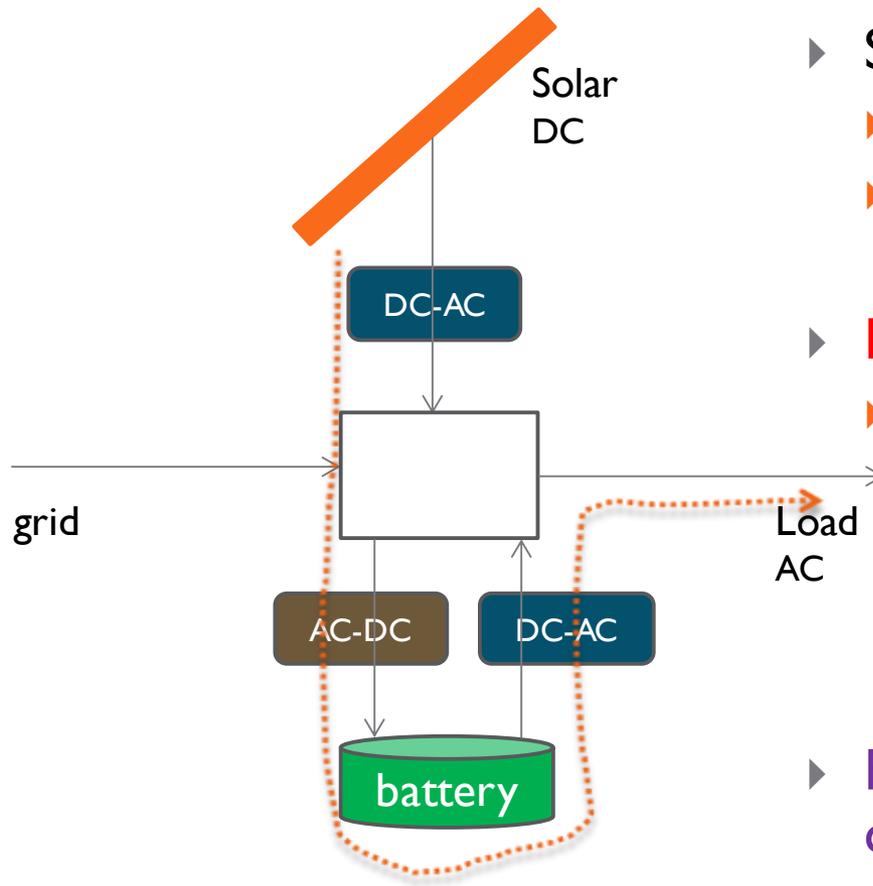


Towards Next Gen Powering of
Indian Homes Capitalising on
Decentralised Solar Green Energy
Energy-efficient DC Appliances
Smart Load Management

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Decentralised Solar Power at Homes



- ▶ Solar PV gives DC Power
 - ▶ But load is AC
 - ▶ Needs a DC-AC convertor
- ▶ Now if we add a battery
 - ▶ Battery stores only DC
 - ▶ Require a AC-DC convertor for charging
 - ▶ Require a DC-AC convertor during discharging
- ▶ For low power, each convertor* can have 10 to 15% loss
 - ▶ Solar with battery may have 25 to 45% loss

* Solar DC-AC may have slight better efficiency

And it gets worse

- ▶ As one realises that home-load is moving towards DC

AC fan	72W	BLDC fan	30W
at speed I	60W		9W
CFL tube	36W	LED tube	15W
low intensity	na		4W

volume prices
similar for fans



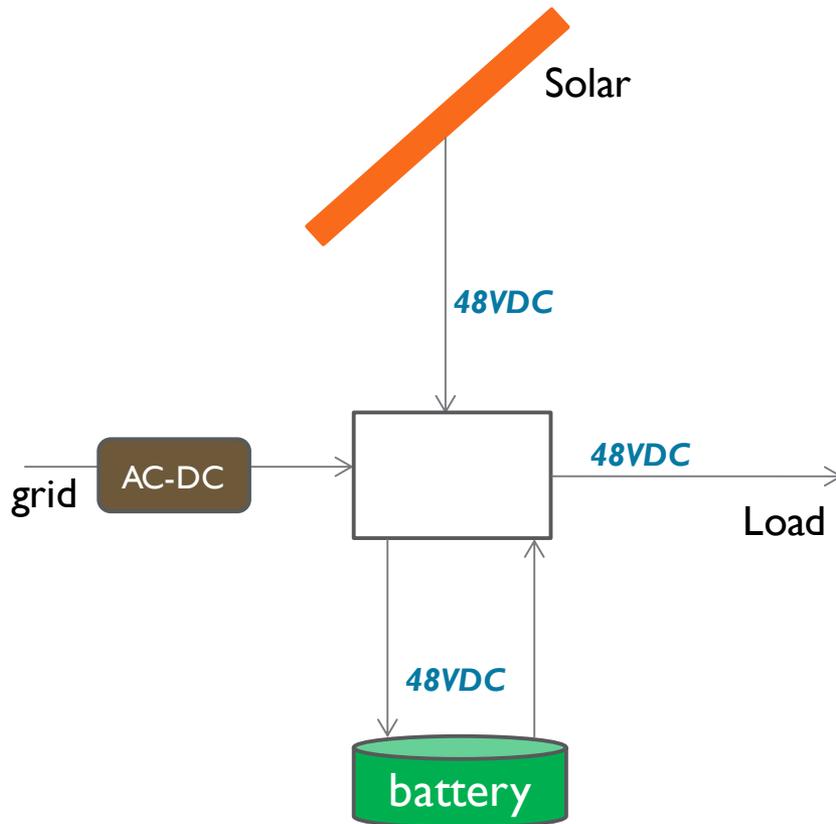
LED tube life much
longer (DC powering
enhances reliability)

- ▶ All Electronics devices work on low-voltage DC
 - ▶ TV (LED/LCD), laptops. Cell-phones, speaker-phones, tablets, speakers
 - ▶ AC to DC conversion has losses from 20% to 50% in each device



- ▶ Even the refrigerators, air-conditioners, washing machine in future will be BLDC motors
- ▶ Use of DC-powered and energy-efficient devices
 - ▶ Consumption **down by 50%**

Move to **Solar-DC** at Home Premises



- ▶ 48V DC line as an additional power line at home
- ▶ Highly power-efficient usage of Solar
- ▶ Low-power from grid alone converted from AC-DC
 - ▶ Designed to have minimal loss
- ▶ Battery can be added with higher efficiency (no convertors), if required

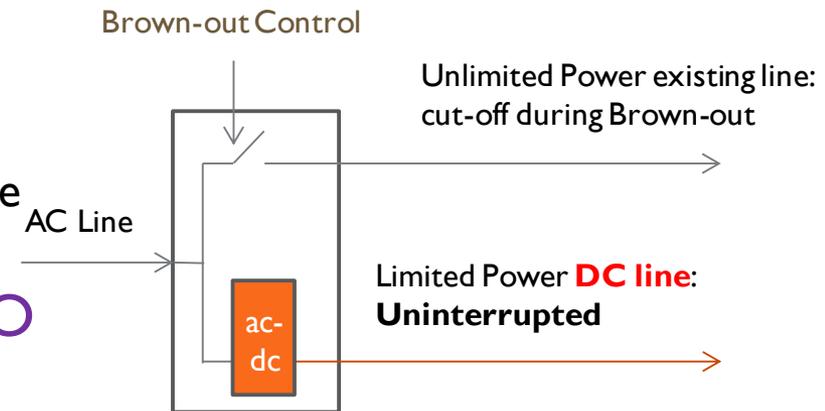
and the **Load Management Innovation**

- ▶ with the aim to Create a **PULL** for solar-DC and **Prevent** Black-out at homes

- ▶ Power shortage gets Discom to cut power (**black-out**) in select localities
 - ▶ Introduce a **new power-level** for distribution to homes
 - ▶ **Brown-out**: low-amount power transmission -- say 10%
 - ▶ To reach every home and provide 24 x 7 connections

Dilemma

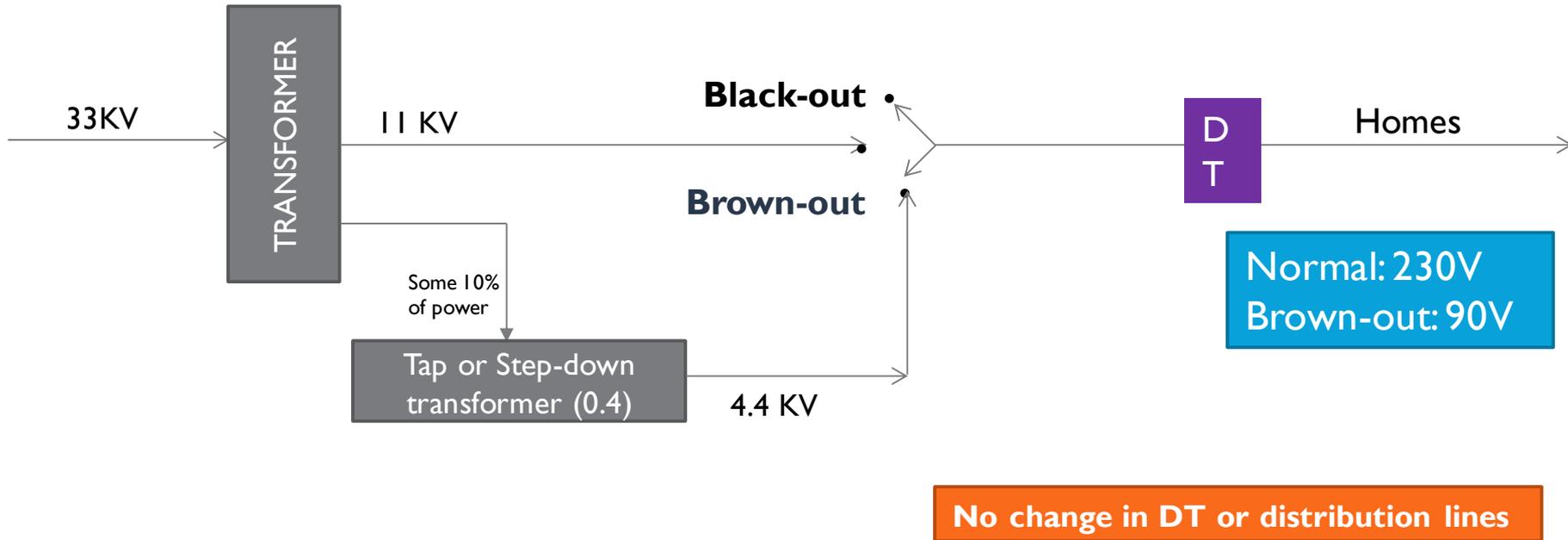
- ▶ **What will 10% power do?**
- ▶ Can distribution-grid supply only 10% of normal power?
 - ▶ Will the homes not draw what they want?
- ▶ **Answer:** Grid to supply power on two lines at homes
 - ▶ Existing **AC line** (unlimited power), but cut-off during **brown-out**
 - ▶ **A new DC** with **limited power**, but always ON
 - ON during **Normal + Brown-out** state
 - ▶ **Large consumers cut-off during BO**



How does one **Signal** Brown-Out?

- ▶ need to signal each home **instantaneously** especially during **unscheduled** shut-down
 - ▶ when **grid-frequency falls below a threshold!**
- ▶ Can one rely on wireless data transmission to each home?
 - ▶ Cost?
 - ▶ Data transmission on cellular network have Latency Issues?
 - ▶ What if jammers are placed near meters?
- ▶ What about in-line PLCC? Not sufficiently developed? Costs?
- ▶ **IITM Innovates to come with a new in-line Signalling mechanism?**
 - ▶ Use a sudden drop of AC voltage level on grid to signal BROWN-OUT
 - ▶ Restoration of Normal level to signal NORMAL

Instant Brown-out Signalling to homes



▶ Brown-out Power is Limited

- ▶ 10% of full power is **small enough** to be made available even during worst power-shortage in each locality

But is 10% Power useful? Yes, if in **DC form**

- ▶ Assume **uninterrupted but limited** Power: 100 Watts DC
 - ▶ enable three lights + 2 fans + cell-phone charging
 - ▶ or three lights + 1 fan + TV (24" LED/LCD) + cell-phone
 - ▶ can be installed incrementally
- ▶ 100W per home is small enough that it can be supplied even in adverse power situation
- ▶ **But what if one wants more?**
 - ▶ Add Solar PV
 - ▶ And if needed a battery to have a solar DC
 - ▶ 500W solar DC would support 5 fans, 8 lights, two TVs, multiple cell-phone / tablet chargers and a laptop charger

But where is the pull to add solar and DC?

- ▶ Decentralised Solar can make huge difference
 - ▶ 240M homes: Avg 500W solar (50 sqft), will produce nearly
 - ▶ $240M \times 0.5 \text{ kw} \times 1600 \text{ solar hours a year} = 190,000 \text{ GWh per year}$
 - ▶ Close to total Domestic consumption in a year
- ▶ The UDC and Solar-DC approach Enables
 - ▶ No black-out in any home (without significantly burdening grid)
 - ▶ Create a consumer demand and Investment for DC appliances
 - ▶ And making decentralised Solar PV attractive for homes
 - ▶ Reduced 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 LIH: Mid and high Income homes will install solar



Multiplying Investments

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

Customer will save significantly in power-bills



What is happening?

- ▶ Installations at homes, offices, labs at IITM
- ▶ **UDC trials for 300 to 500 homes each at Chennai, Hyderabad, Trivandrum and Orissa**
 - ▶ Chennai already ON
 - ▶ Ministry of Power POC in one town with 100K homes in 2015
- ▶ **Off-grid Homes (OGH): 70 million homes**
 - ▶ 25 home deployments in Nilgiris, Orissa, W. Bengal, Sricity and Telegana
 - ▶ Propose to install 100K off-grid homes
 - ▶ With the support of CSR, donations and Government support



To Sum Up: India needs to Lead and not follow

- ▶ Leadership in decentralised Solar DC (Green Power)
 - ▶ define 48V DC standard for low-power home appliances
 - ▶ Plugs / protection / circuit-breakers
- ▶ Leadership in segregating power-lines as a mechanism for load management and bridging supply-demand gap
 - ▶ Version 2.0 of rural grid separation
- ▶ Drive a Mission for 24x7 Electricity to all homes
 - ▶ with Uninterrupted 48V DC line from grid and Solar DC
 - ▶ Connect all homes in 5 years including all rural homes
- ▶ Can complement conventional power generation from Coal and Nuclear well

