AC Versus DC Distribution Systems—Did We Get it Right?

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Issues that Influence the Debate

- Energy Storage, Distributed Generation and Control, and Micro-grids
- Battery Chargers and Electric Vehicles
- Computers, Lighting, and Home Electronics
- Naval and Oceanographic Research

Advantages of and Opportunities for DC Distribution

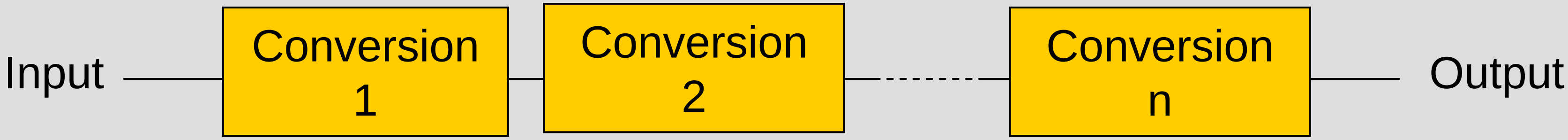
- Incorporation of Renewable Energy Resources
- Reliability and Uninterruptible Supplies
- Voltage Stability
- Fluorescent Lighting and Electronics
- Variable-speed Drives
- Power Quality
- 60-Hz health Concerns

Advantages of AC Distribution

- Voltage Transformation
- Circuit Breaker Protection
- Voltage Stability

Approach for Comparison of System Conversion Efficiencies for Residences

Depending on the topology of a system, different numbers of conversion steps are needed.



Assert an efficiency η for each conversion step. Then,

$$\eta_{system} = \eta_1 \times \eta_2 \times \ldots \times \eta_n$$

Average Electrical Consumption by Appliance Category

Appliance Category	U.S. Mean Household Energy (%)
Heating, Ventilation, Cooling	31.2
Kitchen Appliances	26.7
Water Heating	9.1
Lighting (Incandescent / Fluor.)	4.4 / 4.4
Home Electronics	7.2
Laundry Appliances	6.7
Other Equipment	2.5
Other	7.7

"Table US-1. Electricity consumption by end use in U.S. households, 2001," Energy Information Administration [Online]. Avalable: http://www.eia.doe.gov/emeu/reps/enduse/er01_us_tab1.html

Comparison of System Conversion Efficiency

	Case 1. AC Distribution		Case 2. DC Distribution	
Appliance	**No. Conversions**	**η (%)**	**No. Conversions**	**η (%)**
Heating, Vent.	1	97.6	2	95.2
Kitchen Appl.	1	97.6	2	95.2
Water Heating	1	97.6	2	95.2
Lights-Incand.	1	97.6	2	95.2
Lights-Fluor.	3	92.9	2	95.2
Home Elect.	3	92.9	3	92.9
Laundry Appl.	1	97.6	2	95.2
Other Equip.	1	97.6	2	95.2
Other End Use	1	97.6	2	95.2
Weighted Ave.		**97.0 %**		**95.0 %**

Comparison of Conversion Efficiency -- System having Residential Fuel Cell

	Case 3. Premise Fuel Cell with DC Distribution		**Case 4.** Premise Fuel Cell with AC Distribution	
Appliance	**No. Conversions**	**η (%)**	**No. Conversions**	**η (%)**
Heating, Vent.	1	97.6	2	95.2
Kitchen Appl.	1	97.6	2	95.2
Water Heating	1	97.6	2	95.2
Lights-Incand.	1	97.6	2	95.2
Lights-Fluor.	2	95.2	4	90.6
Home Elect.	2	95.2	5	88.4
Laundry Appl.	1	97.6	2	95.2
Other Equip.	1	97.6	2	95.2
Other End Use	1	97.6	2	95.2
Weighted Ave.		**97.3 %**		**94.5 %**

Conclusions

- Groundwork was laid for the comparison of dc and ac low-voltage and premise energy distribution networks.
- The advantages of ac and dc systems were listed as were several contemporary issues that could affect the future inclusion of dc distribution into our present power systems.
- After accepting the conclusions of a cited paper, in which conductor losses in commercial premise ac and dc distribution systems had been compared, we addressed how series conversion losses may affect the viability of premise dc distribution.
- A systematic method was introduced to create a fair comparison of such hypothetical energy systems.
- The use of residential dc distribution by itself was predicted to be disadvantageous because of the inefficiency of the combined transformer rectifier needed to convert bulk ac power to premise dc power.
- Fuel cells or other local dc generation that feed directly into a premise dc bus could have favorable conversion losses. This was especially true when compared against a premise dc generation source that must immediately convert its energy to ac form.