

Impact of energy storage to future society

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Self introduction

Sony Research Center (1990-2002)

University of Texas (1996-1997)

Prof. John. B. Goodenough

Novel Prize, 2019



Tokyo Tech (2002-2009)

University of Bordeaux I (2005)

University of Tokyo (2009-present)



Storage !

Food

Information

Wealth

Energy

Category of Batteries

Close system

Primary Battery

Irreversible chemical reaction

Secondary Battery

Reversible chemical reaction, Rechargeable

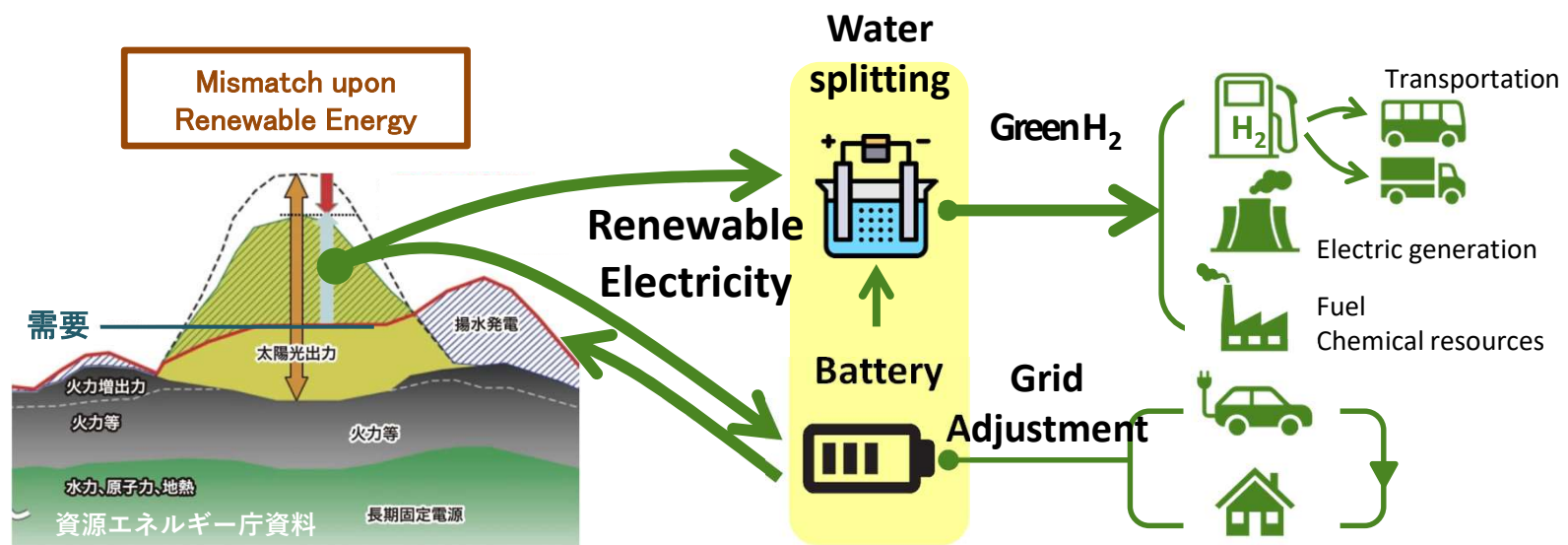
Open system

Fuel Cell

Electric generator by fuel supply and gas exhaust

Importance of electricity storage

Towards carbon neutral until 2050



Smart House



※ 家庭用燃料電池「エネファーム」の発電量とV2Hシステムの充放電量のHEMSでの計測については、一部対応していない場合があります。

Recent world situation on EV

Norway: 100% EV by 2025

England, France: 0% combustion vehicle by 2027

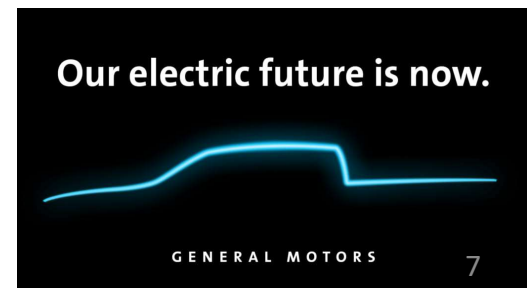
India: 100% EV by 2030

Japan: 70% PHEV or EV by 2030

China: 10% EV last year

Daimler stopped developing combustion engine
(2019. 9. 19, focusing on EV powertrain)

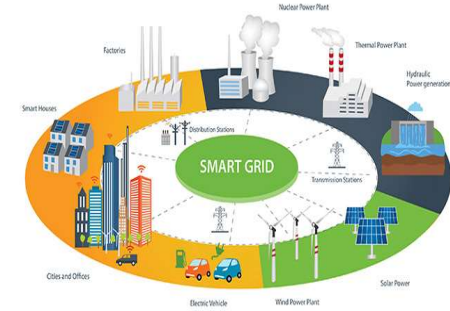
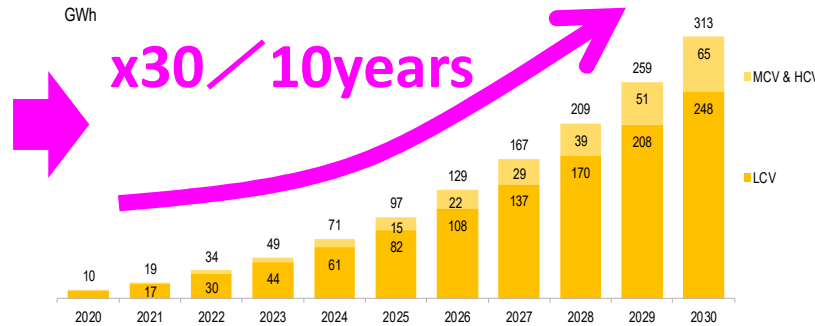
General Motors (GM) 100% changed their factory
at Detroit to EV production.
(2020. 1. 27, investing \$3,000,000,000)



EV Battery : 30 times for coming 10 years !



Electric Vehicles

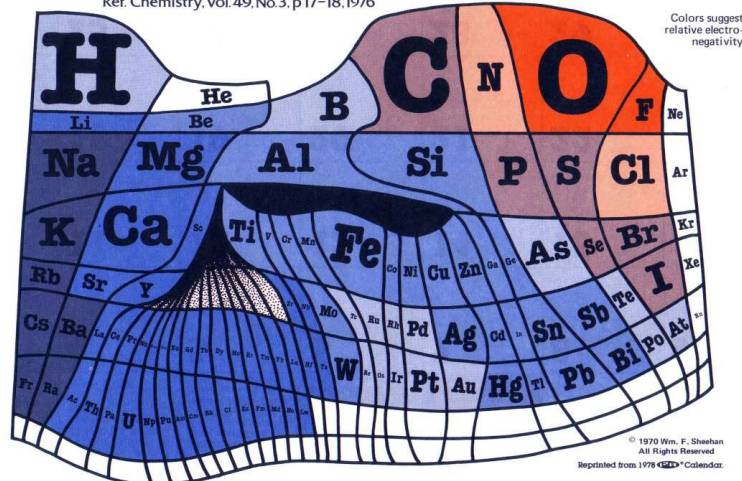


Infrastructure

Toward Sustainability → Element Strategy

The Elements According to Relative Abundance

A Periodic Chart by Prof. Wm. F. Sheehan, University of Santa Clara, CA 95053
 Ref. Chemistry, Vol. 49, No. 3, p 17-18, 1976



Roughly, the size of an element's own niche ("I almost wrote square") is proportioned to its abundance on Earth's surface, and in addition, certain chemical similarities (e.g., Be and Al, or B and Si) are suggested by the positioning of neighbors. The chart emphasizes that in real life a chemist will probably meet O, Si, Al, . . . and that he better do something about it. Periodic tables based upon elemental abundance would, of course, vary from planet to planet. . . W.F.S.

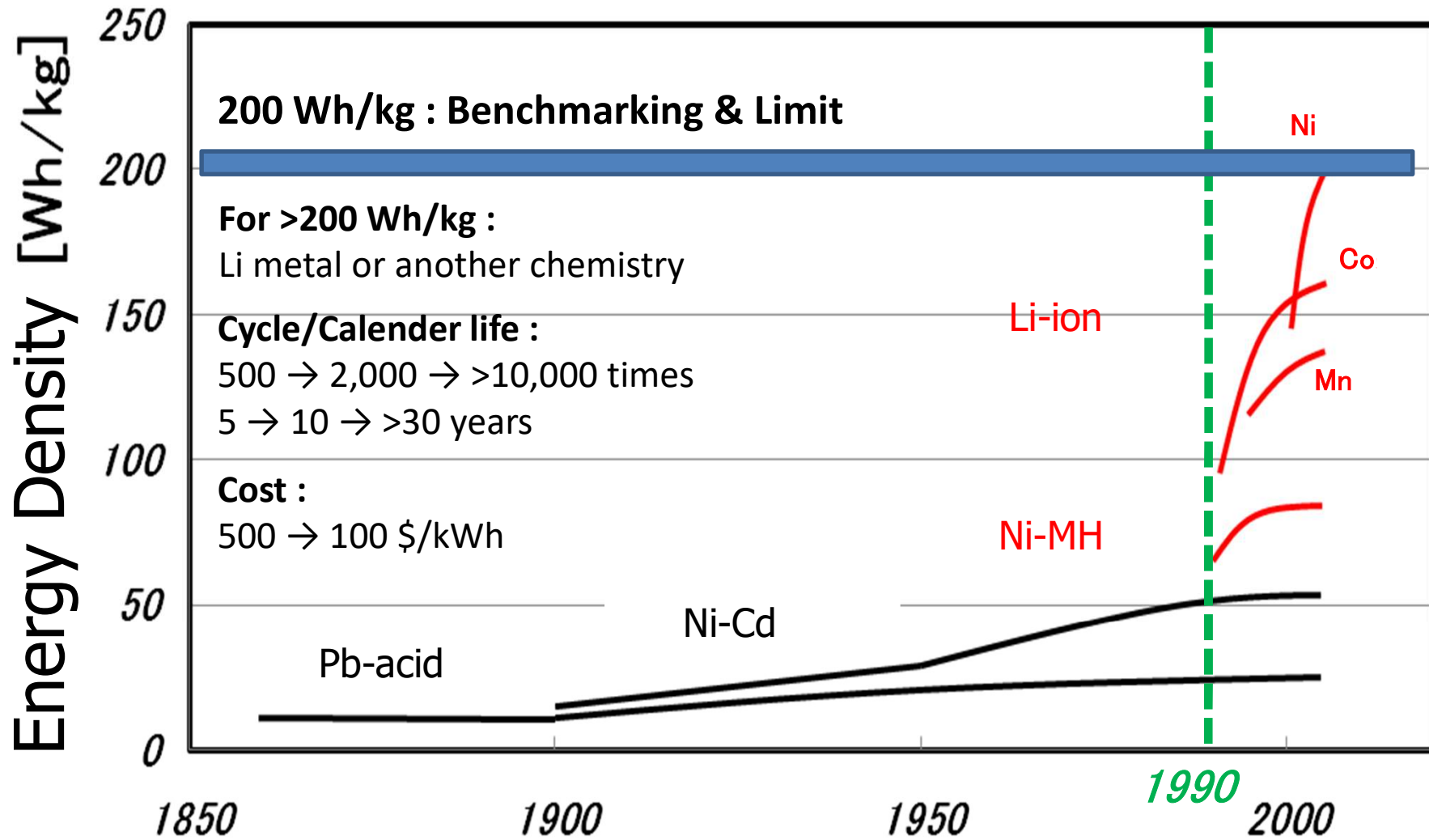
NOTE: TO ACCOMMODATE ALL ELEMENTS SOME DISTORTIONS WERE NECESSARY, FOR EXAMPLE SOME ELEMENTS DO NOT OCCUR NATURALLY.

Li → Na

Co, Ni → Fe, Mn, Ti

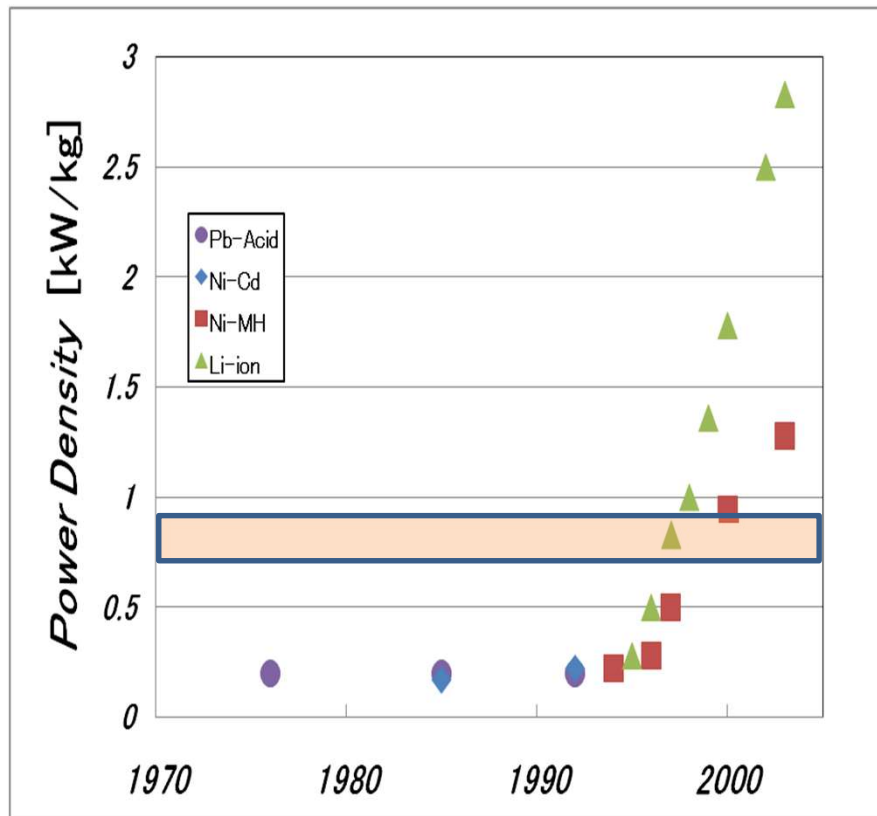
Flammable organics → H₂O

History of Secondary Batteries (Energy Density)

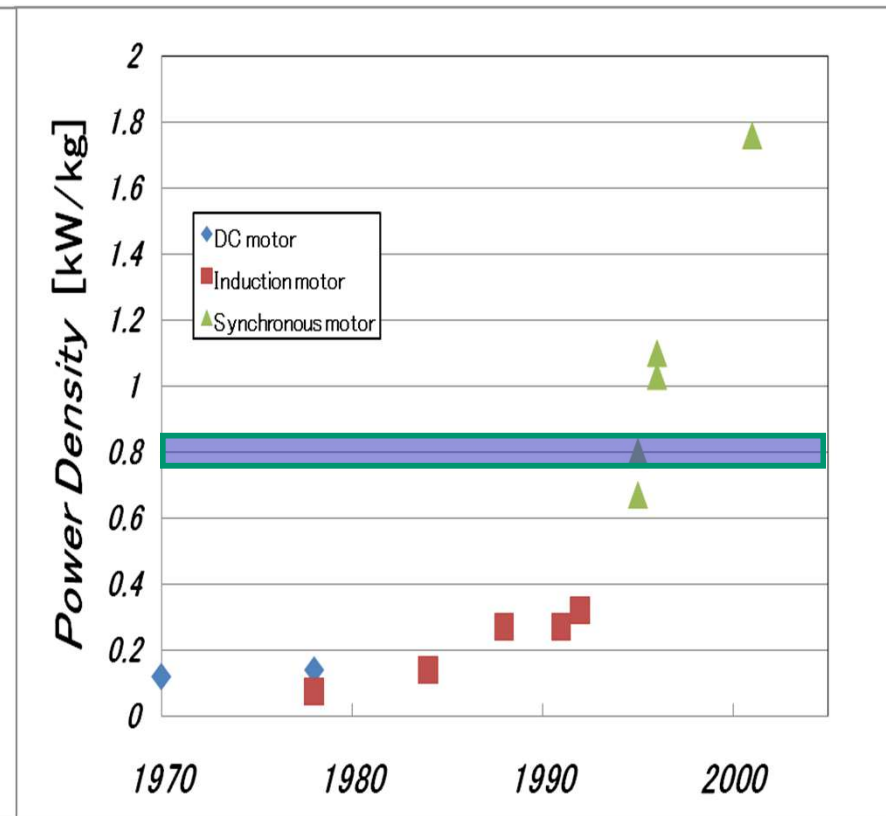


Power density exceeding combustion engine

Batteries

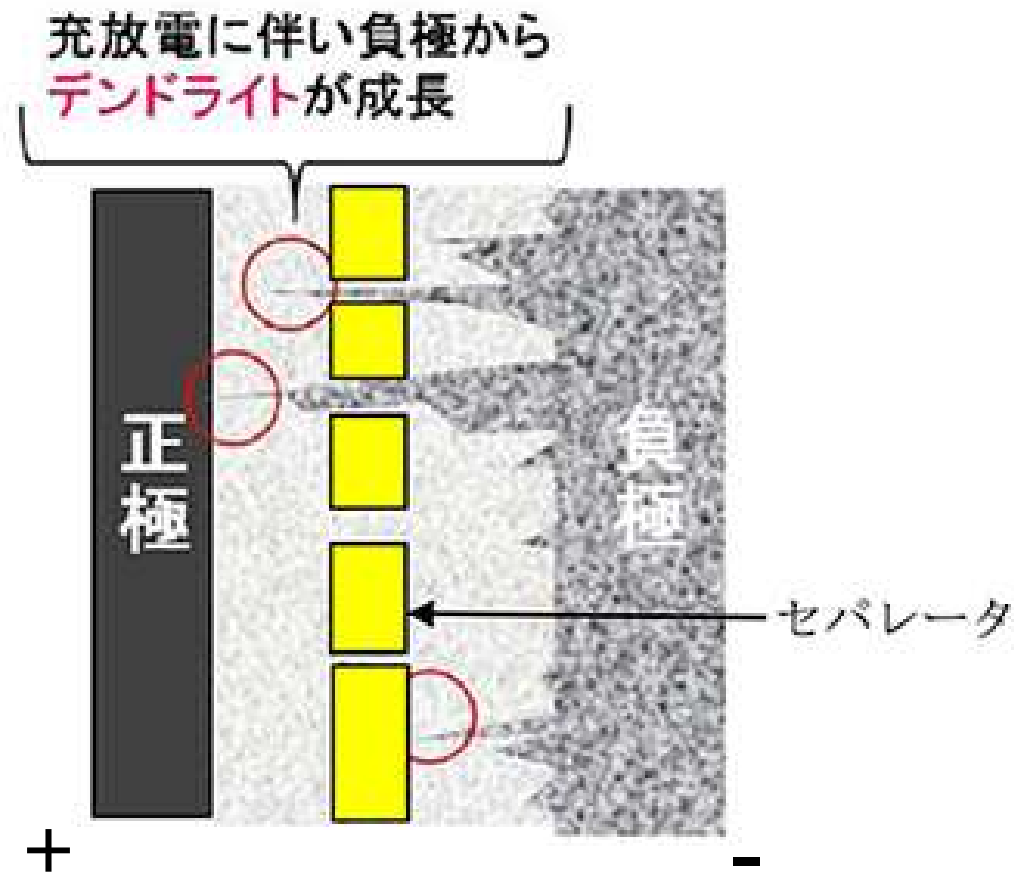


Motor



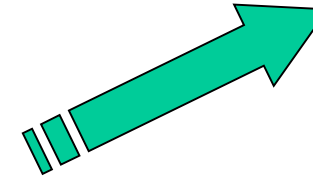
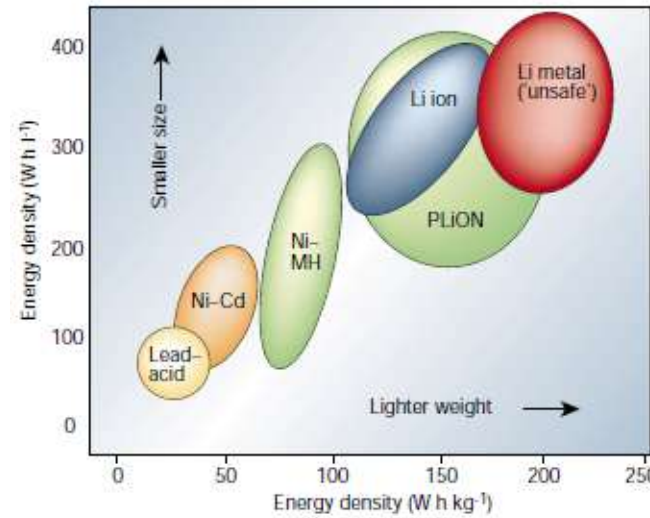
Why called lithium “ion” battery ?

Dendrite growth



Lithium-ion battery: A Nobel prize winner

What's inside and technical issues?



Safety ??
 Cost ??
 Reliability ??

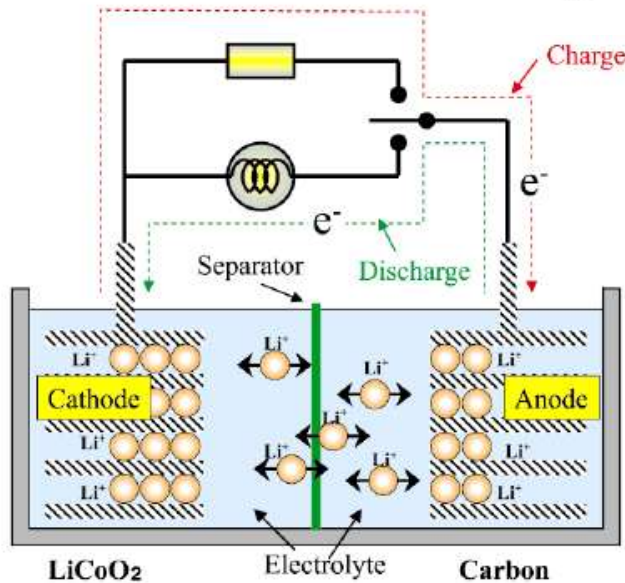
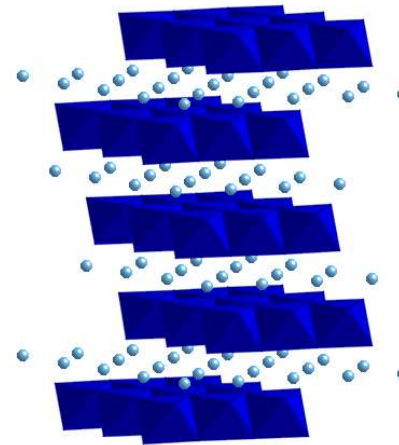
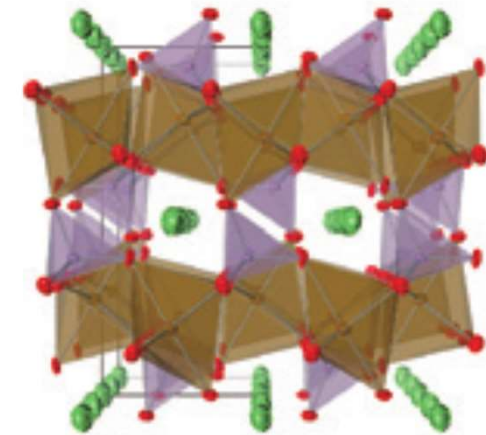


Fig. 1. Schematic of the principle of LIB.



LiCoO₂, LiNiO₂
 Layered rocksalt



LiFePO₄¹³
 Olivine

2019 Nobel Prize in Chemistry



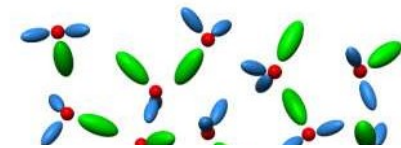
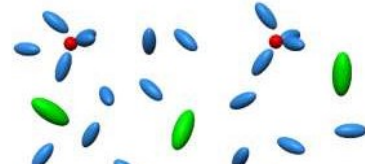
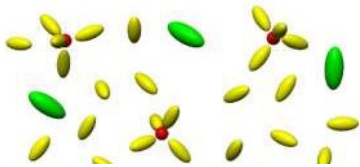
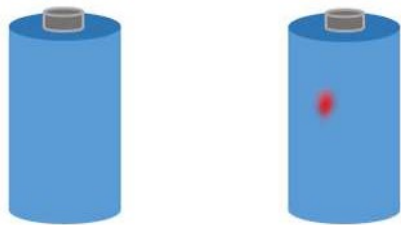
Nobel Prize in Chemistry

For Lithium-ion Batteries



With Prof. John. B. Goodenough, 1997

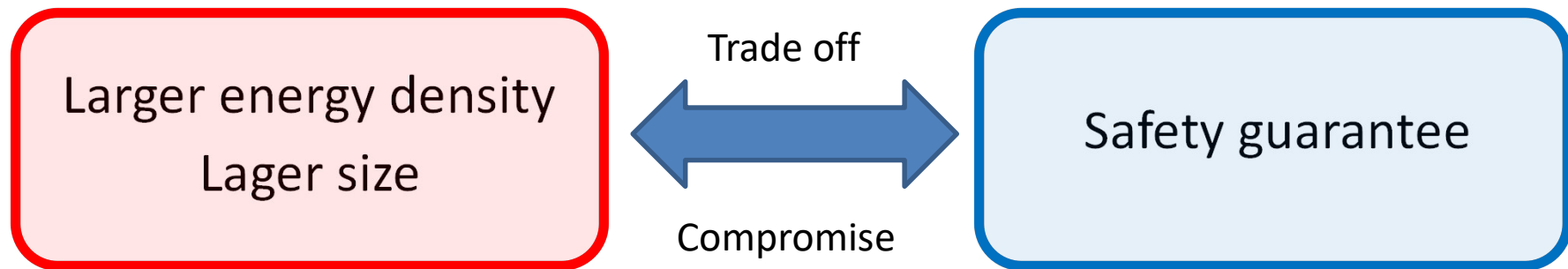
Battery explosion



Explosion of note PC and EV



Dilemma in battery development



Frontier Researches vs. Terminate Researches

Discussion Point

Next generation battery ?

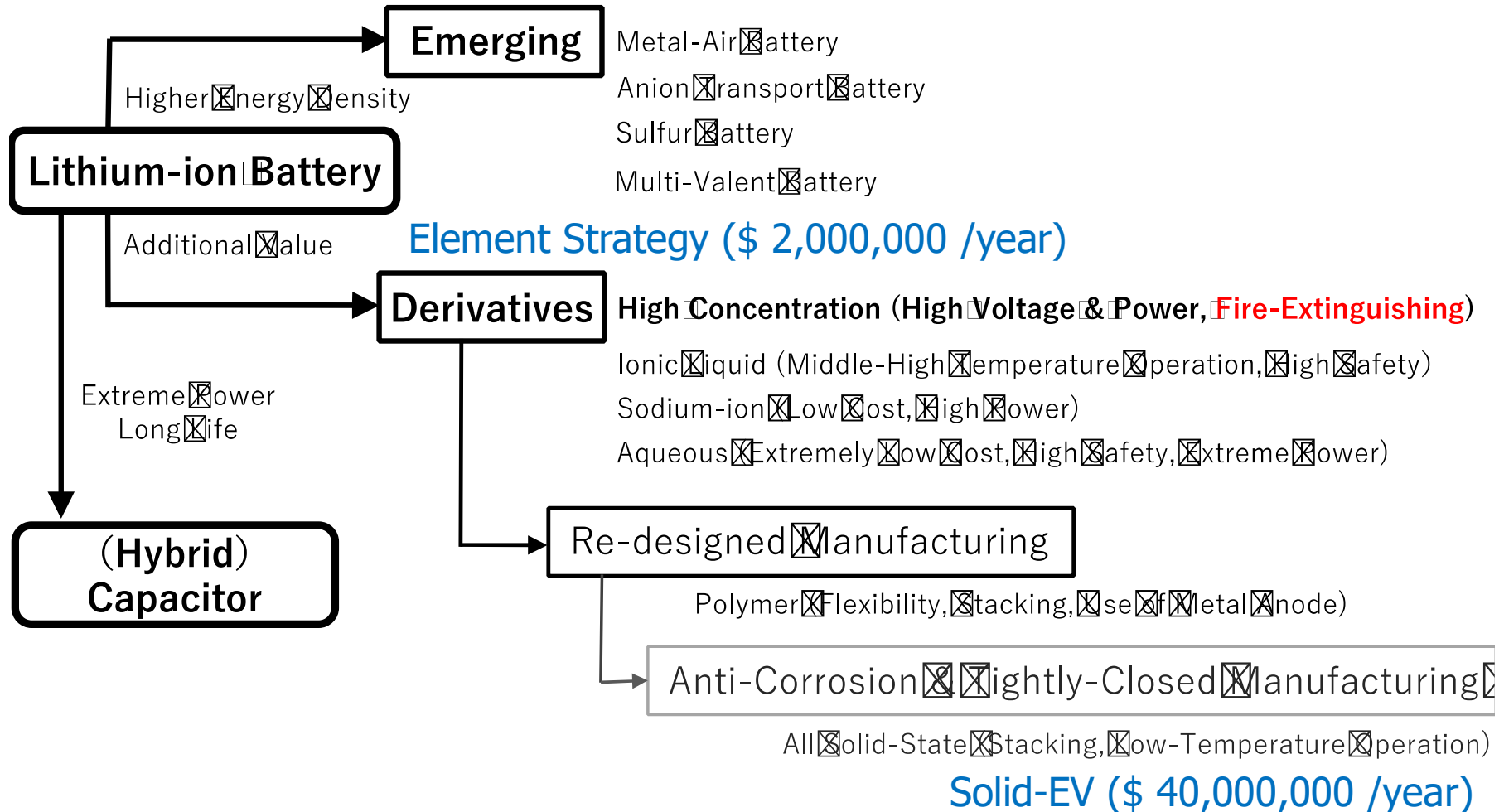
Innovative battery ?

What is really necessary ?

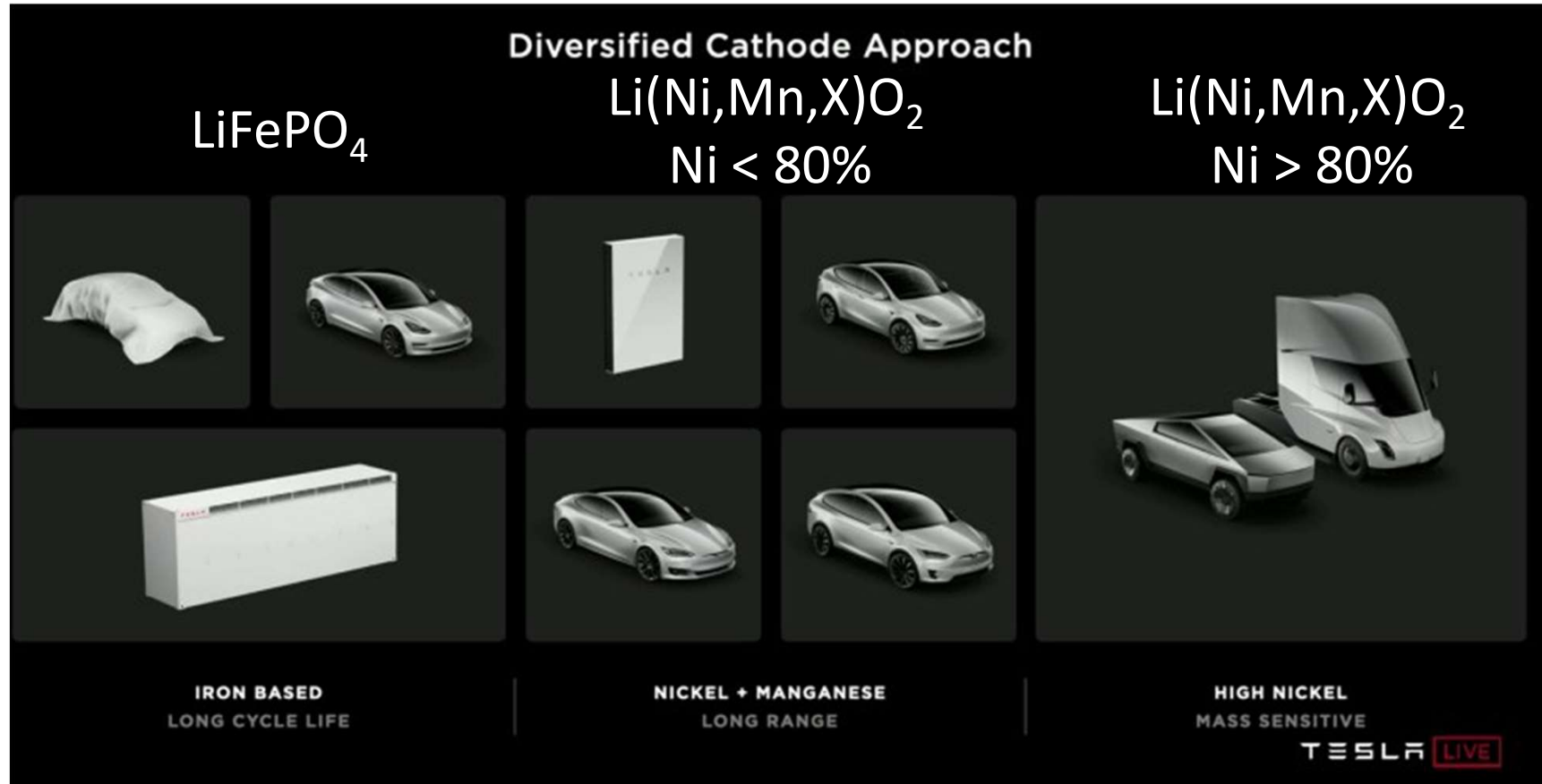
Overviewing battery technologies

What's going on Japanese national project

RISING3, ALCA-Spring (\$ 50,000,000 /year)



Tesla's realistic strategy



Cell size : 18650 → 2170 → 4680

Mounting : Cell ~~→ Module → Pack →~~ Chassis