

UrJar

A Lighting Solution using Discarded Laptop Batteries

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Lack of Electricity

In 2012, over 1.2 billion people (=20% of the world population) did not have access to grid-based electricity, almost all of whom live in developing countries

44.7% of rural India do not have any access to electricity



eWaste

In US, 142,000 computers are discarded per day

India has 58,824 registered IT companies (2011), generating 8,00,000 tons of e-waste every year



Li-Ion Batteries

Li-Ion batteries power laptops, tablets and phones, form a key constituent of e-waste

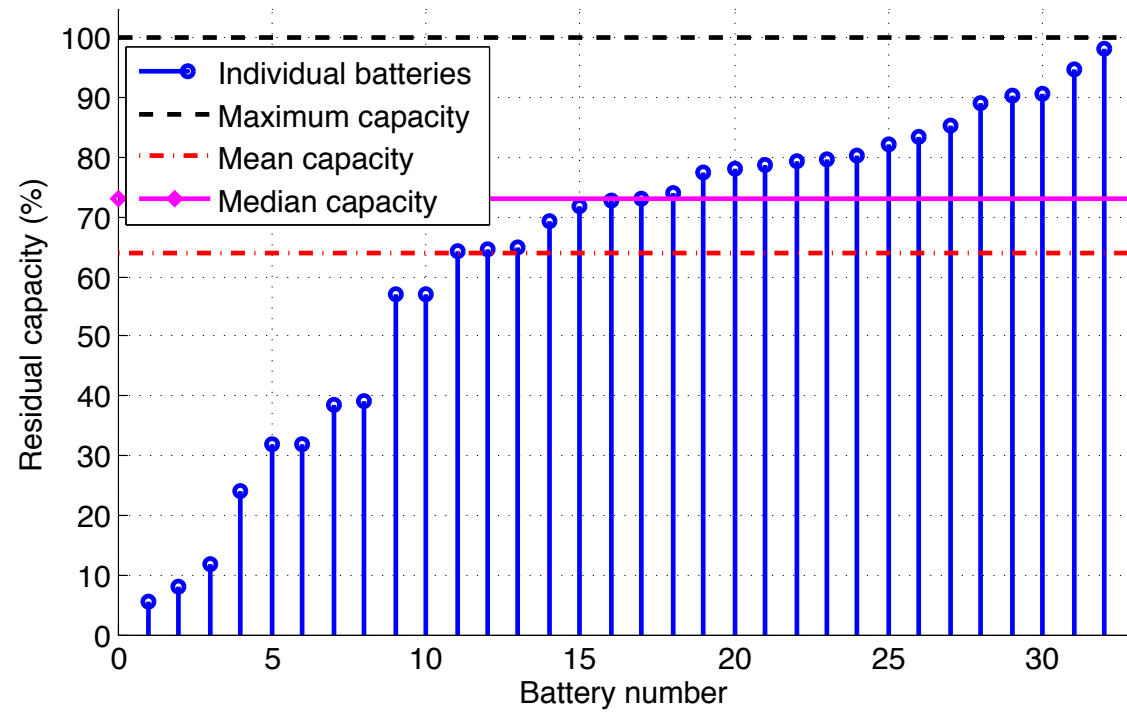
IBM India produced ~10 tons of discarded laptop batteries (2013)

Recycling Li-Ion batteries is **complex, labor intensive and costly**

- Takes 6-10 times more energy to reclaim metals from recycled Li-Ion batteries compared to producing them through fresh mining
- Recycling Li-Ion batteries is not commercially viable
- Discarded laptop batteries end up in landfills, resulting in an adverse environmental impact



Li-Ion Batteries



Charge Capacity: Maximum amount of charge that a battery can hold at any one time

Tested 32 6-cell laptop batteries, 3-years used

Rated charge capacity of 85 Wh. Mean value: 64% (~55 Wh), sufficient to power **3 W LED bulb + 6 W DC fan + 3.5 W phone charger**, for ~4 hours

Solution: UrJar

$UrJar = \underbrace{Urja}_{\text{Energy (in Hindi)}} + \underbrace{Jar}_{\text{Box}}$



UrJar uses discarded (but still usable) laptop battery cells to power low energy lighting (DC) appliances

UrJar address the problems of

- laptop battery e-waste,
- lighting needs in developing countries

UrJar Target Users

‘Bottom-of-the-Pyramid’ users

People with access to intermittent power

- Roadside vendors with mobile carts
- Households in rural India

UrJar primarily powers a DC light bulb

Current Practices Study

To understand current lighting practices of people with no continuous grid access, we conducted a study

25 participants (21 male, 4 female), age: 20-45 years

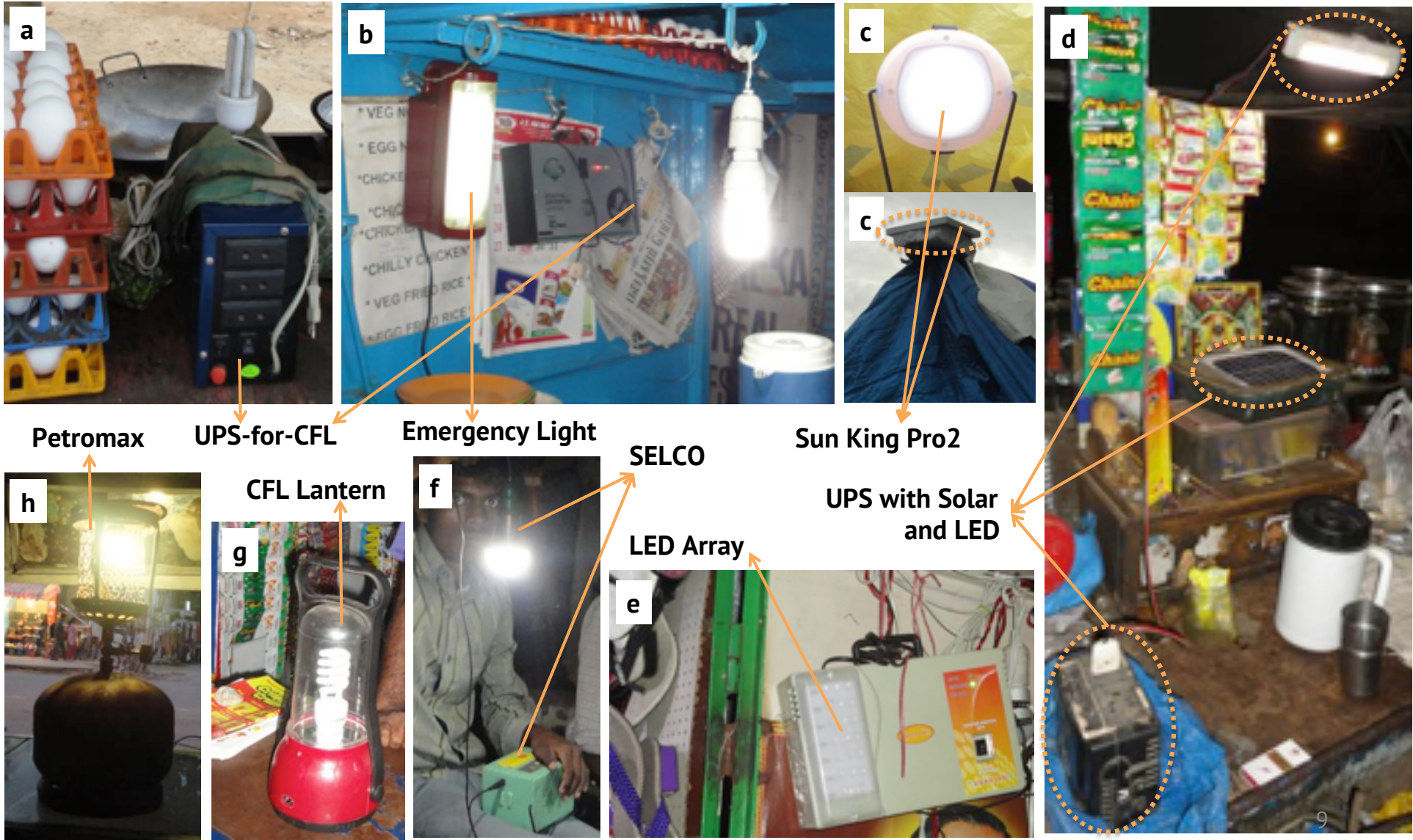
- 21 street side vendors: 10 sold food items (noodles, fruits, sweets, fried snacks), 5 sold tea & cigarettes; 6 sold apparels
- 4 were slum dwellers

35 devices (26 in use, 9 past devices)

17 interviews in Hindi, 2 in English, 6 in Kannada

Each interview for 20-30 mins

Current Practices Results



I. Fossil fuel powered

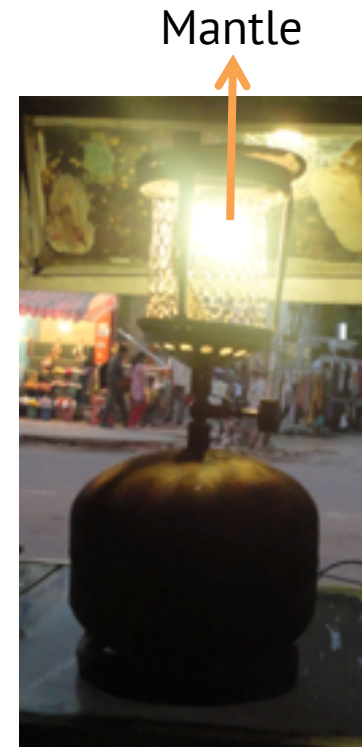
Current: 1 using LPG-based Petromax

Past: 3 LPG-based + 3 oil-based

- Switched to other battery-powered devices

Low capital cost INR 300 - 600

High fuel cost INR 750 - 1200 per month



Petromax

mantle blows up
every month... costs
INR 40 to replace

unsafe to
use

have to travel
1 to 2 kms to
re-fill LPG

not
aesthetic

very
heavy

II. AC-Charged



**CFL powered
by battery**



CFL Lantern



**LED powered
by battery**



Emergency Light

II. AC-Charged

a box with battery and charging circuit

+

a light (CFL, LED, or tube)

23 out of 35 devices

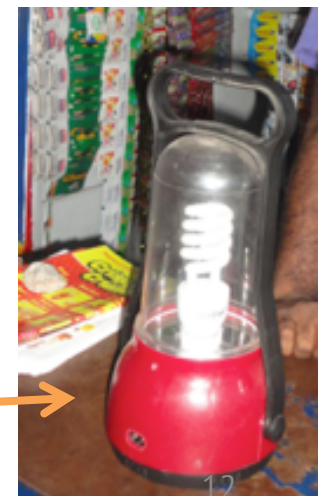
Charged device at home using AC power from grid

15 CFL powered by battery (INR 1200-2800)

5 emergency lights (INR 350-2000)

2 LED powered by battery (INR 1000-2000)

1 CFL Lantern (INR 1400)



II. AC-Charged

Using for 2-36 months | 2-6 hours/day | Charge for 5-8 hours
CFL/LED powered by battery = 12 months warranty

(CFL Lantern) runs for 3 hours at max, because of which I have to close my shop by 9 (PM). Ideally I would like something which works for 4 to 5 hours

not aesthetically-pleasing

power backup duration was not sufficient

(LED powered by battery) expensive but super good

(CFL powered by battery) battery inside the box needs to be replaced every year, which costs INR 600-900

(emergency light) lasted only 3 to 5 months and come with no warranty

III. DC-Charged

Solar panel

+

Battery

+

Light (5W LED)

3 Community Solar
2 Individual Solar



Community Charging



Individual Charging



III. DC-Charged: Community

Community Supervisor

- Maintains charging station (6-large solar panels on roof)
- Collects batteries at 6 AM, connects it to the charging station, distributes charged batteries at 6 PM

Using for past 7-8 months, with bulb on for 12 hours daily
Subscription-based pricing model, INR 200 per month



children can
study at night

get light
during
dinner

helps in avoiding
rats, insects at night

wear and tear
of the wire

no way to
charge mobile
phones

III. DC-Charged: Individual

Sun King Pro 2 (INR 2400); a locally built solution (INR 3000)

Keep the solar panel on the roof of shop/home

Offers 12-months warranty, *“so even if it lasts just a year, it is the same price as SELCO... also the hardware is ours”*

aesthetically pleasing

no dependency on SELCO people

light has 3 levels of brightness

Offers two-USB mobile charging points

comes with a stand to fix the light

very compact



Design Considerations

Lighting ~6 hours daily

Minimize Losses Minimal AC-DC conversion losses

Modular Design Easily replaceable parts; Hide aesthetically unpleasing parts

Pricing <INR 3000; Minimal recurring cost

Clear instructions Prevent malfunctioning of UrJar or connected device

Portability Street vendors can carry it easily

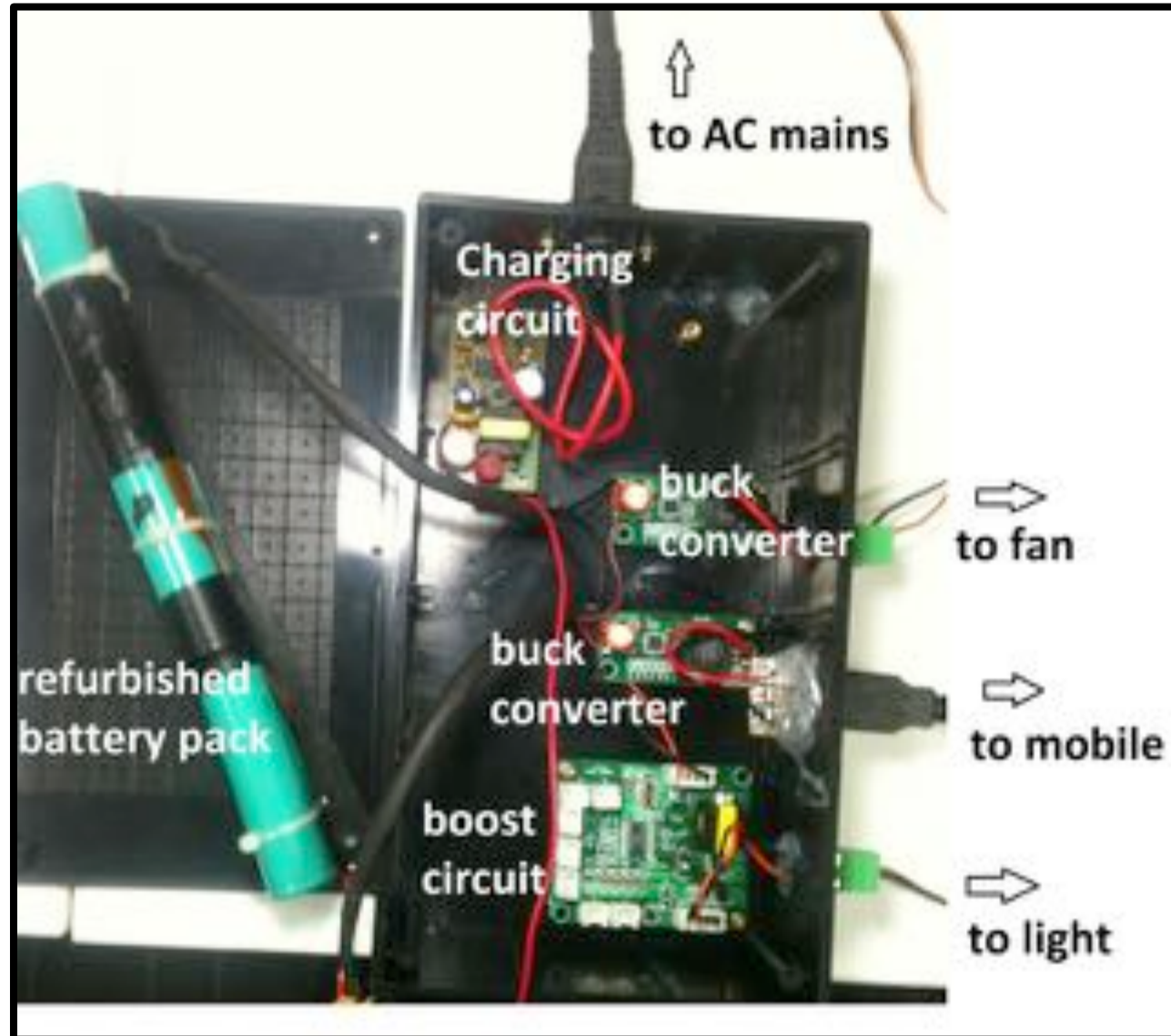
Safety Minimize fire hazards by Li-Ion

UrJar Development

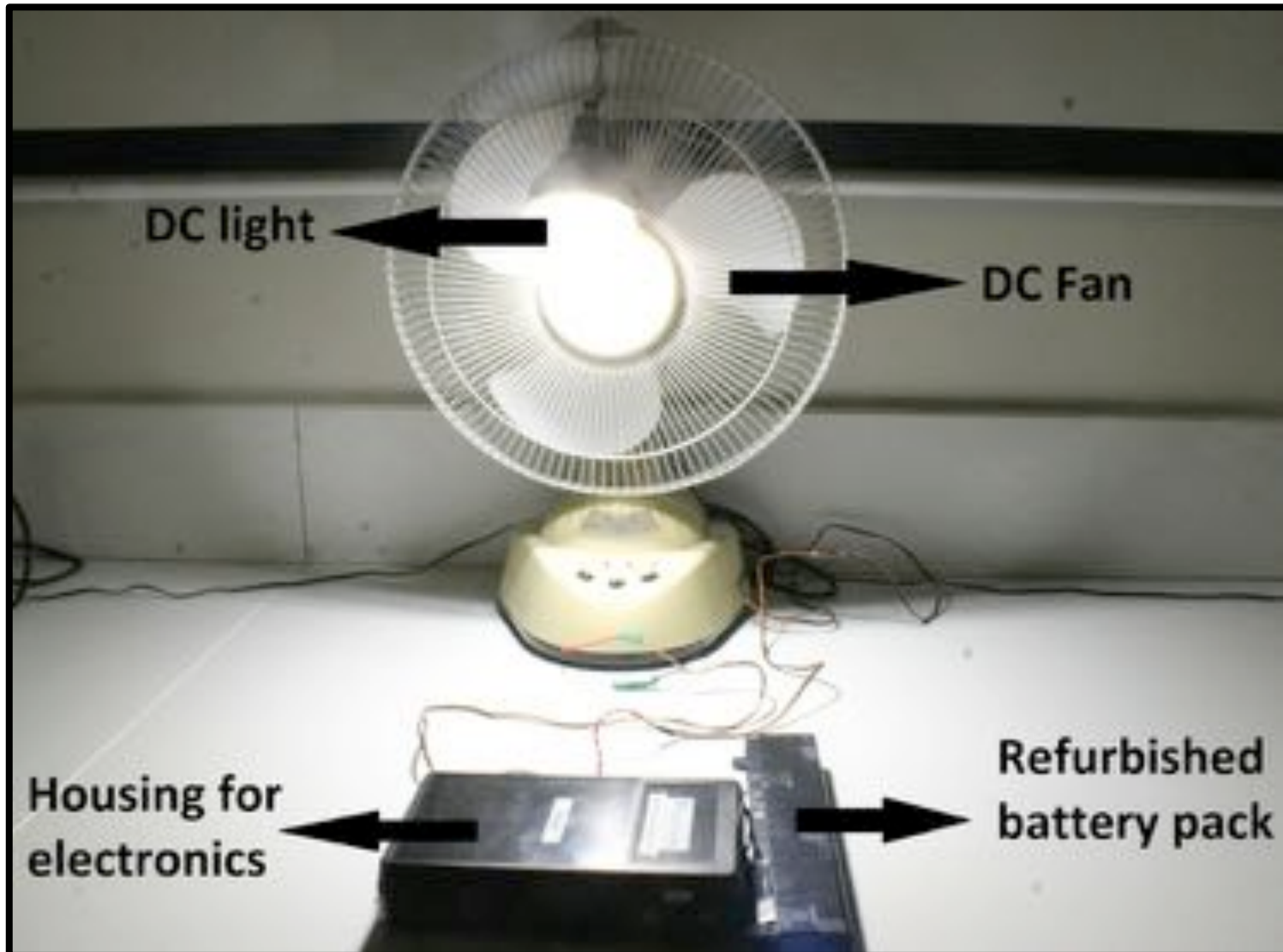
- Step 1** Source used laptop battery packs from eWaste
- Step 2** Disassemble packs to extract individual Li-Ion cells that can still deliver power
- Step 3** Connect re-usable cells to build a refurbished battery pack
- Step 4** Build a **charging circuit** for the re-furbished pack, with **step-up/step-down converters** and other electronics, to power external devices such as a LED light

*All UrJar prototypes were built by Radio Studio India

UrJar Initial Prototype



UrJar Initial Prototype



Evaluation



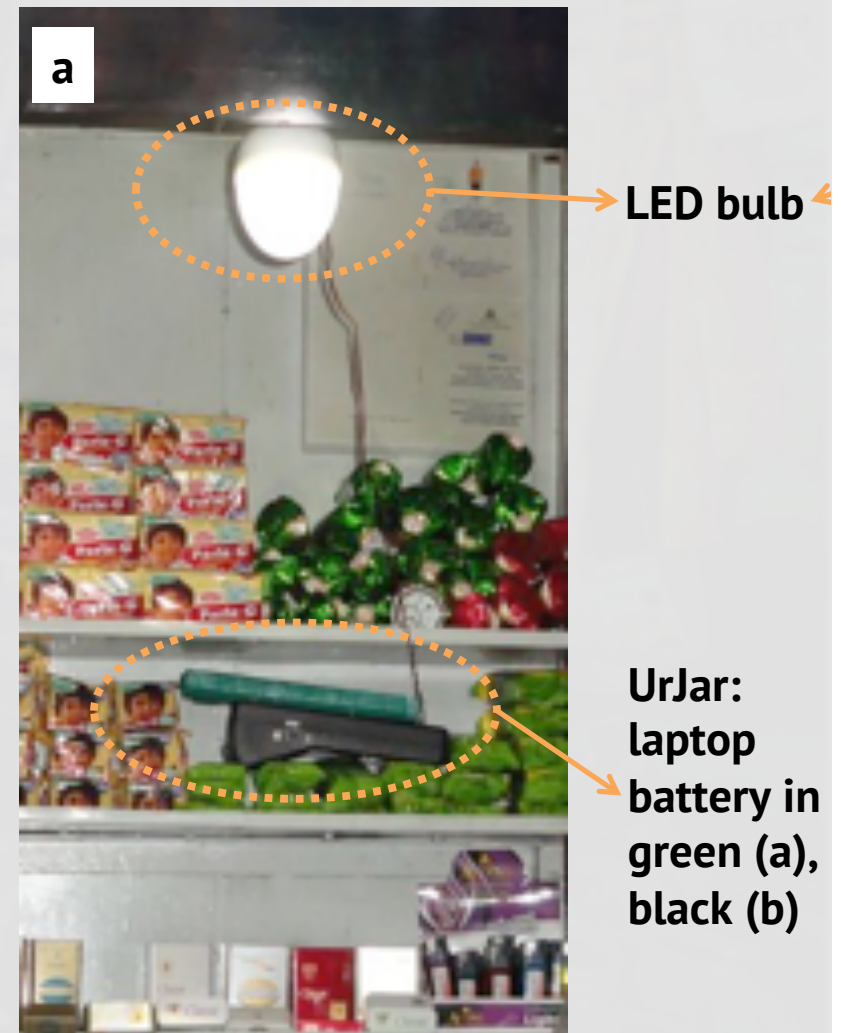
Evaluation

5 participants (4 male, 1 female)

- 1 resident, 4 street-side vendor

Unsupervised settings

Focused on users' experience with *UrJar*, including usage time, charging time, benefits, problems, shortcomings, additional 'good-to-have' features, amount of money willing to spend to buy it

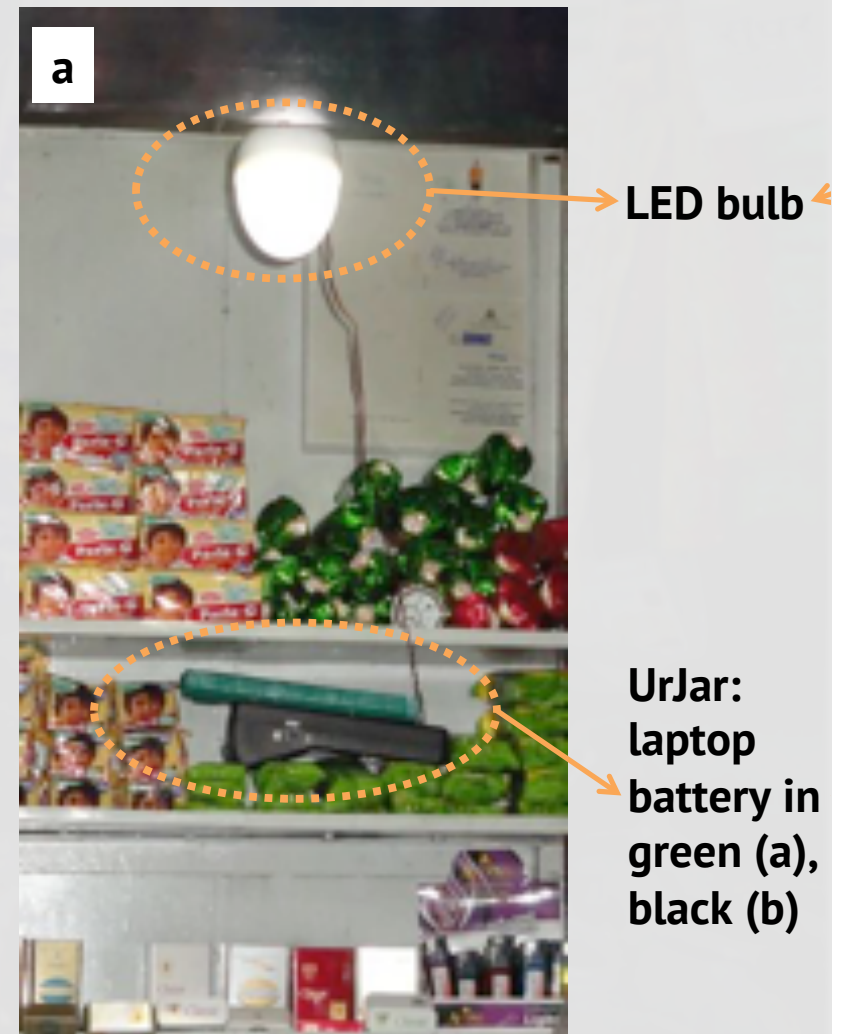


Evaluation

Stage 1: Connect the three parts - circuit box (black-colored box), laptop battery (green-colored bar), and LED bulb - as per intuition

Stage 2: 15-mins training, including how to use, how to connect the parts, how to charge

Stage 3: After a week (3 months for one participant), conducted a 30 mins semi-structured interview



Results

Even after 3 months of usage, the participant was happy and satisfied

no
problem
at all

3/5 participants were able to correctly connect the three parts without any help

easy to
use

Used 4-6 hours daily (one used for 12 hours daily)

No one used UrJar for phone charging

Willing to spend INR 1000-1500 with 1 year warranty



Results

easy to use

brighter lights will help attract customers

the lantern only used to last for a maximum of 2.5 hours daily, and hence I had to close my shop by 9 (PM)... now with UrJar I can keep it open until 11 PM

no problem at all

my (previous) emergency light needed charging everyday; with just one day of charge, this works for 2-3 days, from 6:30 to 11 PM

thicker wires so that rats cannot cut them easily

cheaper

safe

need long wire to hide the device away

UrJar Final Prototype



Benefits

Environmental Benefits

- utilize the latent residual capacity in laptop batteries
- can incentivize organized collection of eWaste
- a cleaner, cheaper alternative than burning kerosene

Business Benefits

- offers potential business opportunity to companies engaged in rural electrification
- UrJar is easy to build, require minimal capital investment

Energy Efficiency Benefits

- uses Li-Ion batteries, powers DC appliances, uses LED bulbs
- Li-Ion batteries can sustain **high depth of discharge**, resulting in longer backup power duration before the need to charge again as well as longer life cycle

Video

Thank You!

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