

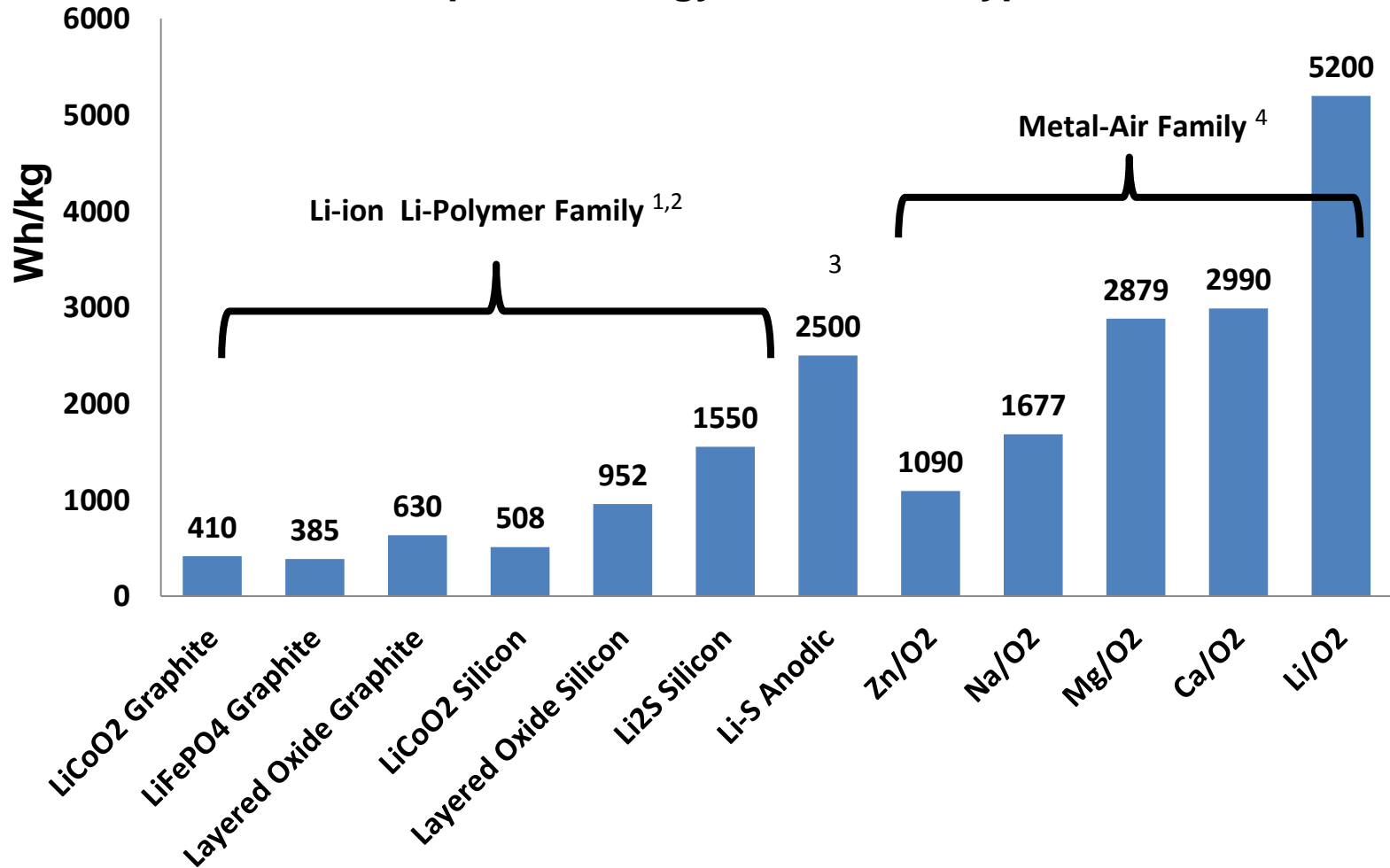


Brussels Battery Workshop

Session 2: Knowledge Transfer from Research to Innovation

Introduction

Theoretical specific energy for different types of batteries



1) Jusef Hassoun, Yang-Kook Sun, Bruno Scrosati, Rechargeable lithium sulfide electrode for a polymer tin/sulfur lithium-ion battery, Journal of Power Sources (2011) , Volume: 196, Issue: 1, Publisher: Elsevier B.V., Pages: 343-348 . **Nanostructured SnC/Li₂S demonstrated at 1200Wh/kg.**

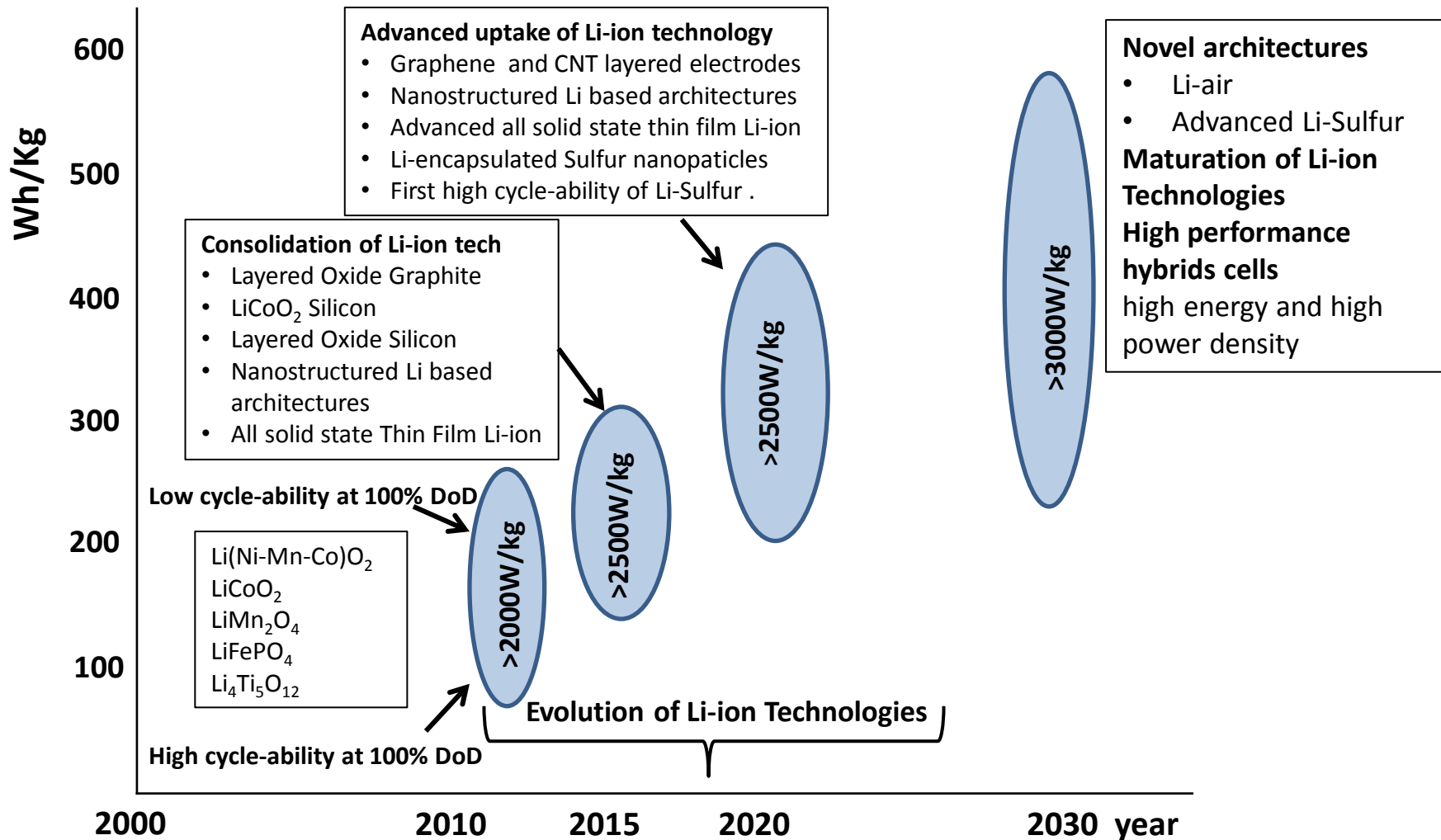
2) Yuan Yang, Matthew T. McDowell, Ariel Jackson, Judy J. Cha, Seung Sae Hong and Yi Cui (2010) New Nanostructured Li₂S/Silicon Rechargeable Battery with High Specific Energy. *Nano Lett.*, Article ASAP doi: [10.1021/nl100504q](https://doi.org/10.1021/nl100504q) : **Nanostructured Lithium Sulfide/Silicon demonstrated at 600Wh/kg**

3) <http://en.winston-battery.com> and www.sionpower.com for Li Sulfur batteries.

4) K. M. Abraham, A Brief History of Non-aqueous Metal-Air Batteries E-KEM Sciences Needham, MA 02492, USA ECS Transactions, 3 (42) 67-71 (2008) 10.1149/1.2838193, The Electrochemical Society.). Note 1: Li-salt water are going to be commercialized at 1200Wh/Kg by www.Polyplus.com. The research on Metal air is focused on Li-air aiming at the demonstration of rechargeability and higher cycle-ability at high DoD.

Note 2: All solid state Li-ion thin films is a fast growing technology which has been demonstrated with higher cycle-ability and higher energy density than Li-P or Li-ion electrolyte www.infinitepowersolutions.com

Specific energy roadmap for commercial battery cells



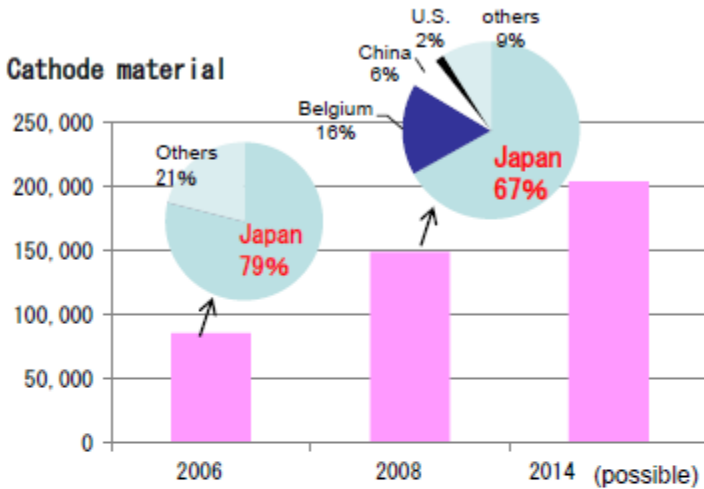
Since 1995 the specific energy of Li-ion has improved an average 7% year until 2011 up to 280Wh/kg. Continuing with CAGR + 5% until 2020 we will have $280 \times (1 + 0,05)^9 = 434\text{Wh/kg}$. Several commercial Li-ion architectures already provide power density >2000W/kg. All solid state Li-ion thin films is a fast growing technology which has been demonstrated with higher cycle-ability and higher energy density than Li-P or Li-ion electrolyte, www.infinitepowersolutions.com.

The Japanese approach to research and to the market

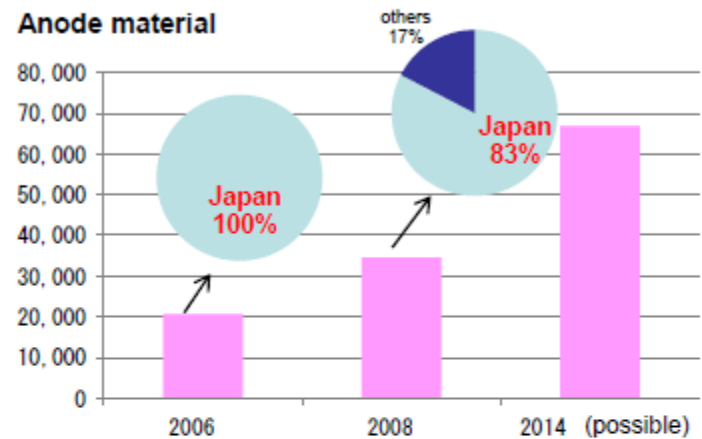
【Lithium-Ion Battery Components】

Global production (millions of Yen)
Share of the global market

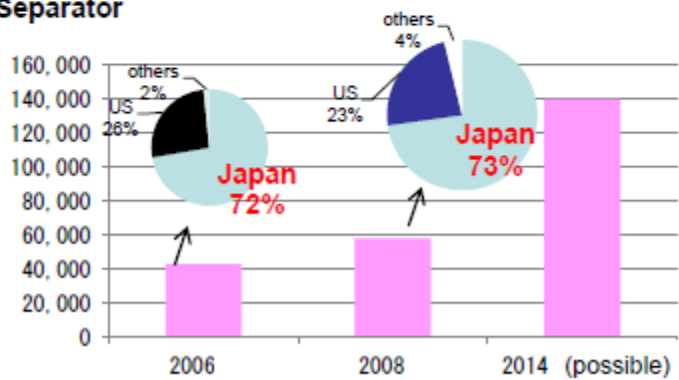
Cathode material



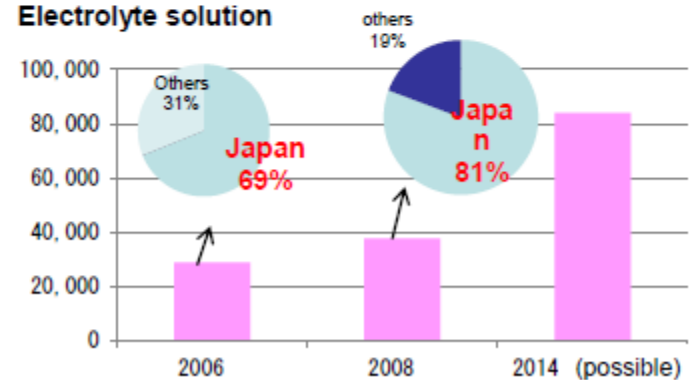
Anode material



Separator



Electrolyte solution



(Source) 2007-2010 Battery Market : Comprehensive Survey for Current Aspect FUJIKAZAI Co.,Inc

EU-27 PV Installations: $50\text{GW}_p/\text{year}$ (80-85% integrated in buildings). The electricity produced $50,000\text{ GWh}/\text{year}$ or about $2,8\text{kWh}/\text{day}$ per kW_p . It can be estimated that 10%-20% of the new PV installations equipped with a battery at an extra cost of only 10% -15%. To store 1/5 of the electricity produced there is a need of new capacity of the order of \longrightarrow **10GWh/year for PV only**

New electromobility: EPAC, E-BIKES, LEVs (<500kg) 5millions/year

$5 \times 10^6 \times 3\text{kWh}$ \longrightarrow **15GWh/year** of battery capacity needed

FEVs- PHEVs: 4 million/year

$4 \times 10^6 \times 20\text{kWh}$ \longrightarrow **80GWh/year** of battery capacity needed

At 150-200€/kWh the market is 15-20 Billions € /year

By 2020 at world level several agencies forecast > 100Billions €/year