One in five people around the world, approximately 1.3 billion people,[1] lack access to electricity. In order to solve this problem, the International Energy Agency (IEA) suggests grid extension should receive 36 percent of all investment compared to 74 percent for mini-grid and off-grid clean energy solutions. In practice, grid extension receives nearly all of the paltry sums dedicated to this important development challenge.

Enabling policy frameworks are critical for unleashing the finance required to deploy mini-grid and off-grid solutions. There is a tremendous market potential, some $12 billion, waiting to be unlocked by the right combination of policies.[2] This market will develop local economies and local jobs providing numerous co-benefits for host countries. This paper summarizes the set of policies that we believe are critical for unleashing the necessary investment to develop these markets locally. Key areas for policy interventions include:

1. **Energy Services Not Electrons:** Supporting deployment and development of highly efficient appliances and agricultural equipment
2. **Building Markets**: Start small, transition support to full access technologies as markets mature: Pico solar products are critical for building the market in the early stages; Tier 2+ "access" to electricity will require prioritized funding support as markets mature to support mini-grids and larger solar home system deployment
3. **Leveling the Playing Field with Fossil Fuels:** Reducing VAT on solar products and targeting and reducing subsidies for diesel and kerosene.
4. **Unlocking Finance:** Public policy can enable access to finance primarily by eliminating risking private investment through loan guarantees. In certain cases, like mini-grids, subsidy support—in the form of rural feed in tariffs (RFIT)—are required to unlock the market.
5. **Defining Utility Regulations in the Off-Grid and Mini-Grid Space:** There is no policy certainty for companies in this space. Policymakers need to ensure light touch regulation that accommodates, rather than precludes, the growth of the industry.

BACKGROUND CONTEXT: ENERGY ACCESS AND THE ENERGY LADDER

Rather than viewing policy interventions aimed at enabling energy access as a single end goal, these ventures should be viewed as a part of a process, or 'Energy Ladder.' The ladder is a conceptual way of understanding how populations can increase their access to energy services as incomes and energy provision expand.

Off-grid solutions are a critical first step onto the energy ladder by providing basic energy services such as lighting, mobile phone charging, fans, and now, super-efficient televisions. For instance, we are seeing companies report consumers moving from products like solar lanterns to solar home systems (SHS) in several markets over time. Once these basic needs are met, many populations are capable of expanding their energy consumption to include higher level needs like refrigeration or even agro-processing.

Rather than waiting for grid extension—which, even if it arrives, can be subject to load shedding or unexpected interruptions—off-grid interventions help place populations on the energy ladder on a time scale that accelerates impact: days and months, not the years and decades they often must wait for centralized power plants and grid extension. With modern 1-5 kilowatt solar systems, connection to the grid is easily possible if and when it eventually arrives. This means that solutions for a single house in developed countries can serve as solutions for a whole rural village in a developing country. Lighting and mobile phone charging are the beginning, not the end of energy access.

This ladder is unlocked by advances in energy efficiency. From off-grid LED lighting to "Skinny Grids"[3] we can revolutionize the cost and effectiveness of rural electrification. Thanks to these energy efficiency advances we can deliver meaningful energy access with much lower amounts of power. By prioritizing the movement of populations onto the energy ladder with immediate basic interventions, governments can tangibly help improve the lives of their citizens and allow markets and interventions to develop over time.

For "access to energy" levels of energy to be attained, it is important that daytime uses of energy, such as agro-processing, refrigeration and internet communications, be provided. This often happens at a community level rather than a consumer level. These interventions may add 30-50 percent to the cost of a SHS price which only provides lighting, phone-charging and perhaps TV and fan services. With further decreases likely for solar panel prices, LED lighting and batteries, as well as more cost-effective designs of mini-grid solutions, a $250/household cost for "access to energy" has a rational basis. In contrast, professional rural electrification modeling shows the first half of households connected via grid extension may cost $500-$1000/household, while the more sparsely populated villages may take $1000-$2500/household to connect.[4] There is ample evidence to suggest off-grid solutions can be at least as cheap, or cheaper, than grid extension, depending on the definition of "access to energy" and how much power and energy this requires.

FIVE KEY PRINCIPALS FOR POLICYMAKING 'BEYOND THE GRID'

We suggest drawing on four key principals in designing any off-grid or mini-grid policy.

PRINCIPLE 1

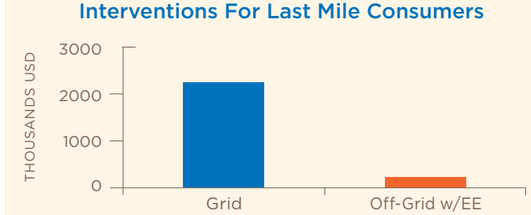
Energy Services Not Electrons: Supporting deployment and development of highly efficient appliances and agricultural equipment

Focus on and reward the entire energy ladder, and the provision of energy services—light, communication, home ventilation and refrigeration, irrigation and agro-processing—rather than simply measuring units of electricity.

Currently available energy efficiency measures allow energy access to be delivered for 50-85 percent less energy input enabling dramatically reduced capital expenditure. From off-grid LED lighting to "Skinny Grids"[5] it is now possible to revolutionize the cost and effectiveness of rural electrification. Thanks to these energy efficiency advances, we can deliver energy access with a much lower amount of power.

Reducing the power required to get populations onto the first level of service is critical—once that first rung is provided, as long as the next rungs are also available, households will leverage electrification to raise income and in turn, will ultimately raise incomes to increase their usage of energy services. During the process of rural electrification in the U.S., households initially received only one light per room, because plugin appliances were viewed as too expensive for farmers. But farmers rapidly moved to full electrification. The same is happening with solar today as poor farmers are able to use the lighting and mobile phone charging systems they already have and then quickly add TVs, radios, and even fans as incomes expand and services increase.

Comparative Costs of Initial Energy Access Interventions For Last Mile Consumers



Off Grid Solutions, Coupled with Highly Efficient Appliances, Dramatically Reduces Costs of Initial Access Interventions

SOURCE: DIFFER, SIERRA CLUB

Ultimately, these initial services (lighting, mobile, fan, TV, plus a small amount of agro-processing) are only the beginning of rural electrification. However, they can have profound impacts on peoples' lives while unlocking the energy ladder.

Setting up the finance mechanisms for initial services also enables the energy ladder to lead to other opportunities like solar irrigation and solar on-grid back-up in place of diesel.

BEST PRACTICE: ***Support Deployment of Highly Efficient Appliances***

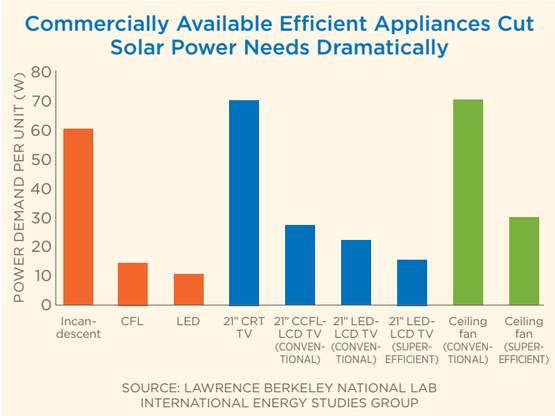
Solar power must be matched with end-use efficiency. LED lighting is an example of how critical energy efficiency is to enable solar and renewable off-grid power. It is actually the LED that unlocks the economics of off-grid solar by reducing the size of everything in the system from panel to battery – and therefore the entire system cost. This concept can and should be applied to government programs that support the development of highly efficient appliances and agricultural equipment.

In order to ensure the success of such programs, we recommend designing programs not based on solar watts, but on the delivery of energy efficient services. That entails creating a government mandated program that works with upstream manufacturers to incentivize the deployment of highly efficient fans, TVs, lighting, and small appliances. Once the ultra-efficient appliances are available, low income customers need to be able to access soft credit for purchasing them instead of less efficient traditional models. Efficiency pays for itself—but it does not finance itself.

PRINCIPLE 2

Building Markets: Start small, transition support to full access technologies as markets mature: Pico solar products are critical for building the market in the early stages; Tier 2+ "access" to electricity will require prioritized funding support as markets mature to support mini-grids and larger solar home system deployment.

Various solutions exist to apply solar power to rural electrification. Small stand-alone solar home systems and solar lanterns are critical near term interventions best suited for getting populations on the first rungs of the energy ladder. In many cases, these initial interventions are financed based on cash sales that replace current expenditure on polluting forms of power such as kerosene lamps. Already these markets are growing rapidly.



Larger solar solutions such as 10-100-watt solar home systems and solar mini-grids have been slower to mature in large part due to capital expenditure barriers. However, they can provide populations with three key advantages: 1) The ability to layer on productive uses, 2) Significantly cheaper prices on a price per watt basis, and 3) The ability to connect to the grid if and when it arrives. Therefore, as markets mature and populations move up the energy ladder beyond solar lanterns and small solar home systems, full-access technologies such as mini-grids and larger solar home systems (10-100-watts) require support.

The cost per watt of solar panels is lower for larger panels and increases substantially for panels smaller than 40-watts. In effect, this doubles or triples the cost per watt of panels. Therefore, in terms of getting the best "bang for the buck," deploying larger solar panels is desirable.

Larger panels can also supply enough power to energize larger end-uses of power, such as refrigeration, agro-processing machinery, water pumps, and similar equipment. However, there is an additional cost of wiring necessary to connect households to the larger panels, which can somewhat offset the savings of larger panels. So, houses located close to each other lend themselves towards mini-grid solutions, while households located hundreds of meters from others lend themselves towards isolated systems. Batteries exhibit a similar cost curve to solar panels, where smaller batteries cost substantially more per unit of energy storage than larger batteries do. Again, large batteries can power larger equipment that small batteries cannot. For a total solution that covers all households, a combination of mini-grid and isolated systems is often the most cost-effective and appropriate.

PRINCIPLE 3:

Leveling the Playing Field with Fossil Fuels:

Reducing VAT on solar products and targeting and reducing subsidies for diesel and kerosene.

Currently, many countries apply taxes, often in the form of value added tax (VAT), to clean energy products like solar lanterns and SHSs. While it is critical for all countries—particularly developing countries—to develop a strong and diverse tax base to pay for public services like healthcare and education, VATs are usually regressive. This means that they hit the impoverished the hardest.

According to Lighting Africa,[6] solar components and products in many geographic areas continue to be hit with multiple taxes—including import duty, excise duty, VAT, and surcharges—which can lead upwards of a 30 percent increase in the price of the final solar product. That means, in practice, the VAT is an unnecessary barrier to sourcing affordable solar products for off-grid and rural populations.

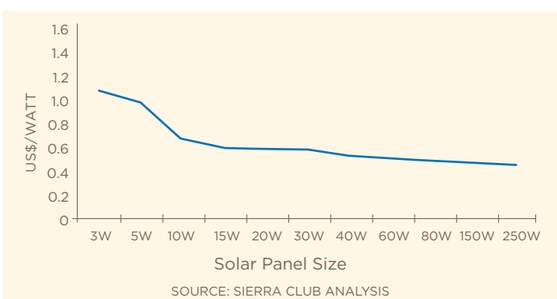
At the same time, many countries continue to heavily subsidize fossil fuels for poor populations. The problem is that the vast majority of these subsidies do not reach the poorest members of society.[7]

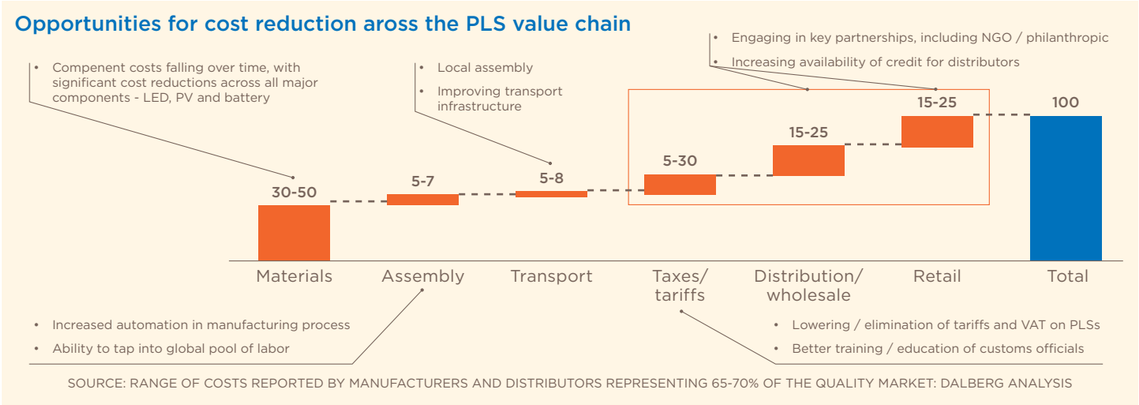
That means, thanks to high subsidies for kerosene, VAT on solar products exacerbate an already unequal energy playing field. The end result is that those desperately seeking energy access turn to heavily polluting, and ultimately more expensive, forms of fuel-based lighting—like kerosene.

As such, many governments have begun to update their tax code to include VAT waivers and exemptions that support rather than hinder solar energy deployment. Many developing countries, such as Burkina Faso, Nigeria, Mali, and most recently, Kenya, have already installed these changes to their tax codes. But many more countries must implement these kinds of exemptions to expand solar power for everyone.

BEST PRACTICE 1: ***Direct subsidy payments for better targeting coupled with sunset credits:***[8]

Governments like India have piloted direct subsidy pro-





grams that ensure money is sent directly to populations (rather than indirectly via subsidized fuel). Such programs can and should be coupled with a predetermined 'sunset date' for payments, providing much needed transition time, and empowering consumer choice. This both reduces subsidy levels and provides a more level playing field for solar LED providers. With these programs, sound design and implementation is the key to success.

BEST PRACTICE 2: ***Reduce and eliminate VATs on solar products***

While we believe that countries should have the ability to use the different policy tools currently available to develop domestic industries, taxes on solar like VAT do nothing but harm those who need clean, reliable energy access the most. Countries should strive to reduce and eliminate these taxes.

PRINCIPLE 4

Unlocking Finance:

Public policy can enable access to finance primarily by eliminating risking private investment through loan guarantees. In certain cases, like mini-grids, subsidy support—in the form of rural feed in tariffs (RFIT)—are required to unlock the market.

The cost of products is no longer the problem for delivering energy to these impoverished communities. Instead, the bottleneck is availability and affordability of finance for both consumers and the businesses working to deliver energy services.

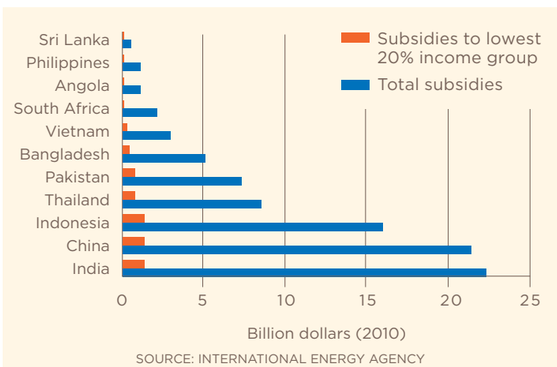
End-user finance is required to move from cash sales to longer-term infrastructure investments. Put simply, the burden of the high capital cost of energy infrastructure should not be placed on the shoulders of the rural poor any more than the urban rich should have to buy a coal power station for cash—investment in such infrastructure spreads this cost over many years. Note that finance and credit mechanisms that facilitate micro-grids and home solar systems also facilitate solar irrigation and the substitution of solar for diesel as the on-grid back-up option of choice.

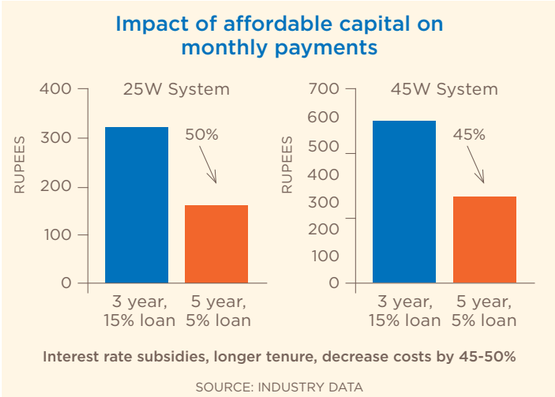
BEST PRACTICE 1: ***De-risk Commercial Debt***

We need to support these new market forces that are already deploying solar LED lighting and replace subsidized kerosene lighting by guaranteeing any loans made to enterprises delivering these services in markets perceived as 'risky.' Ultimately, we suggest a dedicated loan guarantee fund that supports any company providing at least a multi-light and communications along with a minimum level of agro-processing energy service provision, via solar or other clean technologies. The guarantee fund is expected to scale up over several years to eliminate all kerosene lighting, but would unlock rural energy infrastructure investments.

BEST PRACTICE 2: ***Implement a Rural Feed-in Tariff (RFIT)***

Implement a RFIT to public and/or private field partners delivering at least a level of solar energy services equivalent to LED lighting, communications along with a minimum level of agro-processing (mobile phone charging) via village power/micro-grid installations. The RFIT would





likely be a payment given for each household 'connected.' It should be designed to reduce over time after an initial period feeds the market. Bangladesh accomplished this with the capital subsidies for its off-grid solar program, which are set to phase out by 2016.

It is important to note that a traditional Feed in Tariff (FIT) does not need to have a payment based on kilowatts—nor in this case should it. It can be a payment based on proven services delivered. The true value of a FIT is revenue certainty provided.

BEST PRACTICE 3: ***Create Off-Grid Solar Financing Mandates at State Banks***

Creating a mandate for commercial banks, regional rural banks, cooperative banks, and other non-bank financial institutions to offer consumer finance for solar LED products can help enable this finance to flow. Coupling these mandates with training programs to educate staff at state-owned banks on how to properly structure and originate these loans will greatly improve effectiveness. Finally, consider creating a state-owned entity that automatically refinances any loan originated thereby creating liquidity in the market and incentivizing loans (see Bangladesh IDCOL program).

PRINCIPLE 5

Defining Utility Regulations in the Off-Grid and Mini-Grid Space: There is no policy certainty for companies in this space. Policymakers need to ensure light touch regulation that accommodates, rather than precludes, the growth of the industry.

Recent (incomplete) initiatives in both Bihar and Uttar Pradesh India to regulate the prices charged by off-grid providers (on a $/kilowatt hour basis) have lacked awareness of the economic realities. These initiatives did not account for the fact that it is the availability of electricity, not the kWh price, which is most urgent at the first level of electrification. Efforts to regulate the off-grid and mini-grid space on a price per kilowatt hour can and should be avoided. Governments should encourage State and Central regulatory mechanisms which protect both the public treasury and consumers from price gouging, but reflect economic reality. This could, for instance, be structured around minimum service deliver over a given time period.

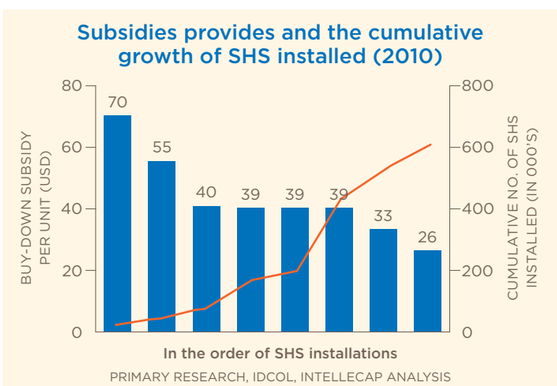
BEST PRACTICE 1: ***Use price-discovery and auction processes to ensure fair pricing of micro-grid services, but use diesel as a bench-mark***

Micro-grids require substantial government enablement, are natural monopolies in each village or larger catchment area, and will require some level of government support to achieve energy access goals. They are therefore appropriate subjects for quality and price regulation.

But governments should not overlook the reality that in off-grid rural markets, the competing product is not grid power, but diesel—any micro-grid that costs less than diesel is, if fairly priced, a good deal for consumers. Fair pricing should be established by using price-discovery and auction mechanisms, and then, if the market is strategically structured, instead of overpaying, the greatest risk is driving margins too low. The IDCOL model in which certain categories of incentives decreased as the market share grew is an important example of how to avoid gouging while not shrinking growth.

BEST PRACTICE 2: ***Treat SHS and other solar appliances for what they are—appliances***

SHSs, solar lanterns and other solar stand-alone products are not natural monopolies. They are simply somewhat complex appliances, and increasingly easier to use. But they are technologically sophisticated products with which the average rural market is not familiar. Government should establish transparent quality certification systems, as many have done with home appliances, and government soft-loans and other support mechanisms should only be provided to products which are in the upper range of quality, efficiency and price. In this way the government can continually reward those market players who perform exceptionally while avoiding the risk of locking the market into one set of products or technologies.



CONCLUSION

The current regulatory approach to the mini-grid and off-grid sectors is for all intents and purposes non-existent. The suggestions outlined in this document provide a pathway forward for reasonable, light touch regulation that can help the sector secure much needed certainty as it continues to grow.

APPENDIX 1: THE BANGLADESH IDCOL EXAMPLE

The best global model to date for off-grid solar is Bangladesh's IDCOL. Some of its features—the initial capital subsidies and the reliance on the World Bank as the securitization market for bank loans—are no longer needed, and could not be duplicated at the scale needed for India.

Scale: So far, 680,000 SHSs have been installed to under IDCOL's solar lighting program, almost all at 20 Watt Power (WP) or greater. Over its seven years, this represents a 60 percent compound annual growth rate (CAGR). The program aims to further grow to a scale of four million SHS installations by 2014, implying an annual growth rate of over 115 percent and a market penetration of approximately 25 percent.

These high projections are going to be driven by the recent inclusion of low-wattage SHS. These SHS can be sold aggressively to low-income household. The shift from higher to lower wattage SHS is enabled by the shift from CFLs to LEDs. 20 WP systems in Bangladesh retail in this program for about $175. In Bangladesh, the 20 WP systems are aimed at the USD$55-$70/monthly income household. But these households are only 20 percent of the IDCOL sales to date.

FINANCIAL INCENTIVES: Financing terms to partner organizations who install solar systems include:

Soft loan: 80 percent of the SHS price for refinancing (cap of $230 USD per system), 10-year maturity with two-year grace period at 6 percent interest, annually and no collateral or security except for a lien created on project accounts.

Credit terms to consumer:

- 15 percent down payment;
- Loan tenor varies from one year to five years (generally it is three years);
- Interest rate varies from 4 to 6 percent per annum; and
- Repayment frequency is monthly.

Declining Subsidies: the program began with direct consumer subsidies. These have decreased substantially and are about to be phased out entirely because the decreasing costs of SHSs make them unnecessary for the targeted consumer segments.

ENDNOTES

1 More information available at http://bit.ly/JrqiqA7.
2 More information available at http://bit.ly/bwyJ4s.
3 More information available at http://bit.ly/1bDWI2B.
4 More information available at http://bit.ly/1bDWI2B.
5 More information available at http://bit.ly/1bDWI2B.
6 More information available at http://lightingafrica.org.
7 More information available at http://bit.ly/loMiXHS.
8 More information available at http://bit.ly/17jHWTl.

SHS SEGMENT	MONTHLY INCOME OF TARGET CONSUMER SEGMENT	MONTHLY REPAYMENT BY CONSUMER ON SOLAR LOAN
50 Wp (approx. USD 380)	More than USD 125	approx. USD 9.7
20 Wp (approx. USD 165)	More than USD 55	approx. USD 3.7
10 Wp (approx. USD 100)		approx. USD 1.9 (36 monthly term) approx. USD 3.5 (20 months term)
SOURCE: INTERNATIONAL FINANCIAL CORPORATION'S LIGHTING ASIA PROGRAM		

APPENDIX 2: SAMPLE ENERGY LADDER

	BUSINESS AS USUAL						ENERGY EFFICIENT					
	TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5	TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Service description	Kerosene lamps, candles, etc.	Task lighting and phone charging (OR radio)	General lighting AND television AND fan (if needed)	Tier 2 AND any low power appliances	Tier 3 AND any medium power appliances	Tier 3 AND any high power appliances	Kerosense lamps, candles, etc.	Task lighting AND phone charging (OR radio)	General lighting AND television AND fan (if needed)	Tier 2 AND any low power appliances	Tier 3 AND any medium power appliances	Tier 3 AND any high power appliances
Peak available capacity (W)	-	2.5	50	200	2000	2000	-	2.5	25	125	1500	3500
Duration (hours/day)	-	> 4	> 4	> 8	> 16	> 22	-	> 4	> 4	> 8	> 18	> 22
Number of lamps	2	2	4	4	8	8	2	2	4	4	8	8
Lamp technology	Kero	Bulb	Bulb	Bukb	Bulb/ Halogen	Bulb/ Halogen	Kero	LED	LED	LED	LED	Watts
Watts/lamp	-	15	40	40	60	60	-	1	1	3	5	5
Lumens		150	500	500	750	750	-	150	500	500	750	750
Hours/day	4	4	4	4	4	4	4	4	4	4	4	4
Phone charger max mA		500	500	800	800	800	0	500	500	800	800	800
Number of phone chargers		1	1	2	2	2		1	1	2	2	2
Fan or air-con (watts)			4	30	50	1300			2	15	25	1000
TV (watts)			20	30	200	200			10	20	100	100
Refrigerator, capacity cu. ft.				< 5	5-15	> 15				< 5	5-15	> 15
Refrigerator (W)				160	240	360				80	120	180
Refrigerator, hours on				6	10	12				6	10	12
Washing machine capacity, cu. ft.					< 4.5 cu. ft.	> 4.5 cu. ft					< 4.5 cu. ft.	> 4.5 cu. ft
Washing machine (W).					1500	2000					750	1000
kWh/year - lighting		44	234	234	701	701		3	18	18	58	58
kWh/year - phone charging		3	3	8	8	8		3	3	8	8	8
kWh/year - fan or air-con		7	49	82	82	1460		3	15	27	27	1095
wWH/year - TV		0	29	117	292	292		0	15	58	146	146
kWh/year - refridgeration		0	0	350	876	1577		0	0	175	438	788
kWh/year - washing machine		=0	0	0	219	219		0	0	0	110	146
kWh/year - other		0	0	0	0	219		0	0	0	0	219
Energy consumption, kWh/year		**53**	**315**	**791**	**2178**	**4549**		**9**	**50**	**287**	**788**	**2461**
							% reduction	83%	84%	64%	64%	46%

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