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Reluctantly Redundant:
The Real Cost of Power

August 2010

India is burdened with a substantial power deficit resulting in vast tracts of the country, living in the dark shadows of frequent power outages. The government has embarked on a number of initiatives to bridge this power deficit over the next decade.

Meanwhile, India's hapless citizens have already invested around Rs 100,000 crores (US$ 20 billion) in power back-up equipment due to the poor reliability of grid power. Another Rs 30,000 crores (US$ 6 billion) is the recurring operating expenditure incurred to maintain back-up power equipment. Further, a large portion of this operational expenditure is diesel fuel which, is subsidised by the government.

The real cost of power is therefore, frightfully high. Yet, we all *reluctantly* pay this price for power *redundancy,* to compensate for the inefficiency and deficiency of a basic public service that should have been provided for and/or architected by the government, many decades ago. Unless the government and regulators craft solutions that address the specific power needs of different segments of society, we will all have no option but to invest in and maintain a high-level of power redundancy.

No segment of consumers has been spared; whether residential, commercial, or industrial, all pay a substantial premium for this power backup.

We remain, reluctantly redundant.

Research Methodology

The key objective of the study was to identify the backup mechanisms used by various consumer segments, the capital and operating expenditure associated with this investment and ultimately estimate the real cost of power.

Our research study involved extensive search of the literature, as well as primary research interviews with 1,500 individuals, across 21 cities in the country. The respondents spanned residential, commercial and industrial consumers.

Our research highlights the significantly higher cost of power borne by consumers who are forced to use back-up equipment and the surprising lack of awareness with regard to the true cost of power. In spite of the higher cost incurred, the consumer is only able to run a limited set of basic appliances on this back-up power.

Our research also provides a perspective on the following:

- Duration and frequency of power outages
- Peak and non-peak season outage
- Appliances run during outage periods
- Type and capacity of backup equipment used
- Premium paid by consumers
- Comparison of real cost of power in “outage cities”, against Mumbai
- Awareness levels of high cost of back-up power
- Usage of mechanisms to deal with poor quality of power.

Our work reveals that substantial investments have already been made by consumers in setting up and maintaining equipment to deal with power outages.

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Chronic Power Outages

Several cities across the country are plagued by chronic power outages throughout the year.

The gap between power demand and supply, results in many cities across the country facing severe power outages. While some cities face severe power outages only during the peak power usage season, where the summer heat prompts households to use ACs/ coolers etc, other cities face a chronic outage virtually throughout the year. The daily duration of power outage also differs widely across locations (Exhibit 1 & 2). Some cities have a defined load-shedding schedule, while others face more sporadic outage.

Exhibit 1

Severity of power outage varies widely across the country

Severity of Power Outage

No	City	Peak Season							Non-peak Season						
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	Bangalore	1.5	1.5	1.5	1.5	1.5	1.5	1.5							
2	Bhopal	2.5	2.5	2.5	2.5	2.5	2.5	2.5							
3	Chennai	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	Coimbatore	2	2	2	2	2	2	2	1	1	1	1	1	1	1
5	Delhi	2	2	2	2	2	2	2							
6	Faridabad	4	4	4	4	4	4	4	1.5	1.5	1.5	1.5	1.5	1.5	1.5
7	Gurgaon	5	5	5	5	5	5	5	4	4	4	4	4	4	4
8	Hyderabad	1	1	1	1	1	1	1							
9	Indore	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	Kanpur	7	7	7	7	7	7	7	6	6	6	6	6	6	6
11	Lucknow	3.5	3.5	3.5	3.5	3.5	3.5	3.5	1	1	1	1	1	1	1
12	Ludhiana	4	4	4	4	4	4	4	4	4	4	4	4	4	4
13	Madurai	2	2	2	2	2	2	2	1	1	1	1	1	1	1
14	Mumbai														
15	Mysore	2.5	2.5	2.5	2.5	2.5	2.5	2.5							
16	Navi Mumbai	2	2	2	2	2	2	2	1	1	1	1	1	1	1
17	Noida	6	6	6	6	6	6	6	6	6	6	6	6	6	6
18	Pune	3	3	3	7	3	3	3	Infrequent up to 1hr			5	Infrequent up to 1hr		
19	Rajkot	Infrequent upto 3 hours. No fixed pattern							Infrequent upto 1 hour. No fixed pattern						
20	Vadodara	Infrequent upto 3 hours. No fixed pattern							Infrequent upto 1 hour. No fixed pattern						
21	Visakhapatnam	2	2	2	2	2	2	2							

Severity of Daily Outage

No outage | >0 < 3 hours | >= 3 <6 hours | >=6 hours

Numbers indicate the average daily outage hours

Source: Primary Research, UC Analysis

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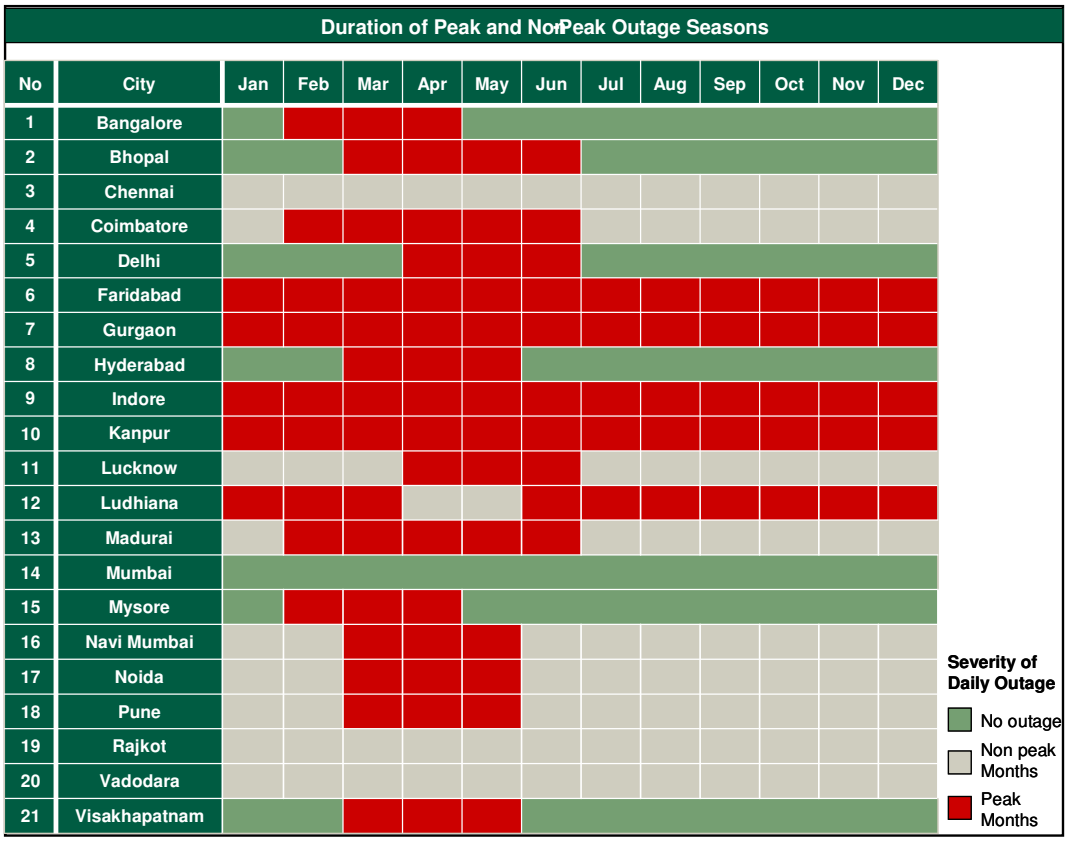
Exhibit 2

The duration of peak and non-peak power outage differs across cities and seasons



Source: Primary Research, UC Analysis

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Residential Consumers

Residential consumers predominantly choose Inverters as their primary back-up equipment, on which they run low wattage appliances.

A majority of residential consumers run only low-wattage essential appliances on back-up equipment, during a power outage. Fans are the most common appliance used and are typically run through the duration of the outage. Lighting appliances such as tube-lights, CFLs and bulbs are the second most common set of appliances used (Exhibit 3). These are typically used only for a portion of the outage period, such as when the outage extends to the evening hours.

A smaller proportion of residential consumers use relatively higher wattage consuming appliances such as PCs and TVs, on their back-up power equipment. These appliances are used only for a small proportion of the outage period (say 1/2-1 hr of a 3-4 hr outage).

There is a distinct correlation between the monthly power consumption level and the type and number of appliances run during power outage. Few residential consumers run very high-wattage consuming appliances such as ACs, refrigerators, ovens and boilers on back-up power. These appliances necessitate shifting from an *Inverter* to a *Generator Set*, as the preferred back-up equipment (Exhibit 3). These appliances consume very high power and constitute 'luxury usage'. Residential consumers, however, tend to use these appliances sparingly (e.g. Microwave oven used if power outage happens during morning breakfast hours).

For a majority of the residential consumers, the cost of a Generator Set capable of running most of their electronic appliances is prohibitive. This results in most consumers choosing Inverters as their back-up power equipment.

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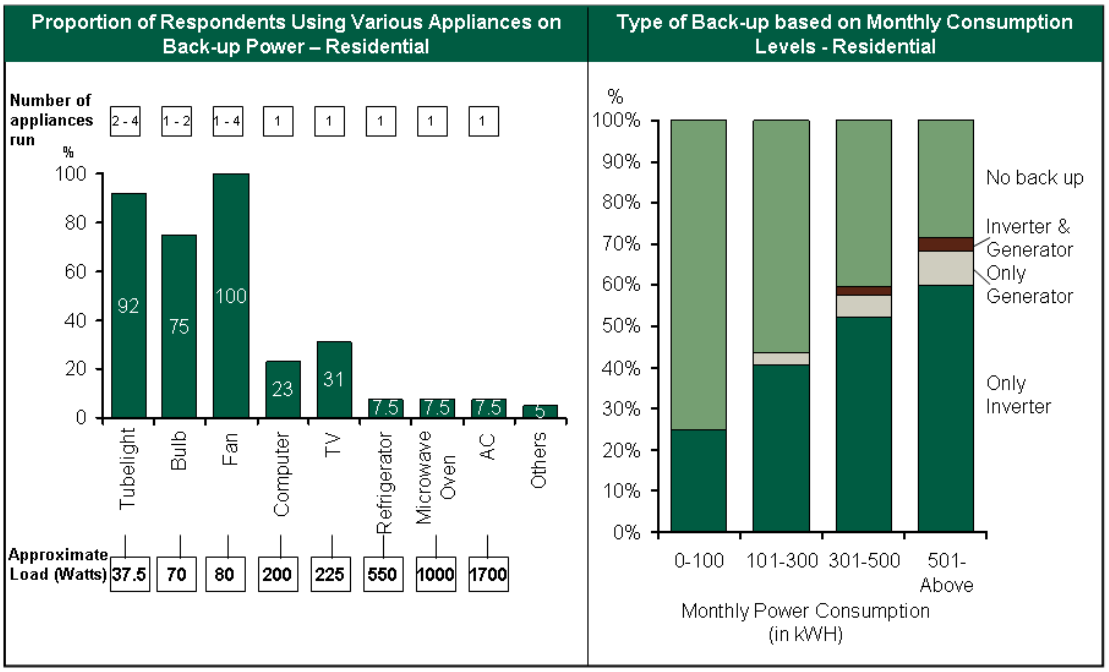
Exhibit 3

A high penetration of inverter sets among residential consumers, supports only low power consuming appliances



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Commercial Consumers

Commercial consumers use a mix of Inverters and Gensets as back-up power equipment. The type of back-up used is largely influenced by business needs.

In the commercial segment, the type of appliances supported on back-up power equipment during the outage period is driven primarily by business needs. Thus, even though low power appliances such as fans, tube lights and bulbs are the most common appliances used on back-up power, a sizeable proportion of commercial consumers, also support ACs and computers (Exhibit 4).

Some commercial consumers also support additional appliances critical to their businesses. These businesses had the following characteristics:

- Sold products that need electric power - electronic retail stores such as Tata Croma
- Customers spent significant time - restaurants like Pizza Hut and other mid to high-end retail stores
- Refrigeration is a critical need - food retail stores, ice-cream parlors
- Machines are critical to the business - auto service garages, photo-printing labs.

Fans are used almost through the duration of the outage, especially during the summer season. Tube-light and bulb usage on backup power was high in stores that rely heavily on displaying products e.g. branded apparel/accessories outlets such as Van Heusen, Raymond's and Adidas. Those who used computers as an integral part of the business operation typically supported the computer on back-up power through the outage duration. ACs was, however, typically used only when customers were actually present in the outlet.

A majority of the commercial consumers used generators as the primary back-up equipment (Exhibit 4). These establishments had the following characteristics:

- Usage of high power appliances such as ACs, electronic appliances and machines critical to business needs
- Higher than average consumption of electricity where back-up power cannot be supplied by Inverters
- Larger size of shop or commercial area
- Office complexes and malls that provide common back-up power to all the individual commercial outlets.

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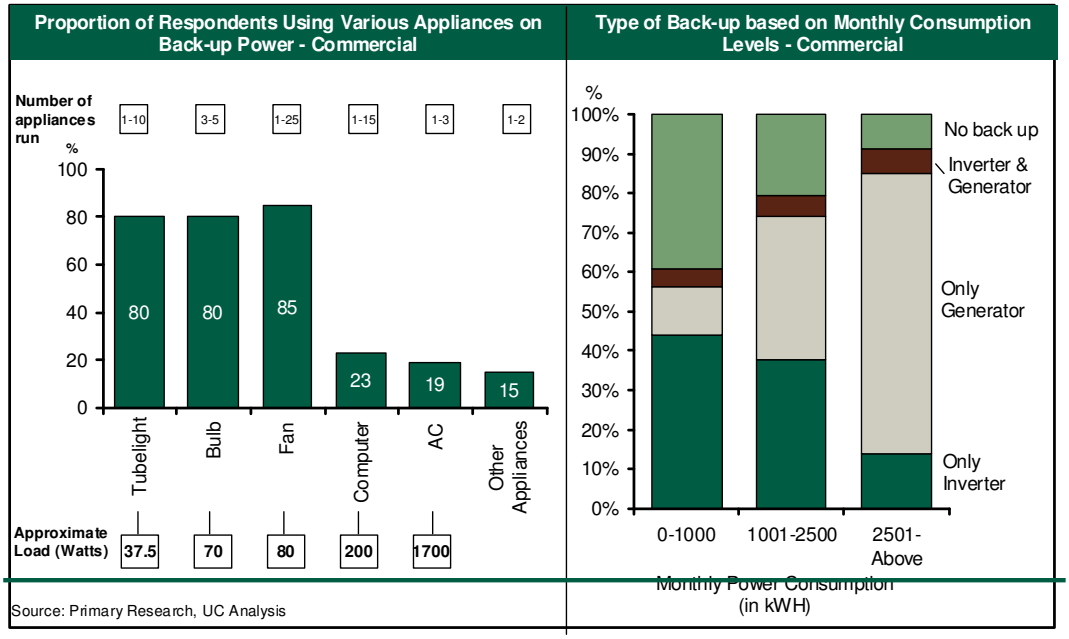
Exhibit 4

A higher number and higher wattage of appliances in the commercial segment, has resulted in higher penetration of generators



Source: Primary Research, UC Analysis

Premium for Power

The premium paid above grid power cost, increases with outage severity, when using Inverters.

The total expense on back-up power generation apportioned across the total power consumption by a consumer can be viewed as the 'premium' above the grid power cost, borne by the consumer.

The quantum of the premium borne by the consumer depends on several factors:

- Duration of back-up power equipment usage – The premium increases with increase in the daily outage duration, since a larger number, or higher capacity battery storage units have to be used (Exhibit 5 & 6).
- Load/ Power consumption to be supported on back-up equipment – The premium increases with increase in the number and especially the type of appliances that a consumer chooses to run. The higher the load to be supported, the higher is the capacity rating of the Inverter, thus resulting in a higher initial investment.

The cost of backup power generated using an Inverter, can be allocated across multiple cost heads (Exhibit 5 & 6):

- Inverter capex - This cost head reduces with increase in average outage duration as the cost gets spread across a larger number of units of power generated. Typical inverter life is ~ 8 years
- Battery capex - This is the largest cost head, both because batteries are expensive and has a shorter life, compared to the Inverter. The batteries need to be replaced, typically, every 3 years
- Battery AMC costs - This is a smaller cost and reduces with increase in average outage as the expense is spread across a larger number of generated units
- Operating expenses - This is the expense on grid power, that is used to charge the inverter batteries.

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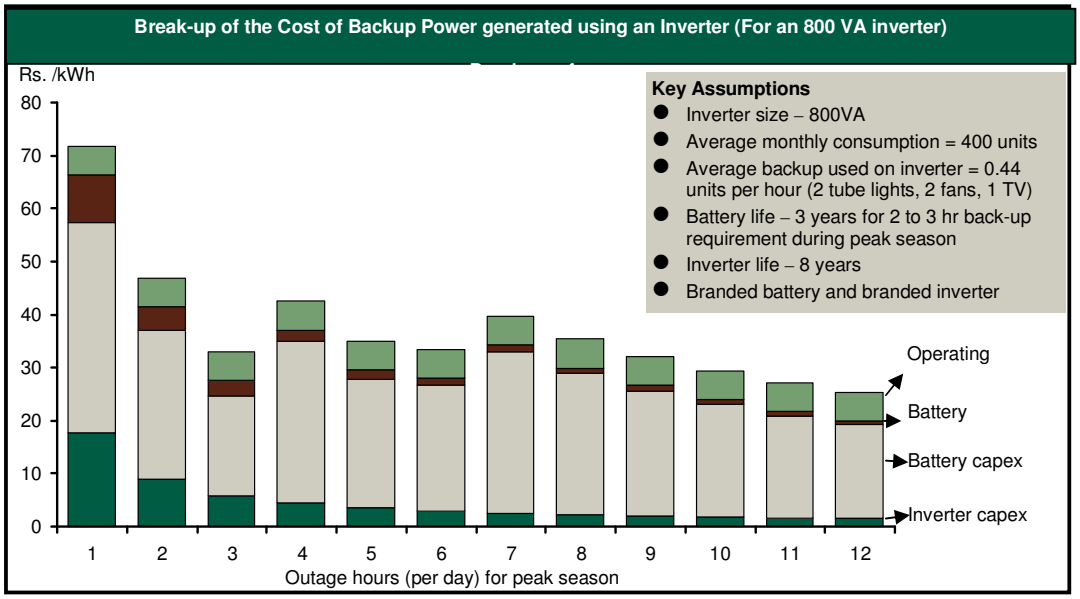
Exhibit 5

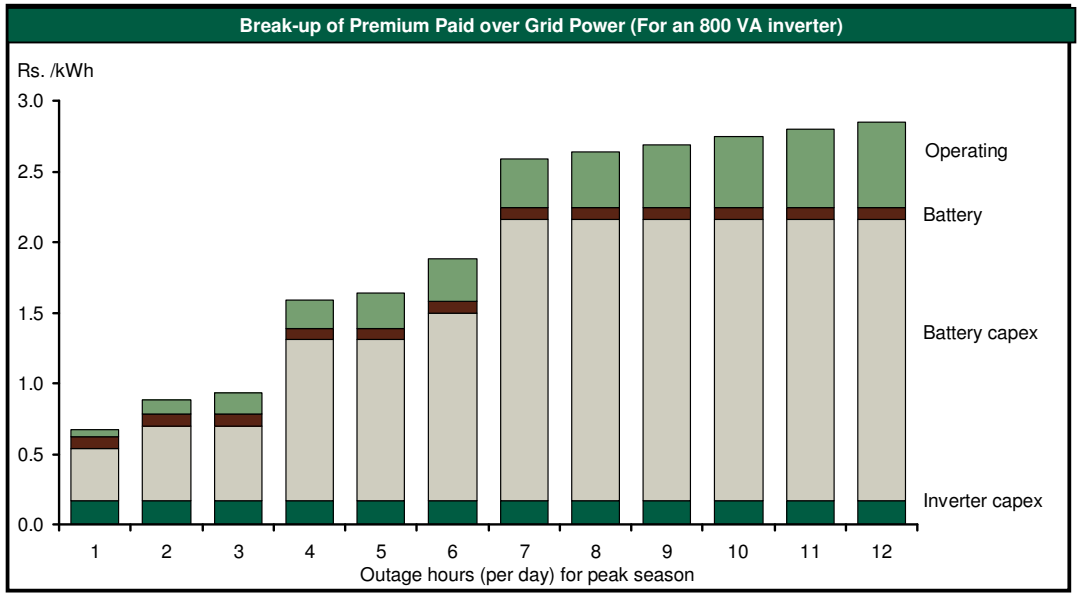
For an inverter mechanism, the battery capex accounts for a large portion of the cost of generated back-up power



Source: UC Analysis

Exhibit 6

Premium paid above grid power cost, increases with outage severity



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Residential Premiums

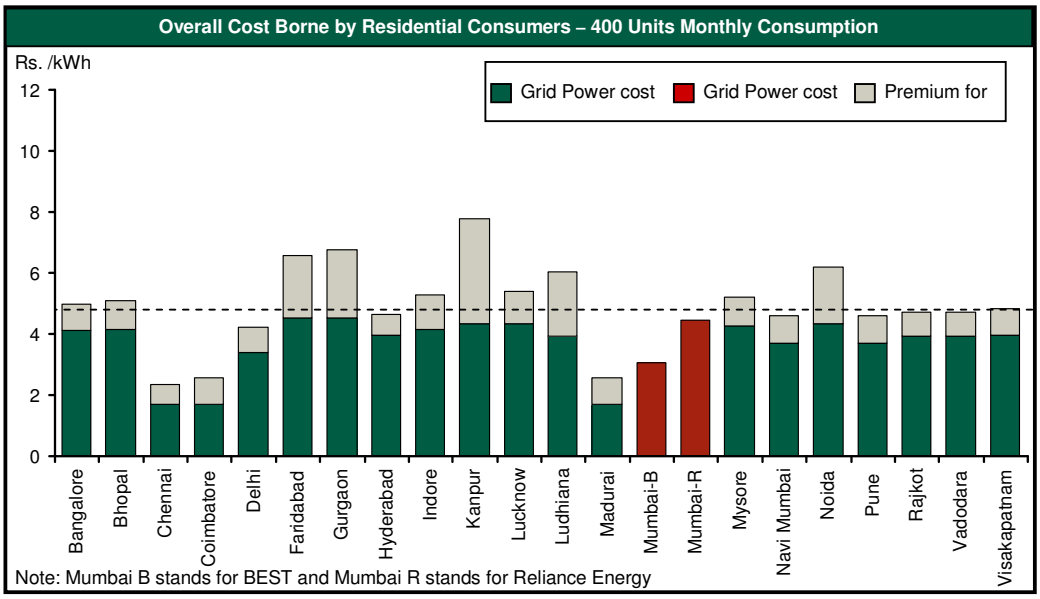
Residential consumers across the country, pay widely varying premiums over grid power cost, when using backups.

The premium paid by residential consumers varies widely across cities. This is because the premium depends on the duration of usage of back-up power, which in turn depends on the severity of the daily outage and the duration of the peak outage season (Exhibit 7).

To illustrate the difference in the premium paid, consider the case of a consumer with a typical monthly consumption level of 400 units, supported by an 800 VA inverter back-up. This consumer pays a premium of ~80% above the grid power cost when faced with a severe outage of 6-7 hours daily, throughout the year. This consumer would pay a premium of only ~17%, however, when facing a 1 hour daily outage for 3 months in the year and less frequent/ lower duration outages for the rest of the year (Exhibit 7).

Exhibit 7

Across cities, residential consumers could pay widely varying premiums, ranging from 17%- 79% over grid power cost



Source: Primary Research, UC analysis

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This premium will increase 3-4 folds should the residential consumer choose to run all appliances in the house on backup power.

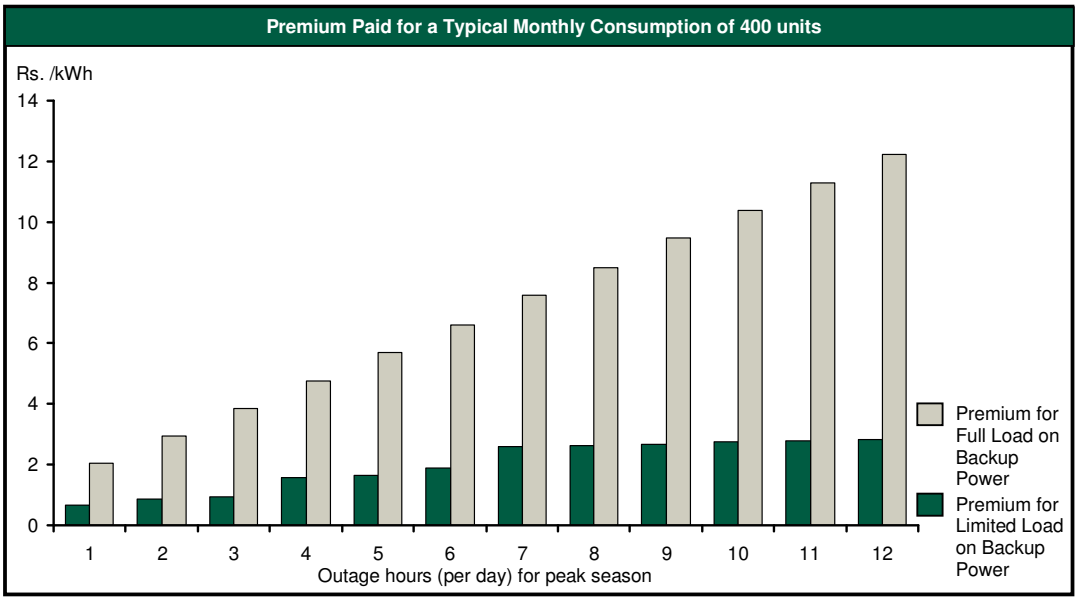
A typical residential consumer using an Inverter as a backup mechanism is able to run only a very limited set of appliances.

To be able to run the full load of appliances (including AC, geysers/ boilers, microwave ovens, refrigerators) on back-up, even for a limited period of time, the consumer will have to shift from an Inverter to a generator set.

To illustrate, even to run a single medium capacity AC, a generator set with a rating of at least 5 KVA will have to be used, instead of an 800 VA Inverter, to accommodate the initial starting surge required by the AC. This is similar to a 24x7 power supply, where the consumer can run all the appliances in the house. Thus a consumer will effectively end up paying a premium 3-4 times higher, if he chooses to run a normal load of appliances on back-up, instead of a limited set of appliances (Exhibit 8).

Exhibit 8

The consumer pays 3 - 4 times the premium to run all appliances



Source: UC Analysis

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The premium paid above grid power cost increases almost linearly with the increase in the daily outage hours, for generator set usage.

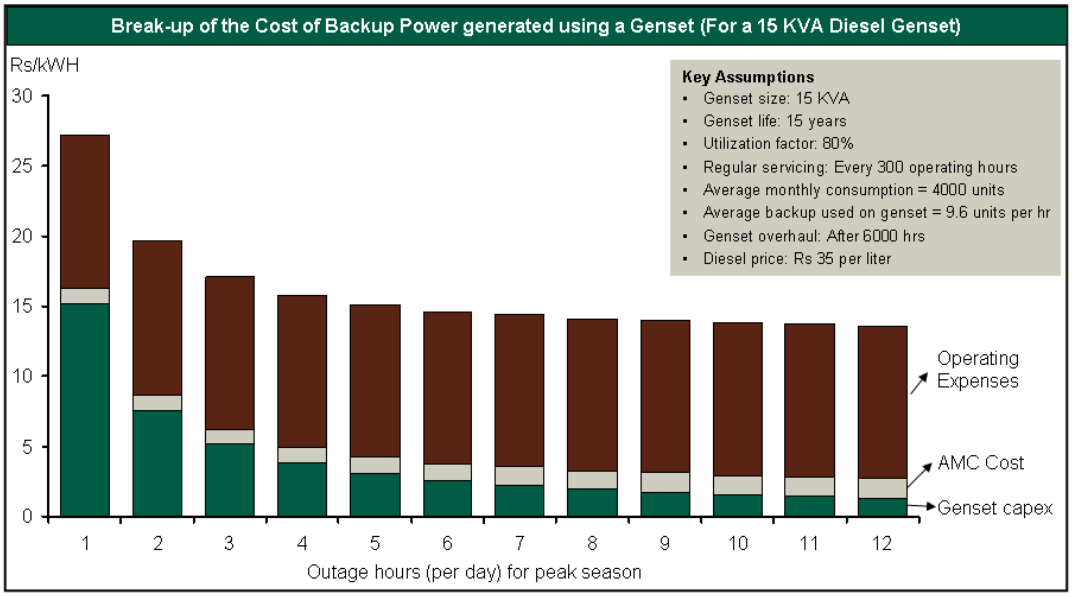
Even in the case of a generator set used as back-up equipment, the premium paid, increases with increase in the outage duration.

The premium borne by a consumer using generator back-up depends on several factors (Exhibit 9).

- Genset capex – The percentage contribution of the genset capex towards the total premium reduces with increase in outage duration as the capex gets allocated across a larger base of generated back-up power. The capex gets allocated over the life of the genset (diesel genset life of ~15 years)
- AMC cost – Refers to expenses for servicing and maintenance of generator sets, which also add to the premium paid for back-up power
- Operating expenses – The fuel (petrol/kerosene/diesel) expense is the major operational expense. Fuel expenses contribute very significantly toward the premium paid for backup power using a generator set. The amount of fuel consumed is highly correlated with the amount of power delivered by the generator back-up. These results in the premium paid for back-up power increasing almost linearly with increase in the utilization of the genset (Exhibit 10).

Exhibit 9

For a generator set, the operating cost (mainly fuel expense) accounts for a large portion of the cost of generated back-up power



Source: UC Analysis

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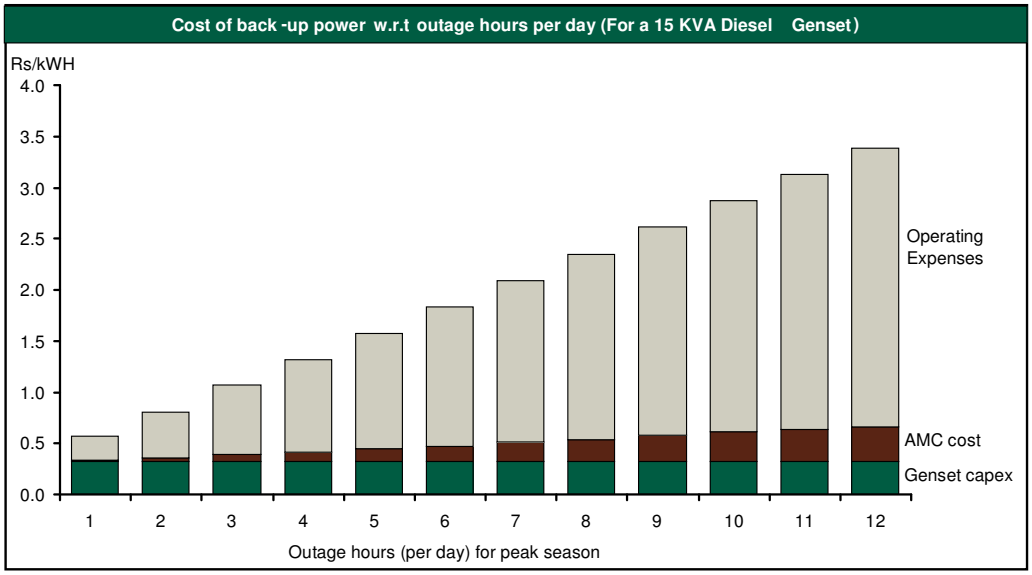
Exhibit 10

For a generator set, the operating expense (mainly fuel cost) accounts for a large portion of the premium



Source: UC Analysis

Higher Commercial Premiums

Commercial consumers pay an even higher premium for back-up power, compared to residential consumers.

The premium paid by commercial consumers also varies widely across cities, since this premium depends on the duration of usage of back-up power, which in turn depends on the severity of the daily outage and the duration of the peak outage season in a given city (Exhibit 11).

To illustrate the range of premiums borne by commercial consumers using generators, consider the case of a mid-sized commercial establishment with a typical monthly consumption level of 1,500 units. They have chosen to install a diesel generator as a back-up system. They pay a premium of ~150% above the grid power cost, for severe outages of 6-7 hours/ day throughout the year. A similar establishment will pay a premium only ~11% above grid costs, for a 1 hour daily outage, 3 months in the year, coupled with less frequent and lower duration outages, the rest of the year (Exhibit 11).

Commercial consumers in Mumbai pay a higher tariff per unit of grid power for the assured 24x7 supply that they enjoy, compared to their counterparts in other cities. With the premium paid for back-up power, however, consumers in many other cities with severe outages end up bearing higher overall cost per unit of power consumed (e.g. Faridabad, Gurgaon, Kanpur, and Ludhiana).

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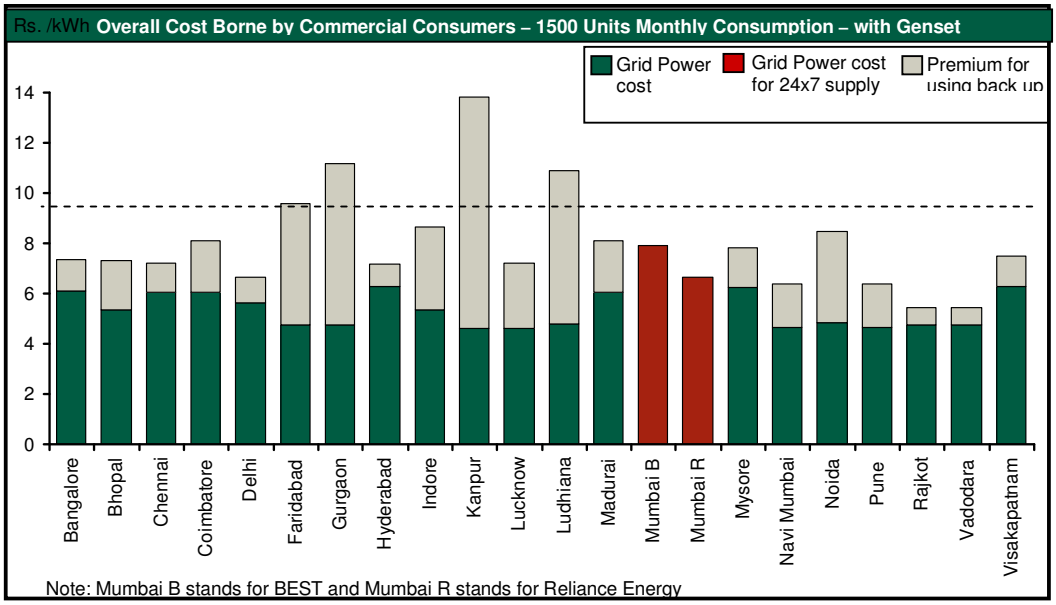
Exhibit 11

Commercial consumers pay a premium ranging from 14%- 199% over the grid power, for using genset power



Source: Primary Research, UC analysis

Lower Consumption, Higher Premiums

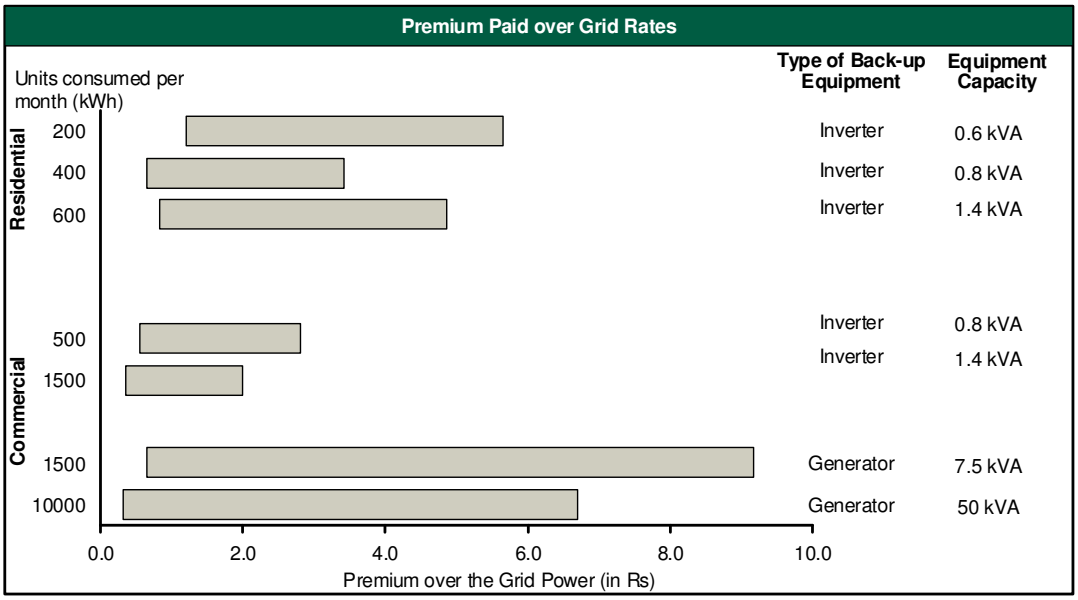
The premium paid above grid power cost varies across consumers in different monthly consumption brackets, with lower consumers paying higher premiums

Residential consumers in the lower consumption category who choose to have a back-up; end up paying a higher premium on average as compared to those in the higher-consumption brackets (Exhibit 12). The key reason is that as consumers increase the capacity of their back-up, with increase in their monthly consumption levels, the investment does not increase linearly with the increase in capacity.

Even in the commercial segment, the range of premiums paid is higher for lower consumption categories, when comparing similar power back-up equipments, say inverters, only (Exhibit 12). The premium increases significantly, however, for those choosing to have a generator set instead of an Inverter.

Exhibit 12

Residential consumers pay a premium ranging from 17%- 132% while commercial consumers pay a premium ranging from 7%- 199%



Source: UC Analysis

Awareness of Premiums

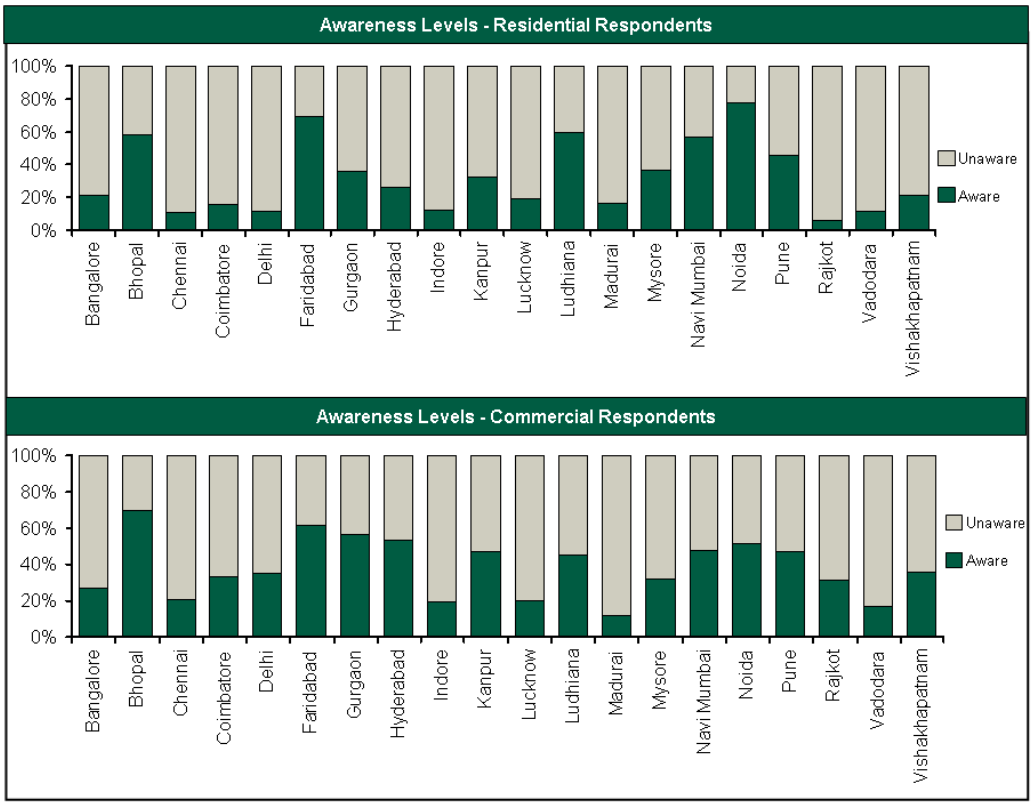
Awareness of the premium paid for back-up power, is higher among commercial consumers.

While a small proportion of residential consumers are aware that they pay a premium when using backup equipments, they are largely unaware of the magnitude of the premium paid.

Commercial consumers, on the other hand, are largely aware of the high premium they pay. They choose to pay this premium because of the criticality of power to their business needs. They are willing to pay a premium on the current grid tariffs, if they are assured of a 24x7 supply (Exhibit 13).

Exhibit 13

Awareness of premium paid for Back-up Power



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Other Investments

The poor quality and stability of power has resulted in other investments in voltage stabilizers, adding onto the cost burden for consumers.

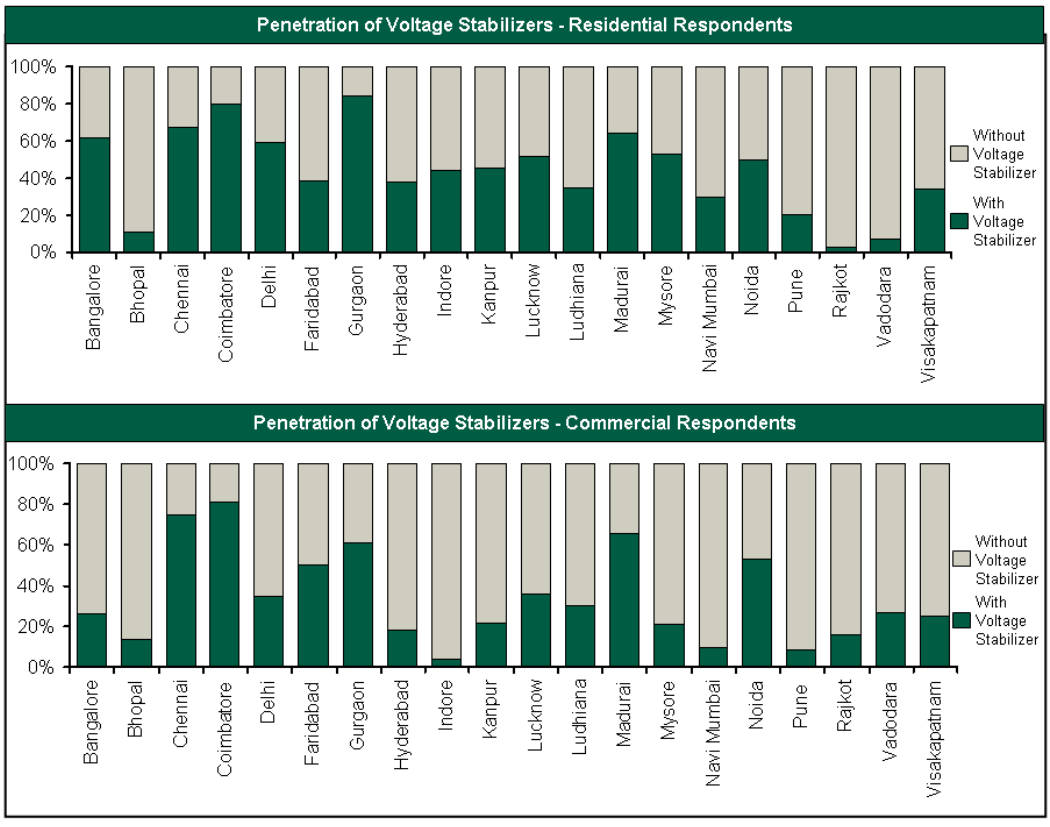
Both residential and commercial consumers use voltage stabilizers across many locations (Exhibit 14).

Residential consumers tend to use stabilizers for protecting specific appliances, mainly refrigerators, air conditioners and in some places for TVs and computers.

Commercial consumers tend to use a voltage stabilizer to protect their main power supply, rather than just for a specific appliance.

Exhibit 14

Prevalence of Voltage Stabilizers



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The Real Cost of Power

India's hapless citizens, however, have already invested a staggering Rs 100,000 crores (US$ 20 billion) in power back-up equipment due to the poor reliability of grid power. Yet another Rs 30,000 crores (US$ 6 billion) is the recurring annual operating expenditure incurred, to maintain back-up power equipment.

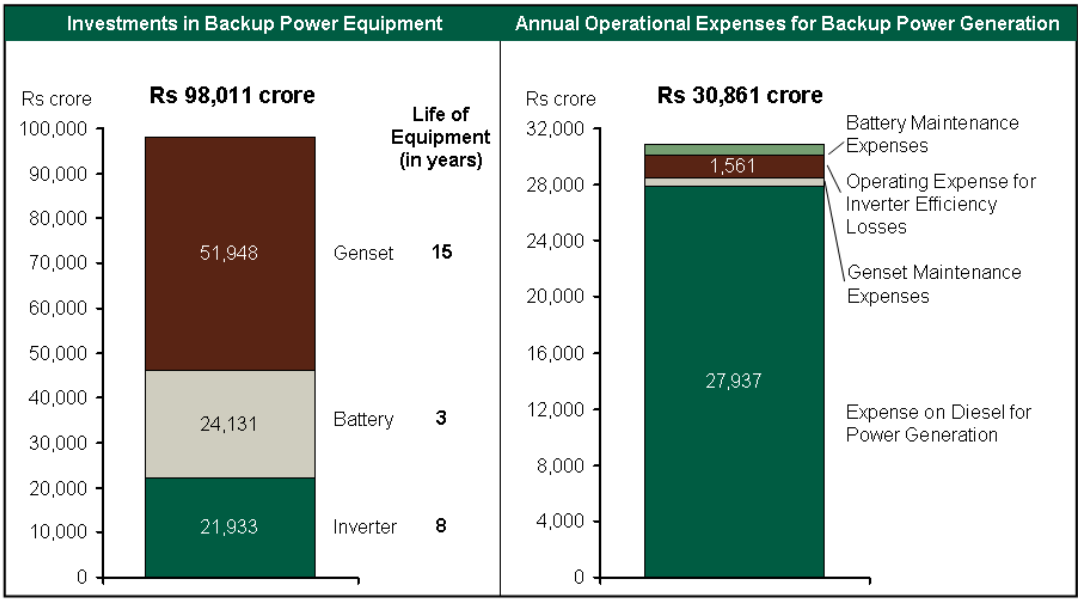
A majority of residential consumers invest in their own power back-up equipments; predominantly inverter systems with batteries and in some cases, generator sets.

Commercial consumers also invest in back-up solutions; predominantly diesel generator sets. Additionally, common back-up facilities are provided by some residential complexes, as well as malls, commercial complexes and office complexes. Newer residential and commercial complexes in the mid-premium range inevitably have a common power back-up.

Investments in generator sets, inverters and batteries must be considered over the typical life time of each of these equipments (Exhibit 15).

Exhibit 15

Rs 100,000 crores is invested in power back-up equipments, with ~Rs 30,000 crores per annum spent on recurring operational expenses



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In terms of operating expenses, diesel, used for power generation, is the major contributor. Diesel, being a subsidized fuel, contributes to the burden on the government. Expense is also incurred on the additional grid power used to charge the batteries. The expense on battery maintenance for inverter systems and generator maintenance is also a recurring operational cost, incurred for generating power during outages.

The real cost of power in India, is frightfully high. Consumers are but reluctant bystanders, forced to pay an exorbitantly high price to maintain adequate redundancy in their precious, but unreliable power supply.

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