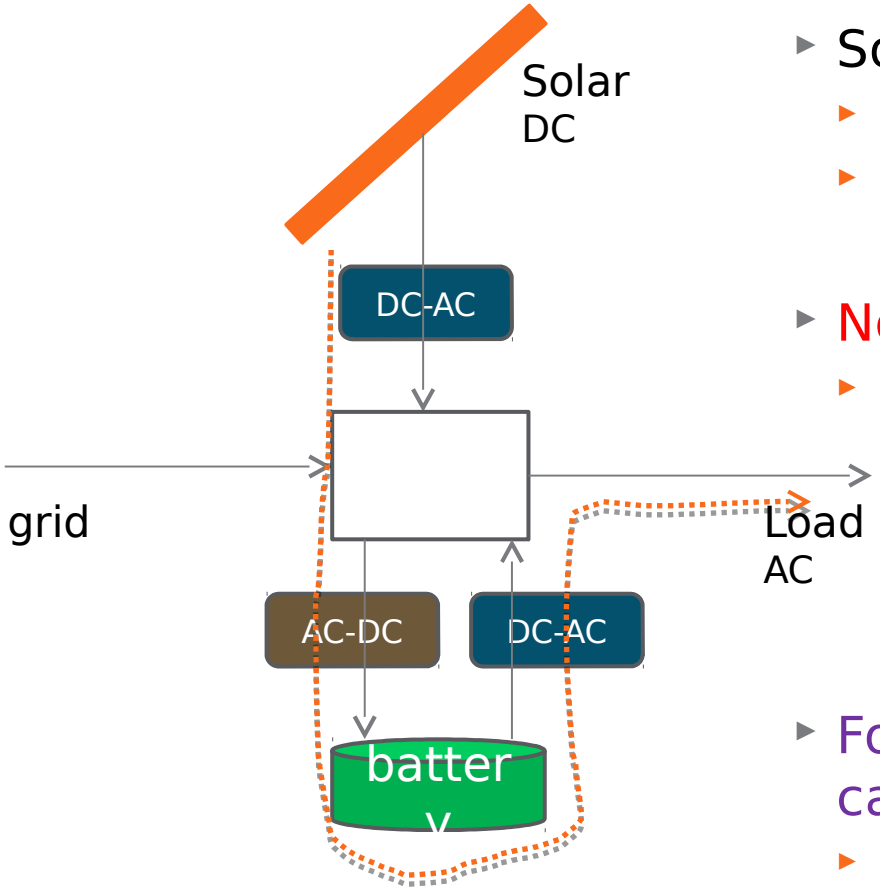
Towards Next Gen Powering of Indian Homes capitalising on

Decentralised Solar Green Energy
Energy-efficient DC Appliances
Smart Load Management

Ashok Jhunjhunwala, IIT Madras, ashok@tenet.res.in

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

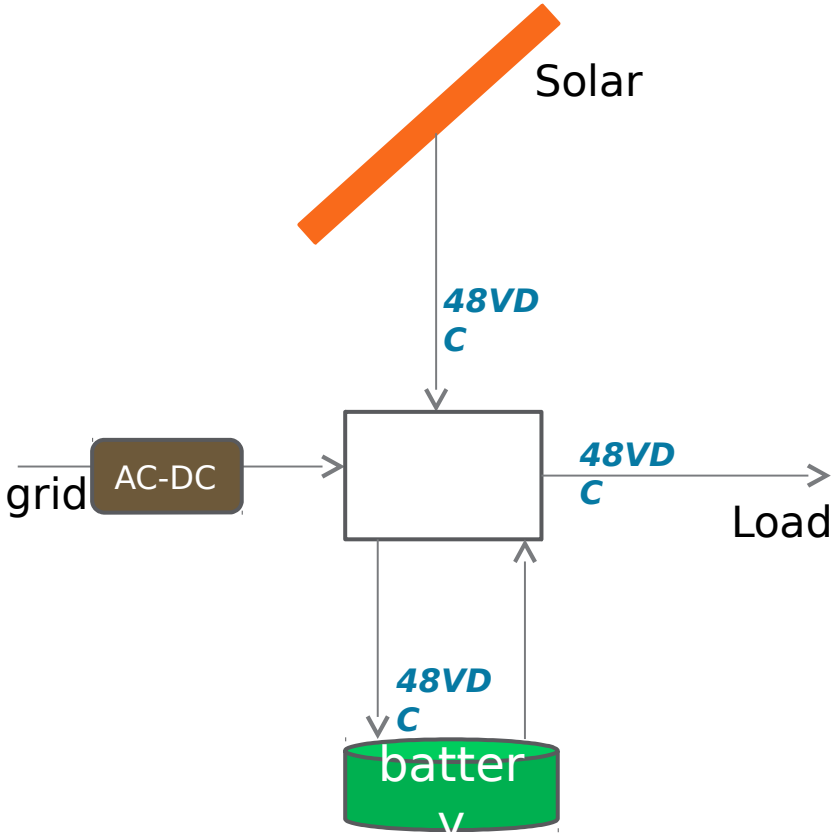
AC fan	72W	BLDC fan	30W
at speed 1	60W		9W
CFL tube	**36W**	**LED tube**	**15W**
low intensity	na		4W

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



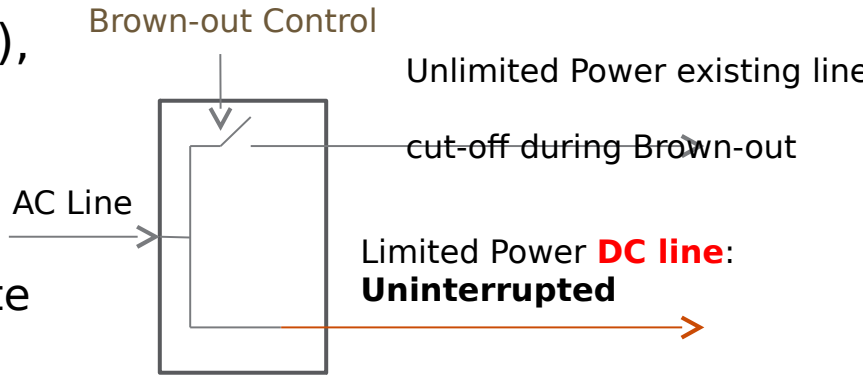
- 48V DC line as an additional power line at home
  - Highly power-efficient usage of Solar
  - Low-power from grid alone converted from AC-DC
    - Designed to have minimal loss
  - Battery can be added with higher efficiency (no convertors), if required

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%

- 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



But what will 10% DC Power do?

- 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 x 0.5 kw x 1600 solar hours a year = 190,000 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

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 30% Government support
      - Need support from alumni