International EV Conference in Macedonia

ELECTRIC VEHICLES
new trends in mobility

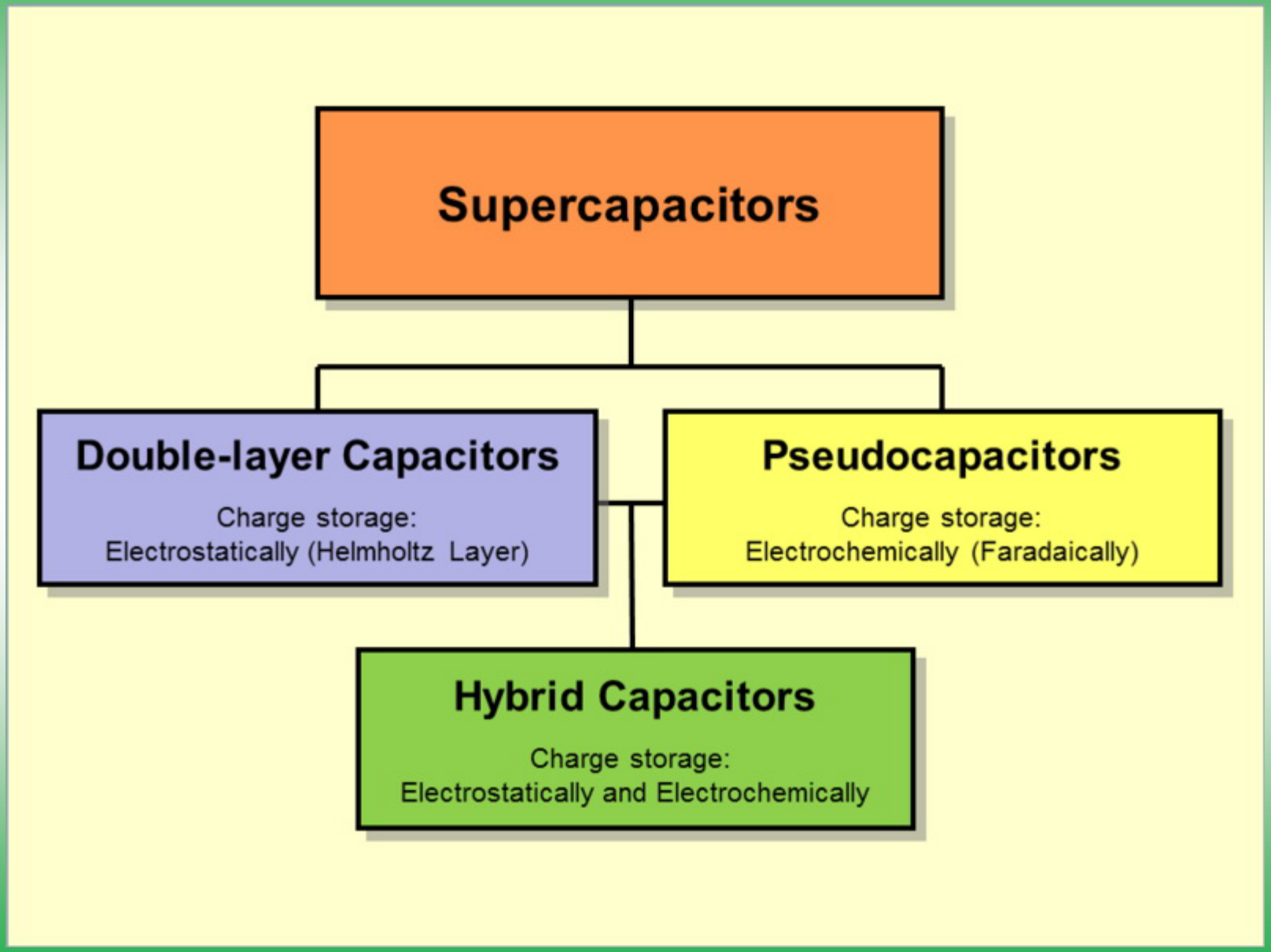
Super-capacitors

Thursday 27th June 2013

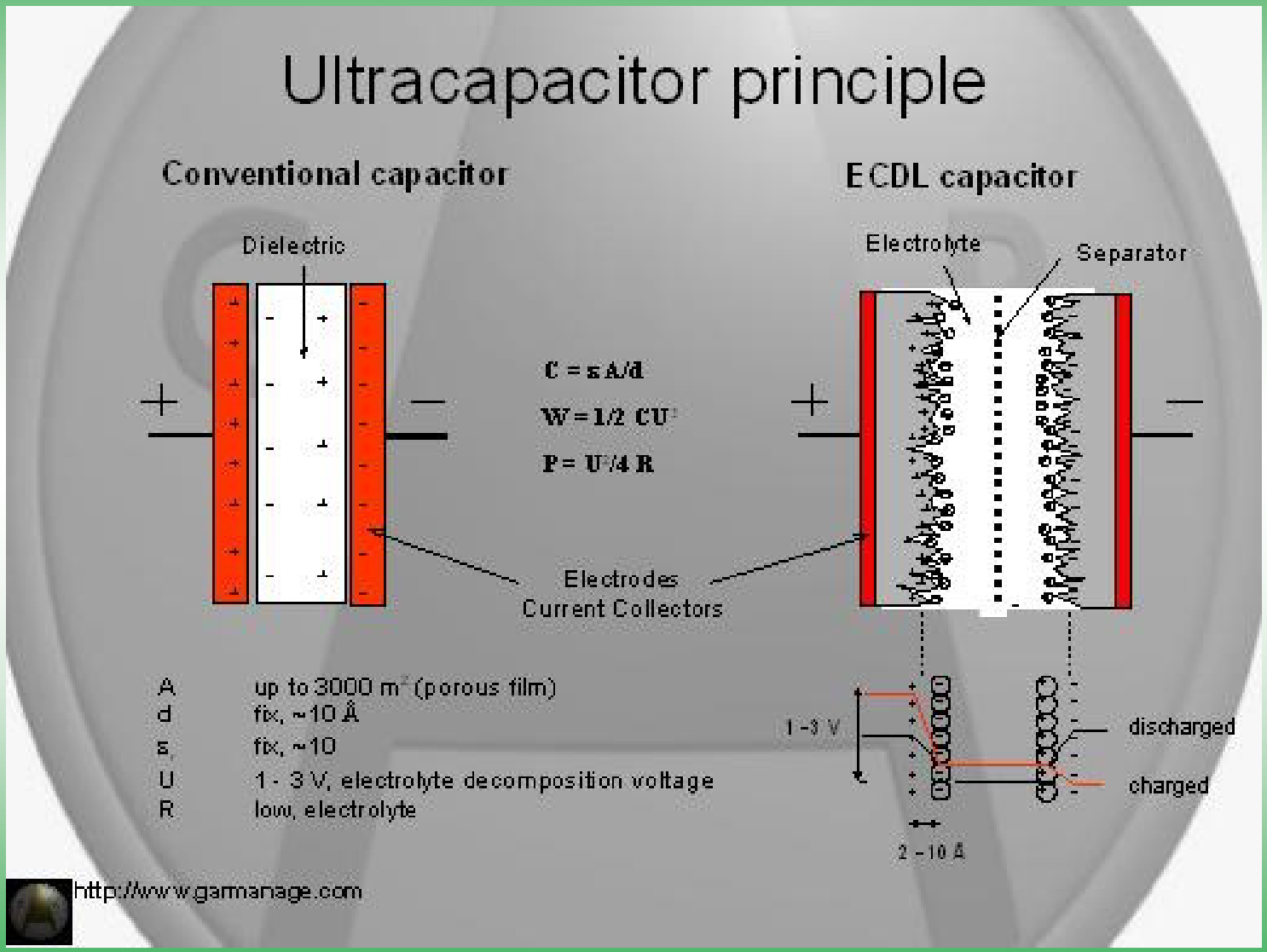
Ing. Dobri Čundev PhD

е-мобилност

Standard vehicle drive

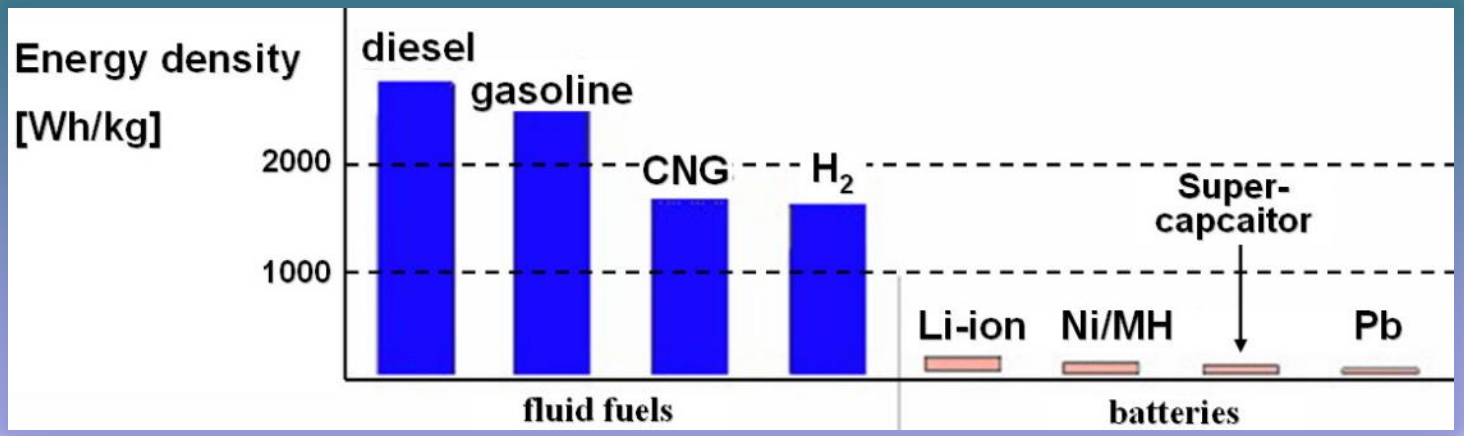


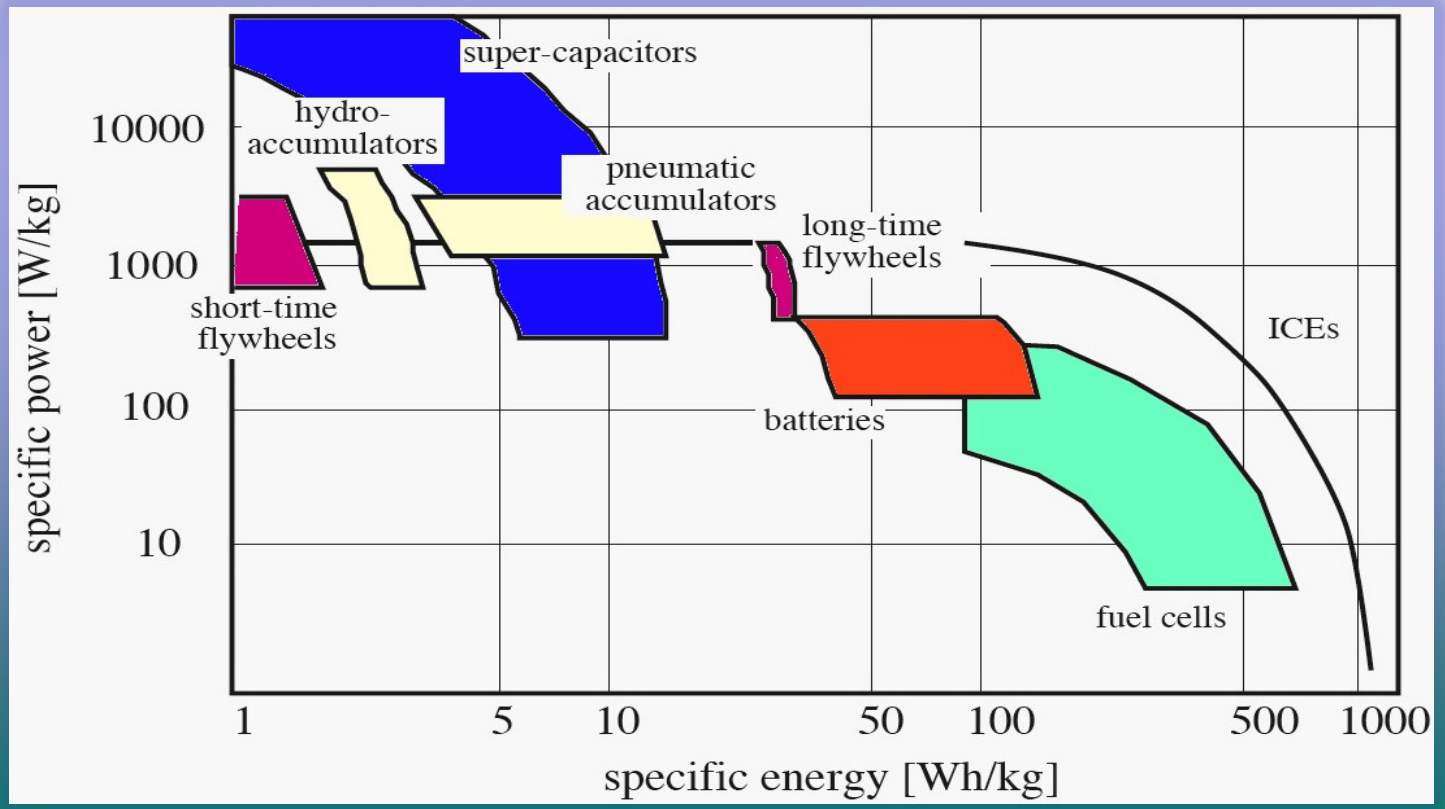
Super-capacitors (Ultra-capacitors)



Super-capacitors (Ultra-capacitors)

Energy density for standard or proposed vehicles on-board energy carriers





Batteries, Super-capacitors and flywheels

	Batteries	Ultracapacitors	Flywheels
Typical runtime	5 minutes to 8 hours	10 seconds to 1 minute	1 second to 1 minute
History in the marketplace	Long (many decades)	Short (a few years)	Longer for low speed, short for high speed
Operating conditions	Narrow temperature range	Wide temperature range	Wide temperature range
Environmental impact	Harmful (lead) if not recycled, hydrogen release on recharge	Harmful if burned	Harmful (circuit boards) if not recycled
Safety	Significant government and local regulations for management of lead and acid	Requires high voltages to operate	Encasements may be required for higher rpm flywheels (in case of breakage while spinning)
Power range	Up to multiple megawatts	Up to tens of thousands of kilowatts	Up to multiple megawatts
Reliability	Moderate (higher for shorter runtimes)	High	Moderate (higher for newer technologies)
Maintenance	Moderate for VRLA Higher for vented / flooded	Moderate	Moderate for carbon fiber Higher for older technology
Recharge time	10 x discharge time	Seconds	Seconds or minutes
Number of deep charge/ discharge cycles	Up to 3,000	Up to 1 Million	Unlimited (assuming maintenance)

Super-capacitor and Li-ion battery comparison

Function	Supercapacitor	Lithium-ion (general)
Charge time	1–10 seconds	10–60 minutes
Cycle life	1 million or 30,000h	500 and higher
Cell voltage	2.3 to 2.75V	3.6 to 3.7V
Specific energy (Wh/kg)	5 (typical)	100–200
Specific power (W/kg)	Up to 10,000	1,000 to 3,000
Cost per Wh	$20(typical)	$2 (typical)
Service life (in vehicle)	10 to 15 years	5 to 10 years
Charge temperature	–40 to 65°C (–40 to 149°F)	0 to 45°C (32° to 113°F)
Discharge temperature	–40 to 65°C (–40 to 149°F)	–20 to 60°C (–4 to 140°F)

Electrical vehicles Ultra-capacitors types

EV in combination of different energy carriers