Low voltage DC distribution system compared with 230 V AC

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Background:

This work was offered by CIT (Chalmers Indutriteknik), CIT is a foundation founded by Chalmers, providing knowledge on commercial terms. CIT has issued this work to find out new solution for normal AC power consuming household appliances which would be compatible with Low Voltage DC.
Why DC?

• Distributed generation from solar and wind turbine is increasing rapidly where each of these resources is intrinsically DC.

• Superior compatibility with the DC energy storage technique such as battery and fuel cell has drawn recent interest of DC use.

• An explosive number of appliances in households, offices and industries run internally on low voltage DC.

• Easier incorporation of distributed generation and back up batteries could be used in an efficient way to supply the DC appliances directly.
THE 230 VOLT AC HOUSE

The DC power sources such as solar cells, fuel cells can be connected with the AC distribution system of a house.

- For solar cell and fuel cell, a DC to AC converter is required in this power system.
- Utilizing solar energy in this way involves two stages of energy conversion and wind energy (micro turbine) needs three stages of energy conversions with inherent energy losses.
- For the micro turbine, a full scale frequency converter is needed to connect with the AC bus.
- For the sensitive loads, uninterruptable power supply (UPS) is required.
Standby losses are 68% of the total losses and it is 56% higher than resistive losses and 48% higher than rectifying losses.
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DC DISTRIBUTION SYSTEM FOR THE HOUSE

- The solar cell is connected to the DC bus with DC/DC converter.

- Compared to AC systems, the DC energy sources (fuel cell, micro turbine) have eliminated one DC to AC conversion stage.

- The energy storage system can be connected directly with the DC bus without any converter.

- To connect the DC distribution system with the existing AC system an additional AC to DC converter is required which is a drawback.

Scheme of the proposed DC distribution system
SYSTEM COMPARISON

Table shows the losses in the feeder cable and energy consumption for different DC distribution system.

The power loss of the 24V DC system is higher than for the other systems.

In the case with the 48V DC system with the optimized wire area the losses could be reduced by almost 44% compared with 48 V DC systems.
Figure presents total energy consumption including the losses for different system.

The 230 V systems are the highest energy consuming system, 48 V DC with optimized cable area is the lowest energy consuming system.
CONCLUSION

- Energy consumption and losses for some common household appliances have been investigated for the 230 V AC distribution systems and Low voltage DC distribution systems of 24 V and 48 V level. The losses are high in the case of 24 V DC systems. The total energy consumption is the lowest for 48 V DC systems with optimized cable area which will save a large amount of energy in the long run.

- There are many advantages for DC system such that, It does not required DC to AC converter to connect solar energy, it does not need AC to DC rectification for the devices which run internally on DC which save inherent energy losses; it reduces the standby energy consumption as it doesn’t need step down magnetic; finally its safe as it is low voltage.
Thanks for your attention