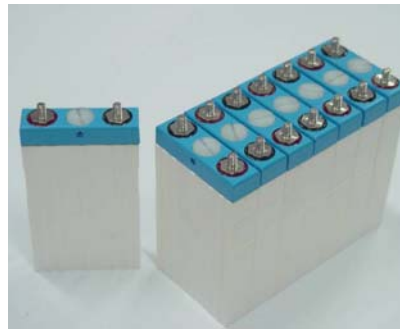
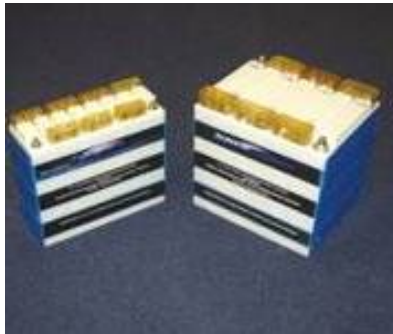


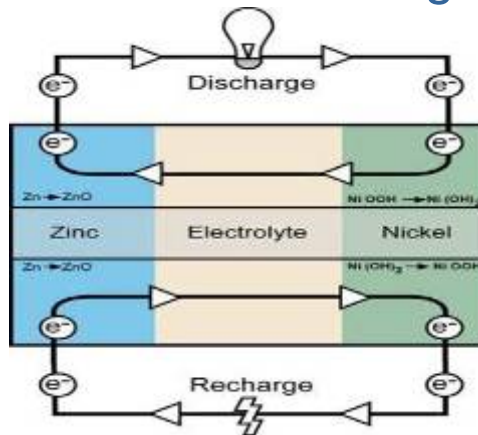
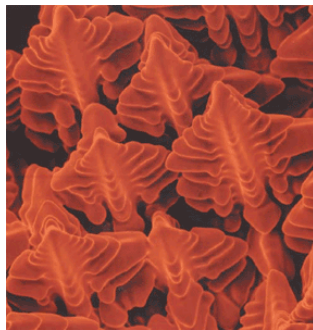
# Introducing Nickel Zinc Batteries to Complement Power Generation



# NiZn Technology Background

- NiZn technology has existed for over 100 years and was in development by Thomas Edison
- In the 1960's, focus on NiZn batteries as replacement for military Silver-Zinc batteries. Not able to be developed due to technological hurdles:
  - Solubility of zinc in the alkaline electrolyte limited life cycle
  - Formation of zinc dendrites across electrodes during recharge resulted in short circuiting and shortened life

Picture of Zn Dendrite which causes short circuiting



# Xellerion Nickel Zinc Batteries

- Xellerion Inc. has overcome previous hurdles and is manufacturing NiZn batteries with excellent characteristics
- Our NiZn batteries are safe, require no heating or cooling and are ideal for incorporation into many types of systems
- In the following slides we have updated the Electric Storage Association Graphs to include Nickel Zinc batteries

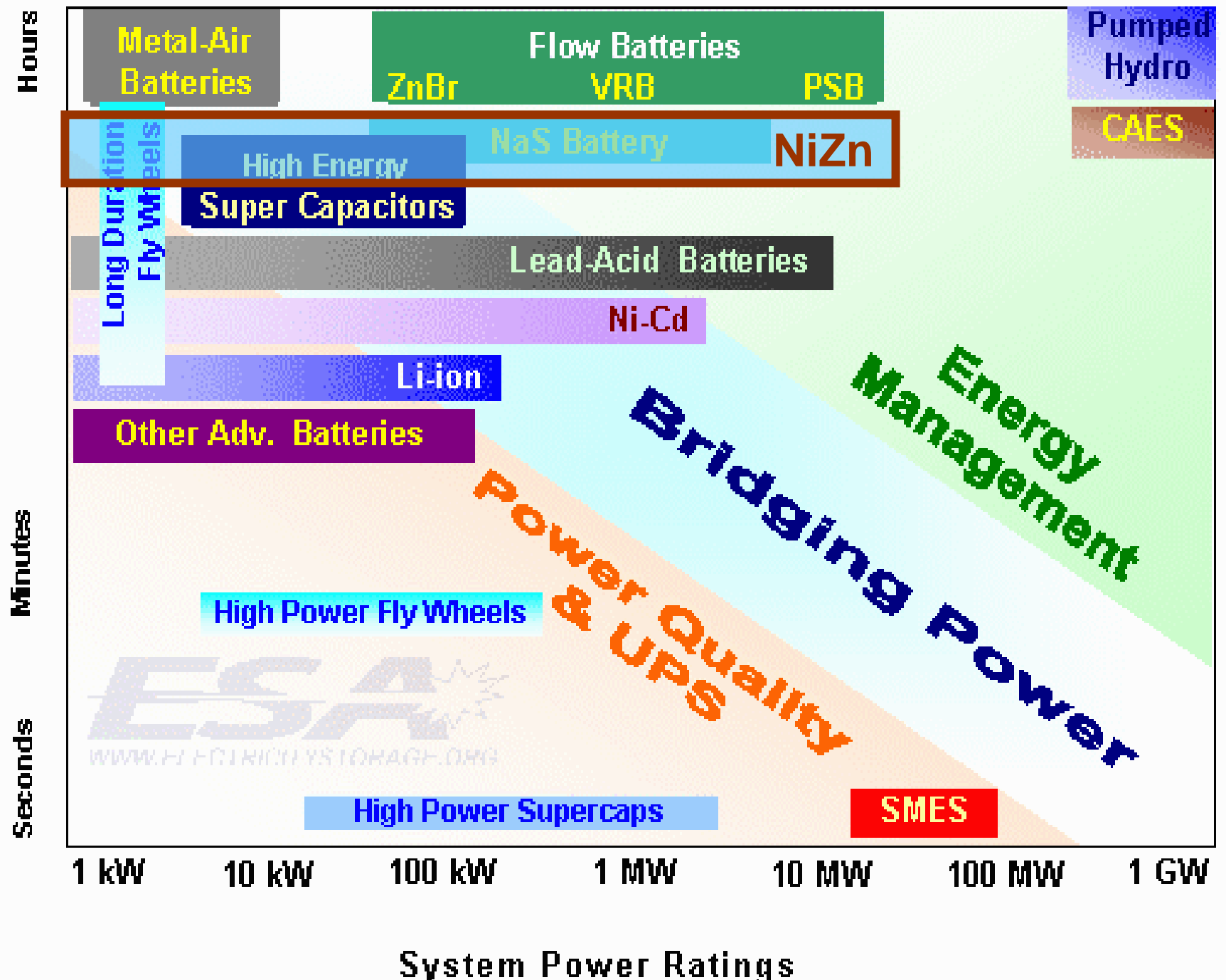


Storage Technologies	Main Advantages (relative)	Disadvantages (Relative)	Power Application	Energy Application
Pumped Storage	High Capacity, Low Cost	Special Site Requirement		●
CAES	High Capacity, Low Cost	Special Site Requirement, Need Gas Fuel		●
Flow Batteries: PSB VRB ZnBr	High Capacity, Independent Power and Energy Ratings	Low Energy Density	◐	●
Metal-Air	Very High Energy Density	Electric Charging is Difficult		●
NaS	High Power & Energy Densities, High Efficiency	Production Cost, Safety Concerns (addressed in design)	●	●
Li-ion	High Power & Energy Densities, High Efficiency	High Production Cost, Requires Special Charging Circuit	●	○
Ni-Cd	High Power & Energy Densities, Efficiency		●	◐
Other Advanced Batteries	High Power & Energy Densities, High Efficiency	High Production Cost	●	○
Lead-Acid	Low Capital Cost	Limited Cycle Life when Deeply Discharged	●	○
Flywheels	High Power	Low Energy density	●	○
SMES, DSMES	High Power	Low Energy Density, High Production Cost	●	
E.C. Capacitors	Long Cycle Life, High Efficiency	Low Energy Density	●	◐
<b>NiZn</b>	High power & energy density, high efficiency, lowest cost/KWh Safe, no heating system or cooling required ingaor	New solutions to old NiZn problems, not yet proven in high volumes, Shipped modest volume being tested	●	●

## Storage Technologies

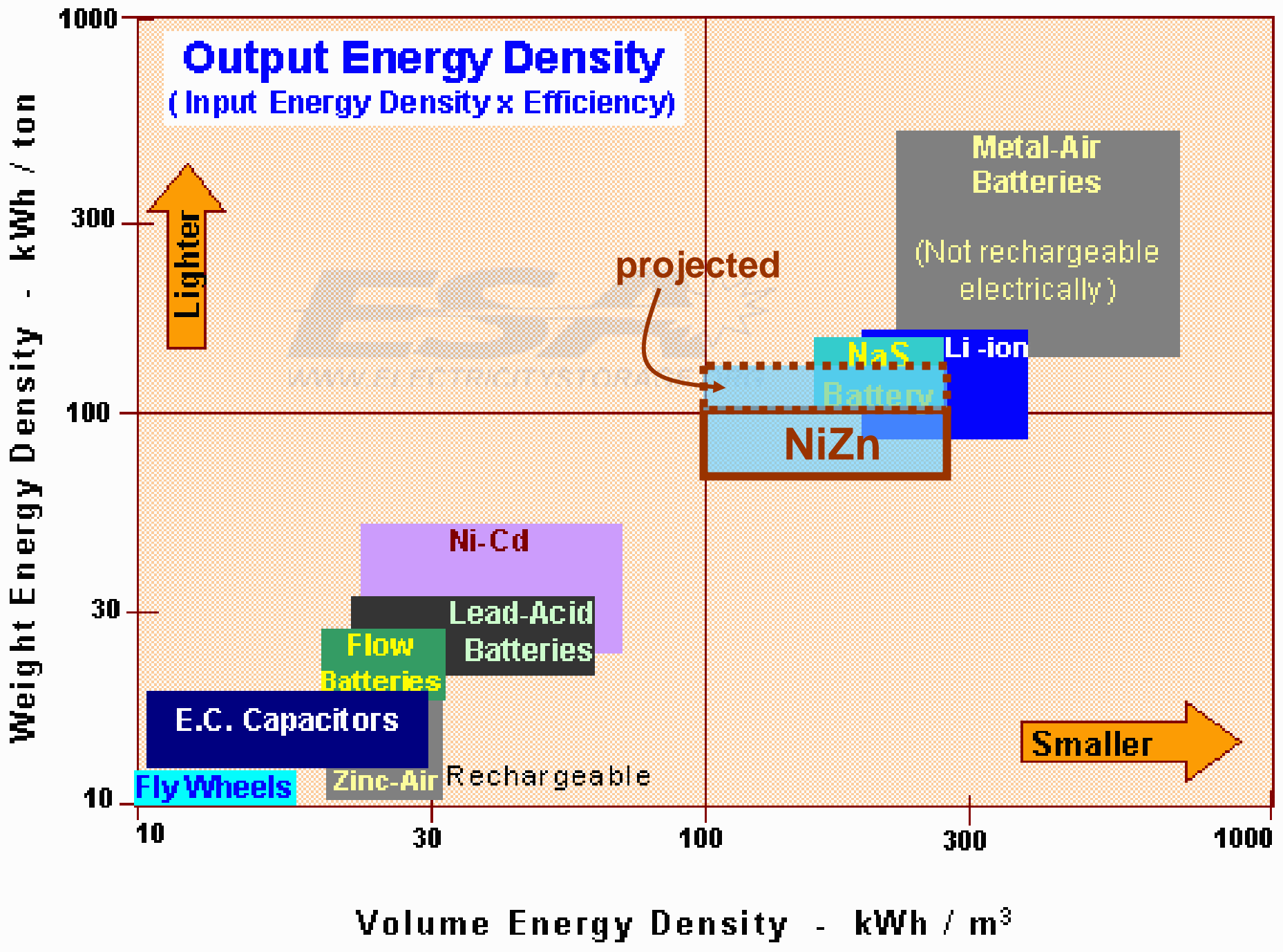
- Fully capable and reasonable
- ◐ Reasonable for this application
- Feasible but not quite practical or economical
- None Not feasible or economical

Discharge Time at Rated Power



ESA  
WWW.ELECTRICITYSTORAGE.ORG

System Power Ratings



**Output Energy Density**  
(Input Energy Density x Efficiency)

**Weight Energy Density - kWh / ton**

1000  
300  
100  
30  
10

10 30 100 300 1000

**Volume Energy Density - kWh / m<sup>3</sup>**

**Lighter**

**Smaller**

**projected**

**Metal-Air Batteries**

(Not rechargeable electrically)

**NaS Battery**

**Li-ion**

**NiZn**

**Ni-Cd**

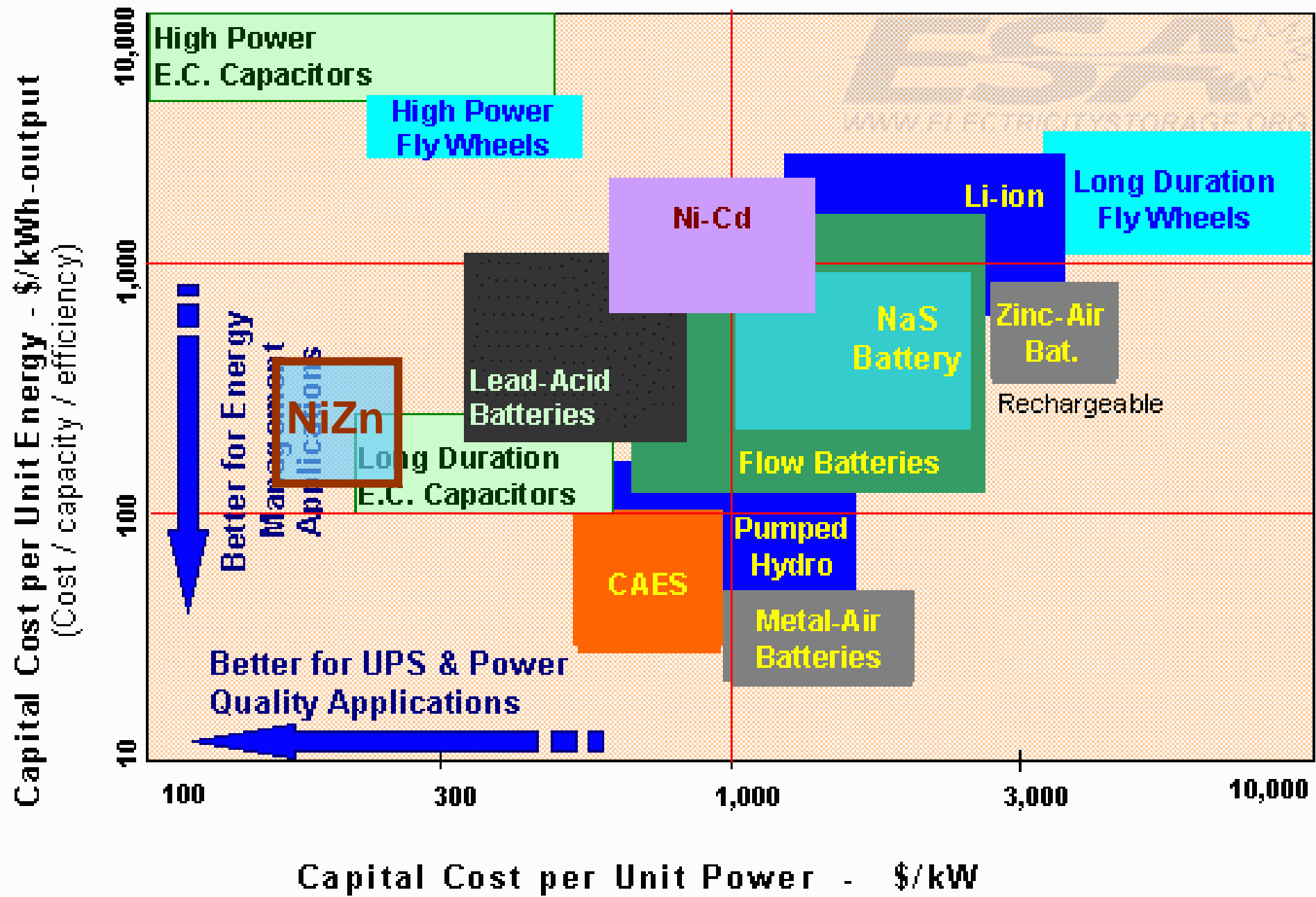
**Lead-Acid Batteries**

**Flow Batteries**

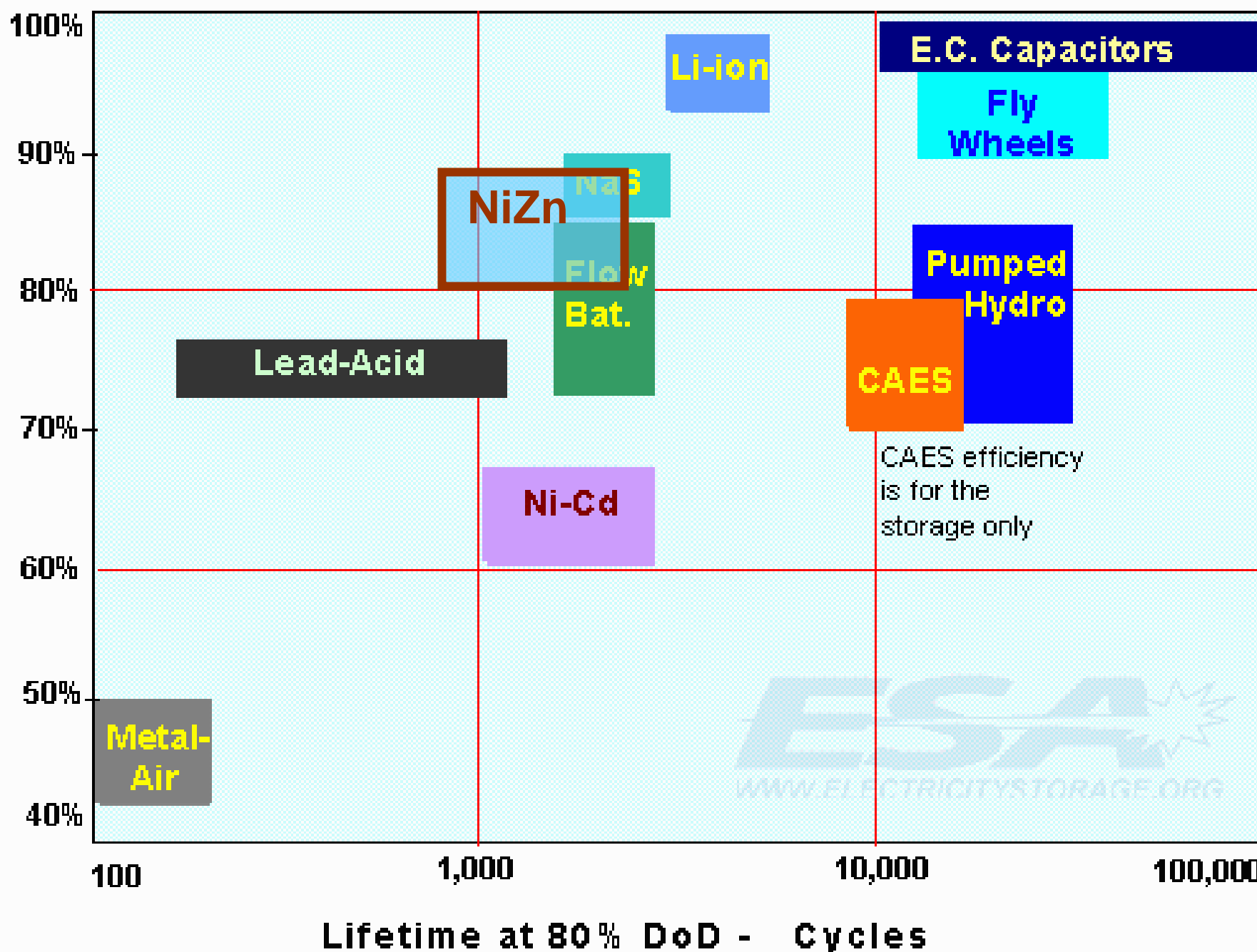
**E.C. Capacitors**

**Fly Wheels**

**Zinc-Air Rechargeable**



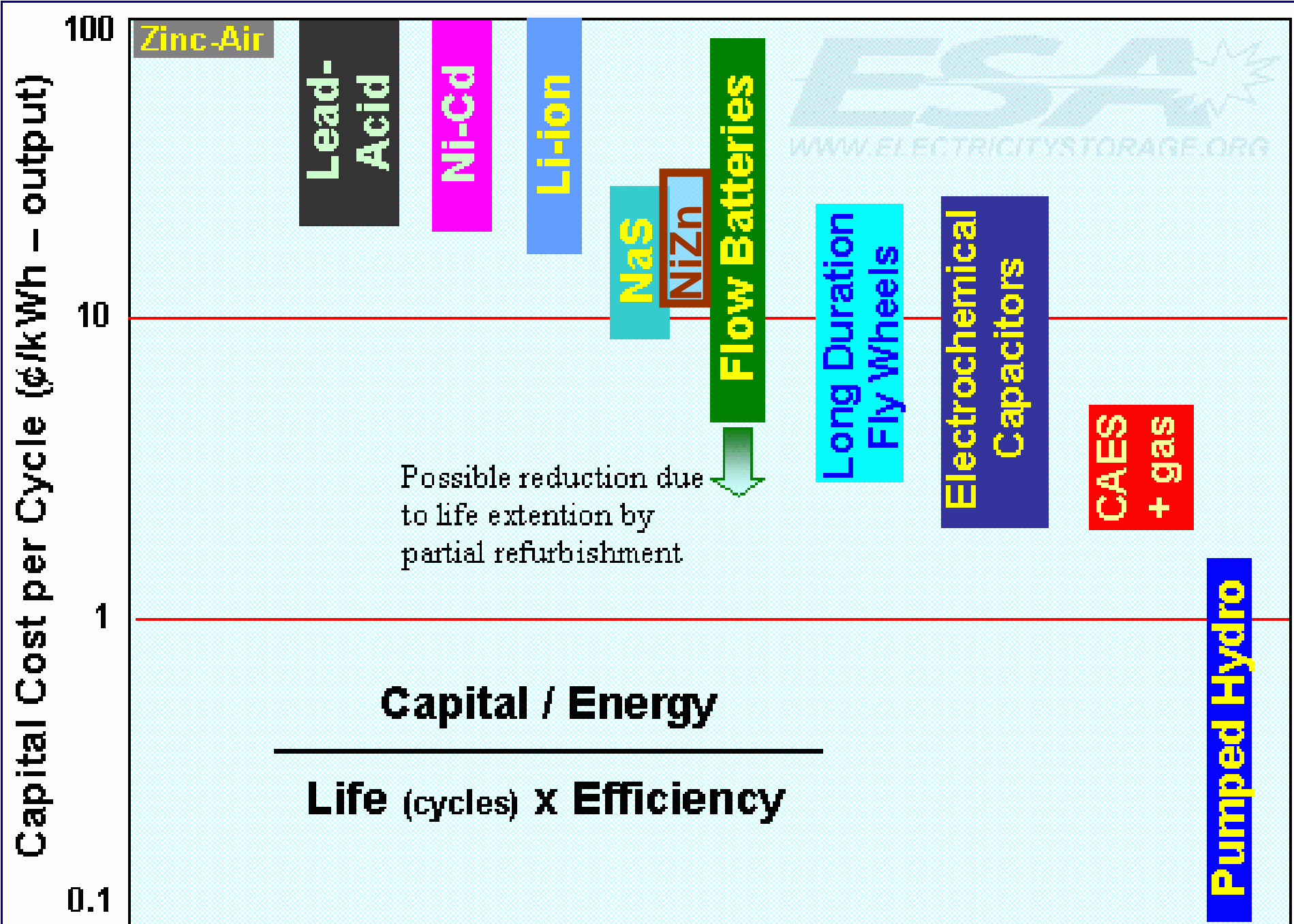
Efficiency (w/o power electronics)



CAES efficiency is for the storage only



Lifetime at 80% DoD - Cycles



Carrying charges, O&M and replacement costs are not included