THE WAR OF CURRENTS IS NOT OVER AND HOW IT IMPACTS THE ELEVATOR

Dr. Pilar Molina–Gaudo
IN THE PAST...
WHAT WAS THE WAR OF CURRENTS?

Westinghouse (and Tesla)  Thomas A. Edison
HOW TO DISTRIBUTE ENERGY

DISTANCE BETWEEN GENERATION AND LOAD ➔ LONG LINES ➔ LINE LOSSES ➔ HIGH COST

**AC**
- Advantages
  - Transformation of voltage levels with transformers
  - AC motors ➔ Simpler
  - Poly phase systems reduce losses
- Disadvantages
  - Suboptimal power transmission
  - Hazardous high voltage AC
  - Line inductances and capacitances

**DC**
- Advantages
  - Safer and simpler
  - No synchronization
  - No harmonic problems
  - DC motors
  - Maximizes power transmission
- Disadvantages
  - Difficult high-voltage generation
  - Difficult DC / DC transformation
  - DC circuit breakers
La info de est transpa, está contrastada en algún sitio?
Estanis Oyarbide; 05.10.2017
AND THE WINNER WAS...

* Chicago 1803 World Fair
ENERGY DISTRIBUTION IN THE WORLD TODAY

Source: http://www.worldstandards.eu/
San Francisco’s Secret DC Grid

The last direct-current power lines are being dismantled just as DC distribution seems headed for a comeback

IN THE PRESENT...
Electricity

Edison's revenge

The humble USB cable is part of an electrical revolution. It will make power supplies greener and cheaper

Edison's Revenge: The Rise of DC Power

In a world of more electronics and solar energy, there's less and less need for AC power.

by Peter Fairley  April 24, 2012

Source: MIT Technology Review. Arpil 24, 2012
**LEDs are DC powered**

*Figure 1 This circuit uses a simple DIAC relaxation oscillator, which activates a constant-current-switching circuit.*
Monitors and TVs

Typical Switchmode Power Supply for Small SVGA Color Monitor
https://www.repairfaq.org/
Data centres

Electric Vehicles

- **40A Level 3 DC fast charger**
  - Specification:
    - Input: 380-440V Three Phase
    - Output: 450Vdc/750Vdc
    - Output power: 20KW to 100KW

- Outlander LEAF
LOCAL GENERATION OF ENERGY

Solar panel

- I-V Curve
- Power Curve
- $I_{sc}$
- $I_{mpp}$
- $P_{max}$
- $U_{mpp}$
- $U_{oc}$
ENERGY STORAGE

Source: Tesla.com

Lithium carbonate
Spot price per tonne, $'000

Economist.com
### AVAILABLE STORAGE TECHNOLOGIES

#### Feature Lead Acid LiOn Ultracapacitor

<table>
<thead>
<tr>
<th>Feature</th>
<th>Lead Acid</th>
<th>LiOn</th>
<th>Ultracapacitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cycles</td>
<td>300-2000</td>
<td>&gt;5000</td>
<td>&gt;1000000</td>
</tr>
<tr>
<td>Specific power (W/kg)</td>
<td>30-180</td>
<td>300-2000</td>
<td>5000</td>
</tr>
<tr>
<td>Specific energy (Wh/kg)</td>
<td>30-60</td>
<td>30-140</td>
<td>5</td>
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<tr>
<td>BMS/VMS</td>
<td>no</td>
<td>yes (BMS)</td>
<td>yes (VMS)</td>
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<tr>
<td>Cost (€/kWh)</td>
<td>170</td>
<td>1200</td>
<td>17000</td>
</tr>
</tbody>
</table>
**Motor + inverter (VVVF drive)**

- Based on well-known industrial drivers
- 500 to 800V at its DC bus
Energy recovery system with ultracapacitors

Energy recovery system and peak power mitigator with ultracapacitors
- Two wire connection to drive
  - New or existing
- One size fits all
  - Parallelization
- No maintenance
- <2W standby
Low-voltage battery high-performance UPS
48V batteries
- Low cost
- Low size

No additional control
- Simple connection

Power scalable
- From 3k5 to ...

Energy scalable
- Full evacuation of buildings
Intelligent power supply (all-in-one energy hub)

- Rectifier
- Inverter
- Braking R
- Standard motor drive
- Bus DC
- 24-48 Vdc
- 120-230 V RMS
- 350-600 Vdc
- Charger DC/DC
- MPPT AC/DC
- Solar-wind powered lift with auxiliary grid connection

Solar-wind powered lift with auxiliary grid connection
48V batteries
  • Low cost
Low power charger 500W
  • Peak reduction
No UPS required
Regenerated energy
Solar
IN THE FUTURE...
Beyond BREAM / LEEDs
IN CONCLUSION
BRING YOU ELEVATOR CLOSER TO A (POSSIBLE) DC FUTURE

- **DC powering of systems**
  - No AC/DC
  - Energy storage
  - Solar energy

- **DC powering of elevators**
  - High-performance UPS systems
  - Peak power mitigation
  - Energy recovery systems
Thank you for your attention
Motor Power
Ahorro: 16.09%
Generation and consumption trips (2 ERS)

Motor consumption

Power provided by ERS 2G

Mains consumption

Savings: 32.17%
Ahorro: 48.26%
## CASE STUDY 3 – COMPARISON WITH REGEN DRIVE

**Case Study 3**

<table>
<thead>
<tr>
<th>Test tower</th>
<th>10 trips</th>
<th>136</th>
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<tbody>
<tr>
<td></td>
<td>10 trips with REGEN drive</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>10 trips with ERS</td>
<td>83</td>
</tr>
</tbody>
</table>

- Test tower in Madrid
- No standby considered
- Only motor is measured