Technological and Deployment Challenges and User-Response to Uninterrupted DC (UDC) deployment in Indian homes

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Power Shortages in India

- India is third largest Electricity producer in India.

Still…

- 33% of households un-electrified
- Most of the electrified homes face Power cuts during load shedding to bridge the demand supply gap
  - 2 hours to 16 hours of Power cuts in most part of the country

Solar-DC a Promising Solution

- Solar DC to reduce Demand Supply gap, making huge sense for Off Grid and near off-grid homes
- Distribution at 48V, helps in reduced losses

Issues

- Acceptance among people for technology and DC
- Lack of standardization and availability of Home appliances

What it Needs ??

- **Instead of Market Push → create a PULL**

Lets Understand…
What happens today during Power shortages in India ??

This is what we call…… A Blackout !!
Common in India
Power shortage gets Discom to cut power in select localities

Options ??

Brownouts

Introduce a new power-level for distribution to homes

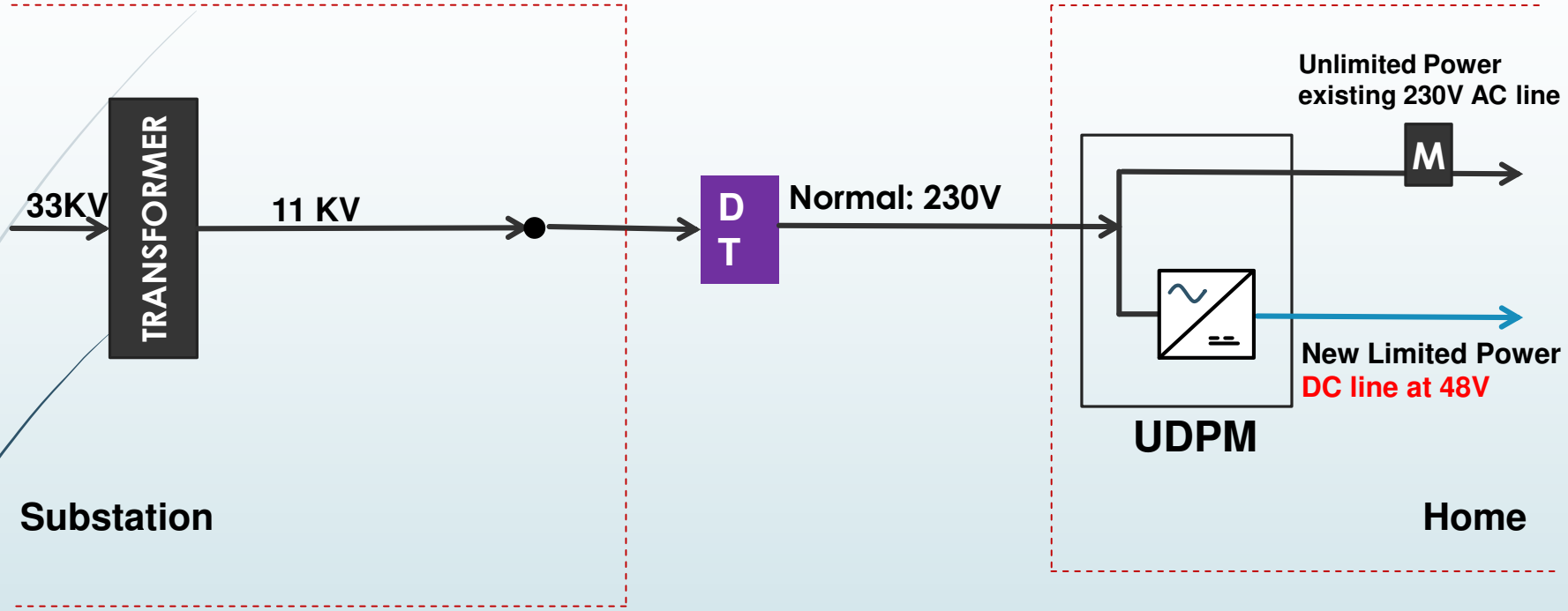
Low-amount power transmission -- say 10%

To reach every home and provide 24 x 7 connections.

Dilemma

- **What will 10% power do?**
- **Can distribution-grid supply only 10% of normal power?**
  - **Will the homes not draw what they want?**

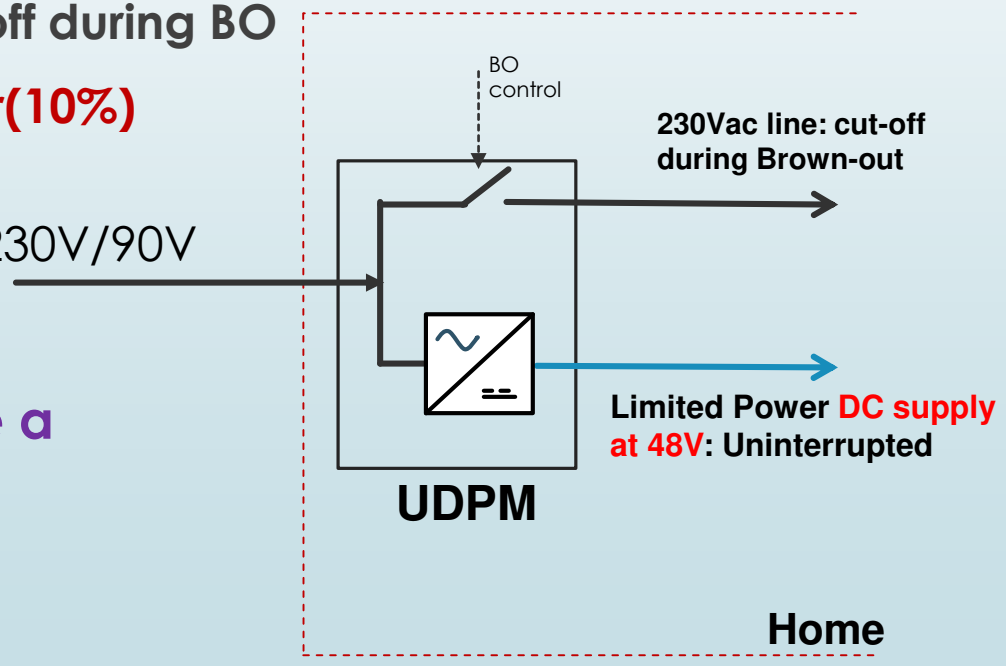
Addition of a DC Power line at each home



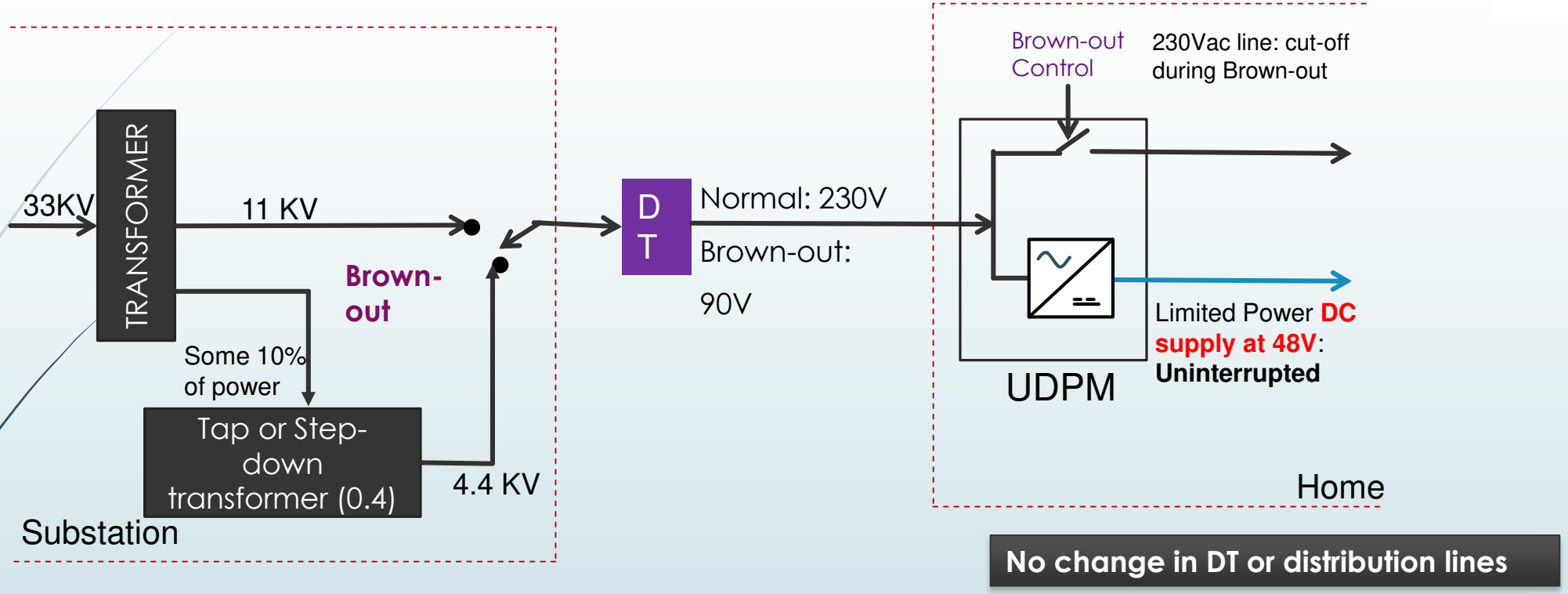
- Substation charge feeders with 11kV Distribution Line
  - Distribution transformer steps down voltage to 230V in each of three phase
- UDPM at home allows using present AC line and a limited power DC line
  - Now make the DC line UNINTERRPTED to create a market pull for DC appliances

Brown-out: 90% Load shedding

- Brown-out: only 10% power
  - Prevent overload by ensuring no home draws > 10%
    - Existing AC line (unlimited power) cut-off during BO
    - A new DC micro-grid with limited power(10%) but always ON
      - ON during Normal + Brown-out state
  - Uninterrupted DC micro-grid will create a market pull for DC appliances



90% Load shedding: How?



- **Brown-out: continue feed 10% power to Distribution Line**
  - Substation feeds 11kV in normal and with 4.4kV in brown-out condition (only 10%) on DL
  - Distribution transformer steps down voltage to 230V in normal / 90V in brown-out condition
- **UDPM detects AC voltage-drop to 90V:** cuts off AC line but continues feeding 48V DC line
- 10% Brown-out Power small enough to be made available even during worst power-shortage

But what will 10% DC Power do?

- Assume uninterrupted but limited Power: 100 Watts DC
  - Can support 3 lights + 2 fans + cell-phone charging
  - Or 3 lights + 1 fan + TV (24" LED/LCD) + cell-phone charging
    - can be installed incrementally
- 100W per home is such a small amount that it can be supplied even in adverse power situation
- What if one wants more?
  - Add Solar PV
  - If needed, add a battery to have a Solar DC system
  - 500W Solar DC can support 5 fans, 8 lights, 2 TVs, multiple cell-phone / tablet chargers and a laptop charger

What it Costs ?

$1 = ₹63

- Require minimal Government Investment
  - UDPM at each home (about ₹1200 per home)
  - minimal change to the existing power distribution infrastructure (about ₹500 per home)
  - Brings in Large Consumer Investment
    - But in small incremental amounts
    - for energy-efficient DC appliances and solar panels

Customer will save significantly in power-bills

- Similar to what happened as telephony moved from fixed line to wireless

UDC Innovation

- Reduce domestic demand: energy-efficient appliances
- Increase Supply as decentralized solar PV gets added
  - Reducing supply-demand gap

- And at the same time have 24x7 DC power at each home
  - Adequate for lowest income homes
  - Middle and high income homes will install solar

- Could help Manage Subsidy
  - Power Distribution Companies unconstrained: would become financially viable
    - Uninterrupted DC power supply at low tariff
    - AC power can be charged at market rates

UDC Field Trials
Tamil Nadu, Hyderabad, Orissa, India

Lots of Field Trials

Location	Name of the Feeder	Total Consumers in the DT	Status
Maduranthakam Town, Madurantakam, Chennai, Tamil Nadu	Maduranthakam Town Feeder	241	Commissioned on Dec14
Moinabad Town, Moinabad, Hyderabad, Telangana	Moinabad Town Feeder, DTR-1	203	Commissioned on Mar15
Thirumala Sub-Station, Poojapura, Thiruvananthapuram, Kerala	Poorjapura Feeder	407	Installation in Progress
Tirimalla Sub-Station, Khorda Circle, Bhubaneswar, Odisha	Bhoisahi Feeder	550	Consumer consent form collection in progress
Tirimalla Sub-Station, Khorda Circle, Bhubaneswar, Odisha, India	IDCO Feeder	81	Commissioned on Mar15

At the Sub Station Side

Home side
Maduranthakam, TN

- Number of houses covered: 241
- Date: December 2014

Feedbacks

"*We use DC devices all day long*, No sweating even during peak season"

"Life has become more comfortable. Now we don't sit and wait for power restoration"

- Most families covered under UDC project at Madhuranthakam were very happy with the results. They appreciated the fans and lights provided by the system.
- **This cluster of 281 houses is presently the only community in the neighbourhood that remains lit even when the rest of the locality is facing power-cuts.**

Moinabad, Hyderabad: Brown-out data

Just before Brown-Out

	Normal P-N Voltage (V)	Normal Current (A)	Normal Power kVA
Phase 1	251.0	84.0	21.08
Phase 2	253.0	62.0	15.69
Phase 3	249.0	90.0	22.41
Total Power (kVA)			59.18

During Brown-Out

	BO P-N Voltage (V)	BO Current (A)	BO Power in kVA
Phase 1	97.6	19.0	1.85
Phase 2	97.1	10.3	1.00
Phase 3	97.0	24.0	2.33
Total Power (kVA)			5.18

- **Brown-out Power Consumption: 10% of Normal Power**
- **203 LIG Homes; DTR capacity 100kVA**
- **Power saving even in normal hours because of DC appliances**

Brown-Out Duration: 2 hrs /day

UDC Moinabad Brown Out Data Sheet				
Date	TIME		Power Consumed just Before Brown-Out in kVA	Power Consumed during Brown-Out in kVA
	ON	OFF		
20-May-15	3:10 PM	4:45 PM	50.70	4.35
21-May-15	3:07 PM	5:07 PM	50.70	4.35
22-May-15	3:15 PM	5:10 PM	59.18	5.18
23-May-15	3:00 PM	5:00 PM	55.33	5.03
25-May-15	2:55 PM	5:00 PM	71.93	4.51
26-May-15	3:20 PM	5:15 PM	44.98	4.89
27-May-15	3:00 PM	5:00 PM	60.02	5.18
28-May-15	3:00 PM	5:00 PM	60.75	4.64
29-May-15	3:00 PM	5:00 PM	57.22	6.06

System Scaling

- UDC FT early results very encouraging
  - EB officials are reporting requests for similar installation from consumers in neighbouring
- Finally an Official Announcement
  - USD 13M towards Uninterrupted DC and DC micro-grid at
    - 100K homes in Bodh Gaya, Bihar, India
    - 5K Homes in Assam, India

$1 = ₹63

There has been talks about an innovative solution in the distribution space that would eliminate blackouts.
We are looking at a solution called Uninterrupted Direct Current (UDC), whereby a parallel DC line will go into every home and compatible appliances can run even when there is load shedding or blackout. Instead of blackout, you would now have a brownout. When there is overload, this line will ensure that a fan and lights continue to work. Even with reduced production, you ensure that these households get power, albeit reduced capacity, to run essential appliances. We are planning two pilots, one for 5,000 installations and another for 1 lakh households, at the cost of Rs 80 crore.

Piyush Goel (Min of Power)
Financial Times (18/5/15)

Thank You

DC Micro-grid at home and UDC Innovation to drive
a dream to Make Power cuts a thing of past, in India too…