

NISSAN MOTOR CORPORATION



Recommendation for End of Life Treatment of Battery

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Why Going EV Direction?

Global Warming

- Europe

Emission

- USA California

Energy Security

- China, India
- Saudi Gulf Country

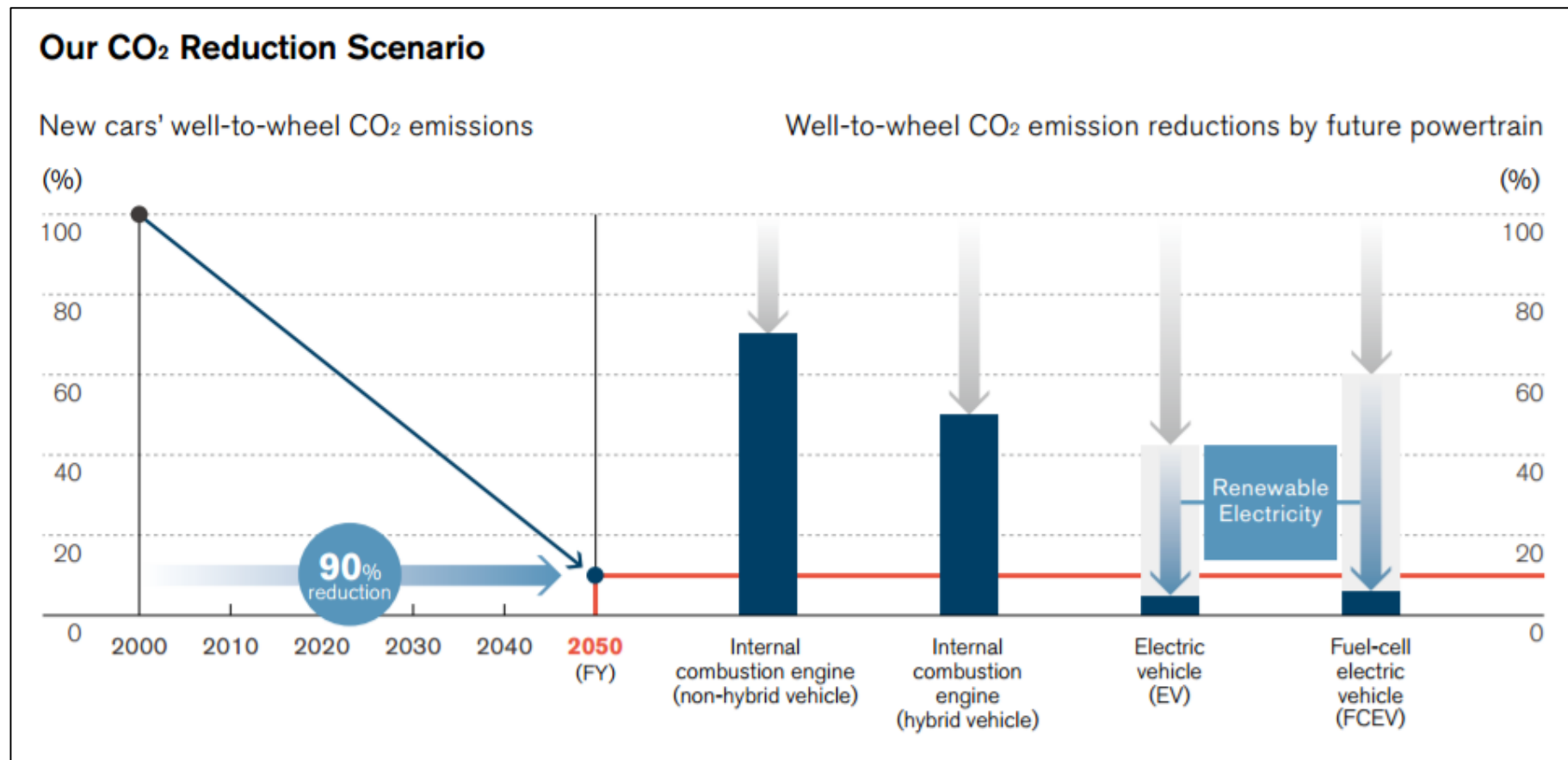
Industrial Innovation

- China, India
- Germany
- ASEAN
 - Low Investment
 - Low Infrastructure
 - Low Operation Cost
 - Low Technical Barrier



CO₂ Reduction Opportunity

- Need Pure ZERO Emission Vehicle (W2W)
- EV/FCEV have potential to reduce CO₂ by 90%

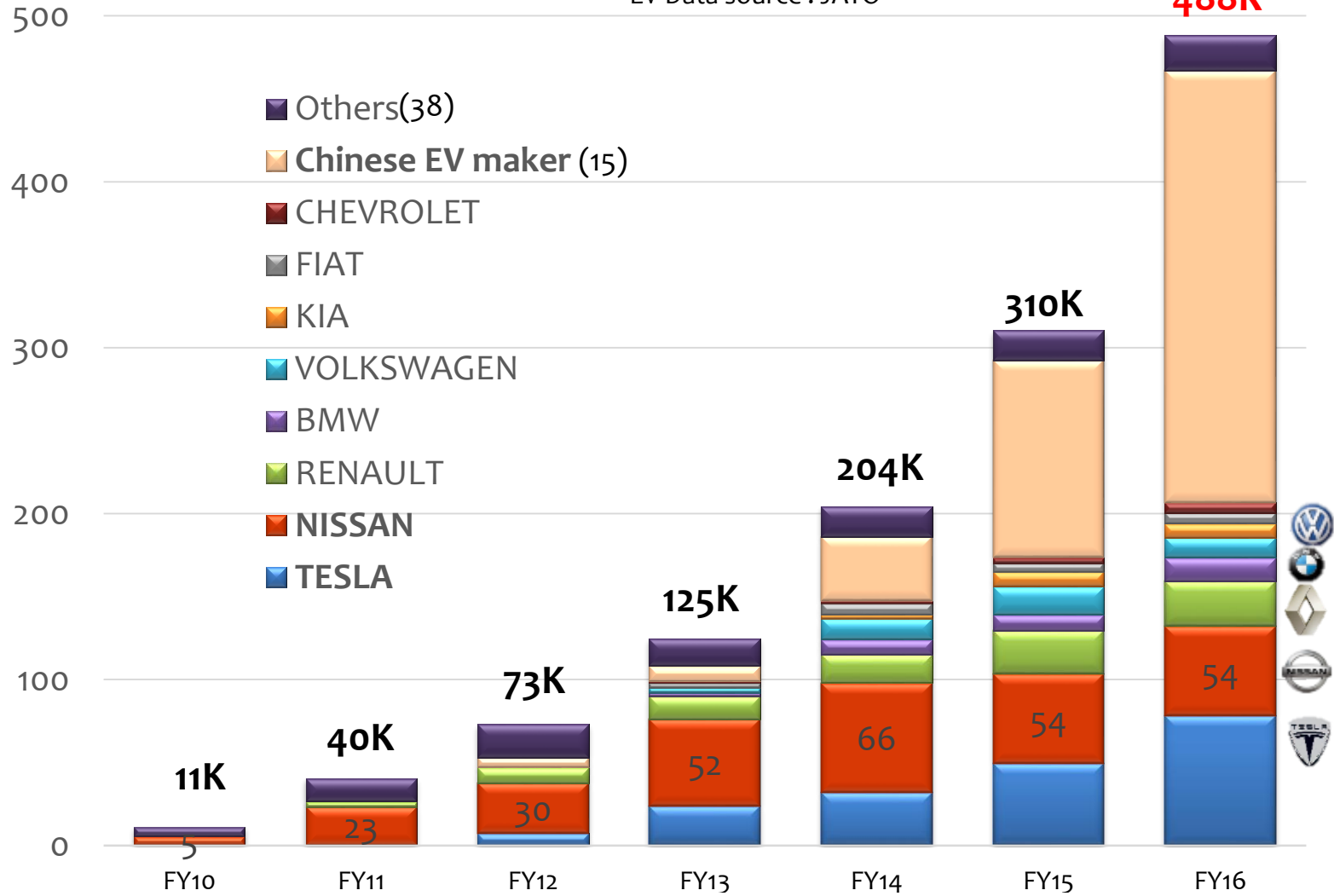


EV Market Growth

120GWh
1500K

(K units/Year)

EV Data source : JATO



**FY20
Forecast

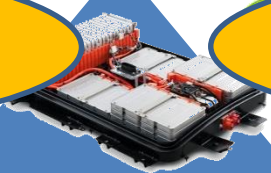
Battery –its task-

Pack

Safety

High Capacity

Battery Pack



Cells

Supply Shortage

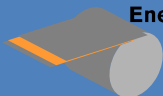
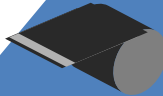
- Precision Machinery
- Semiconductor
- Soft Ware
- Electronics
- Chemical ...

Cells

Electrode

NEC

Energy device



Cathode

Anode

Electrode stacking
Dry room
Separator
Pouch film
Electrolyte

Material

LiMn_2O_4

LiNiO_2



Carbon
PVdF (binder)
Cu/Al-Foil

cond. additives
NMP

Coater

Slurry mixer

Press

Slitter

- Steel, Non Ferrous Metal
- Petro-Chemistry
- Plastics, Resin ...

Resource

Resource Shortage

MnO_2

Li_2CO_3

...

NiO

LiOH

...

Li
Co
Ni

- Mining
- Oil Refinery ...

Safety Achievement



361k Packs

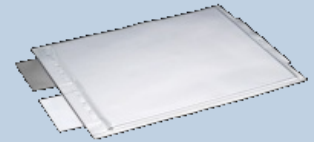
48+ a Module
Per Vehicle



17.5 Mil
Module

=

4 Cells
per Module



70 Mil
Cells

99.9999% Assurance cause
70 Cases

Total Nissan EV Trip Distance ;

9 Bil km

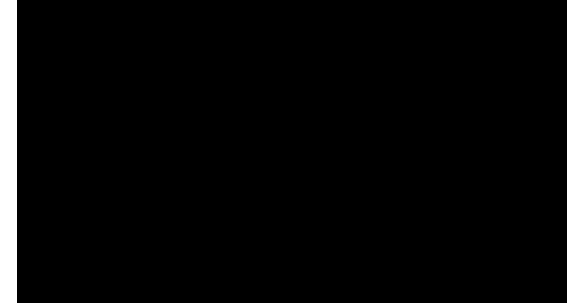
Moon-Earth 11800 rounds
Sun-Earth 30 rounds

0

Fatal Incidents

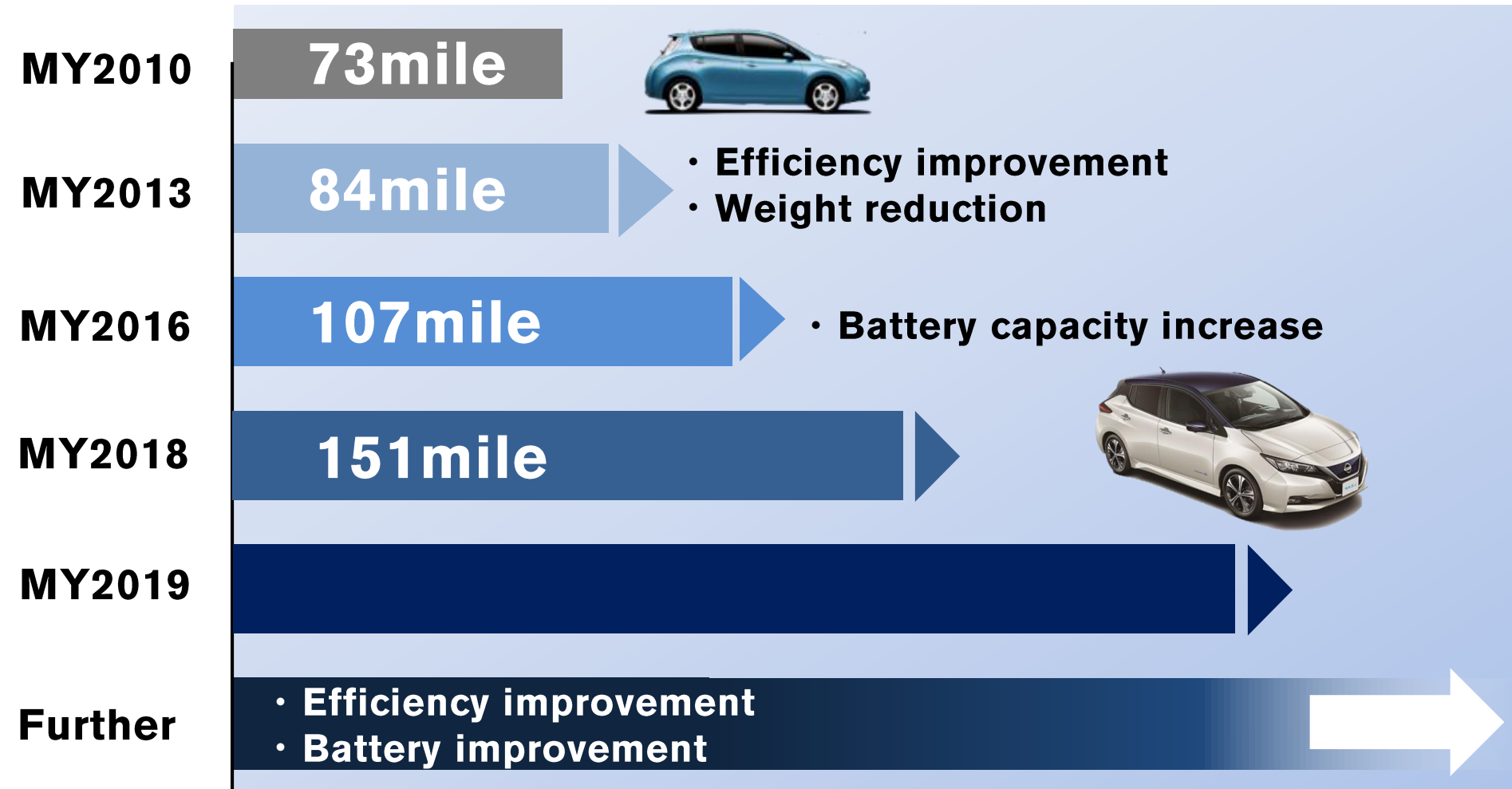
Source; Nissan Motor Co Ltd
As of 2018 Jan

How to Achieve Safety



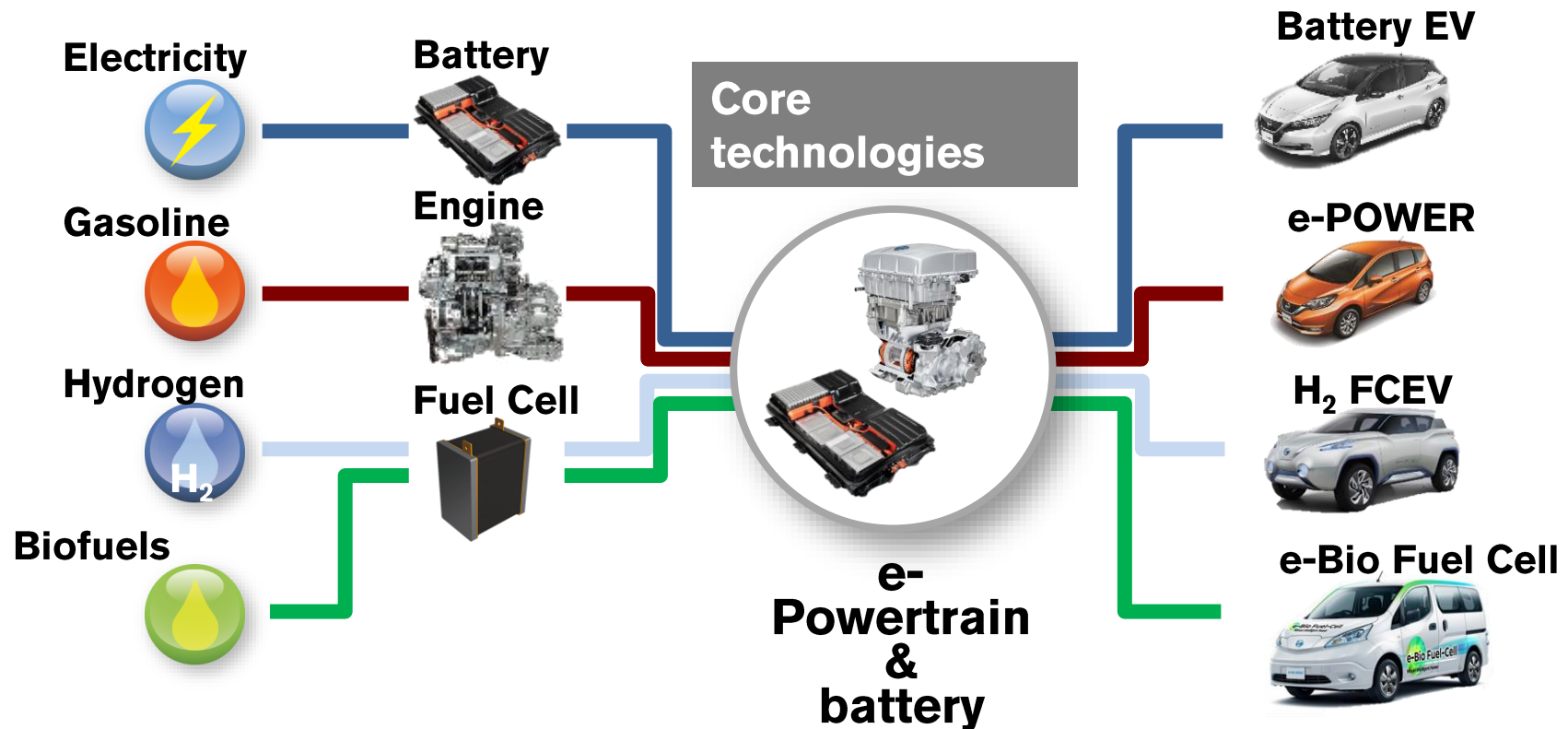
Further Evolution of EV

Range per charge [EPA Average]



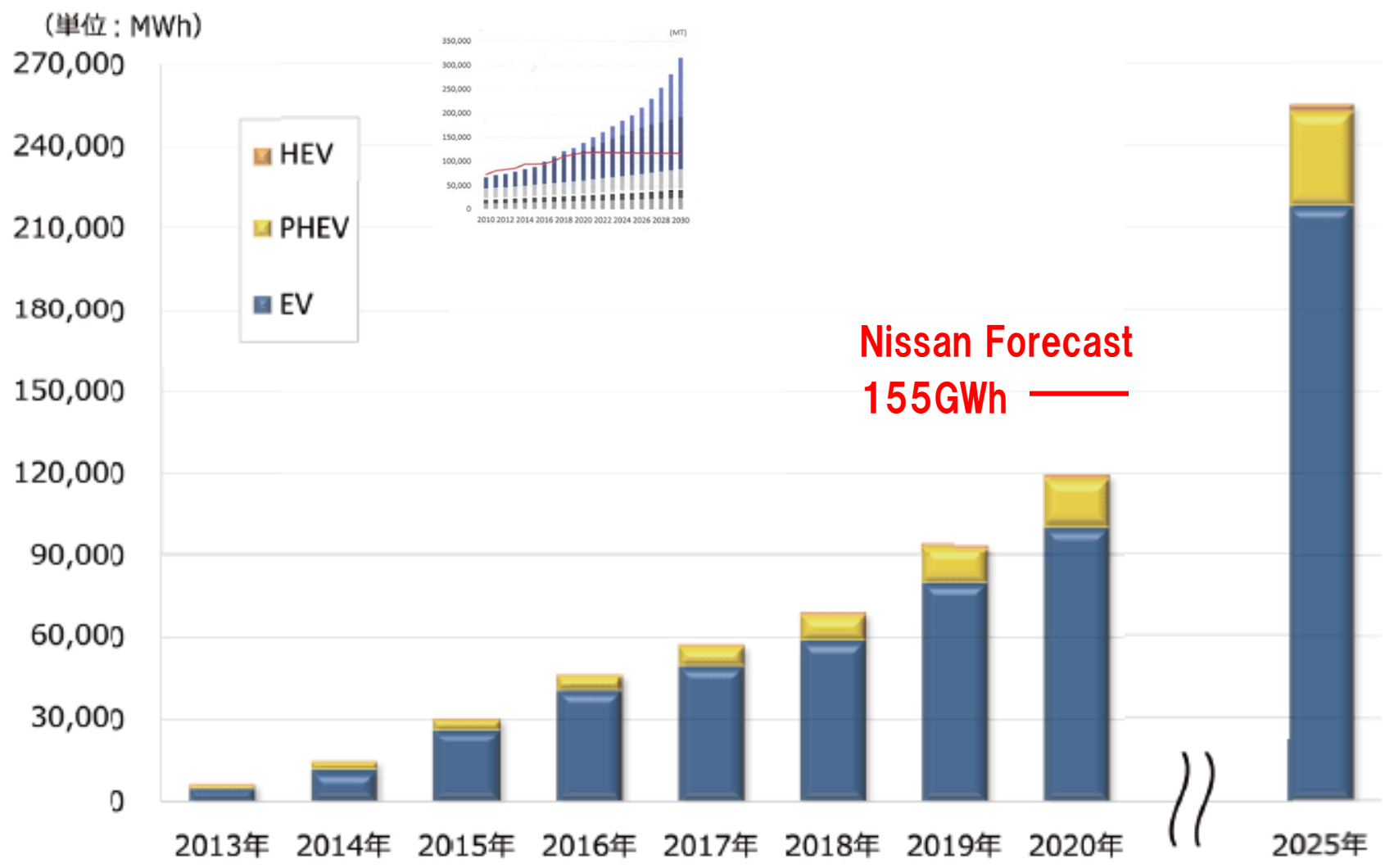
Diverse Applications of EV Technologies

- EV technologies are at the core intelligent Power
- They combine driving pleasure and sustainable mobility, and allow future energy diversity.



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Demand for Li-Ion Battery



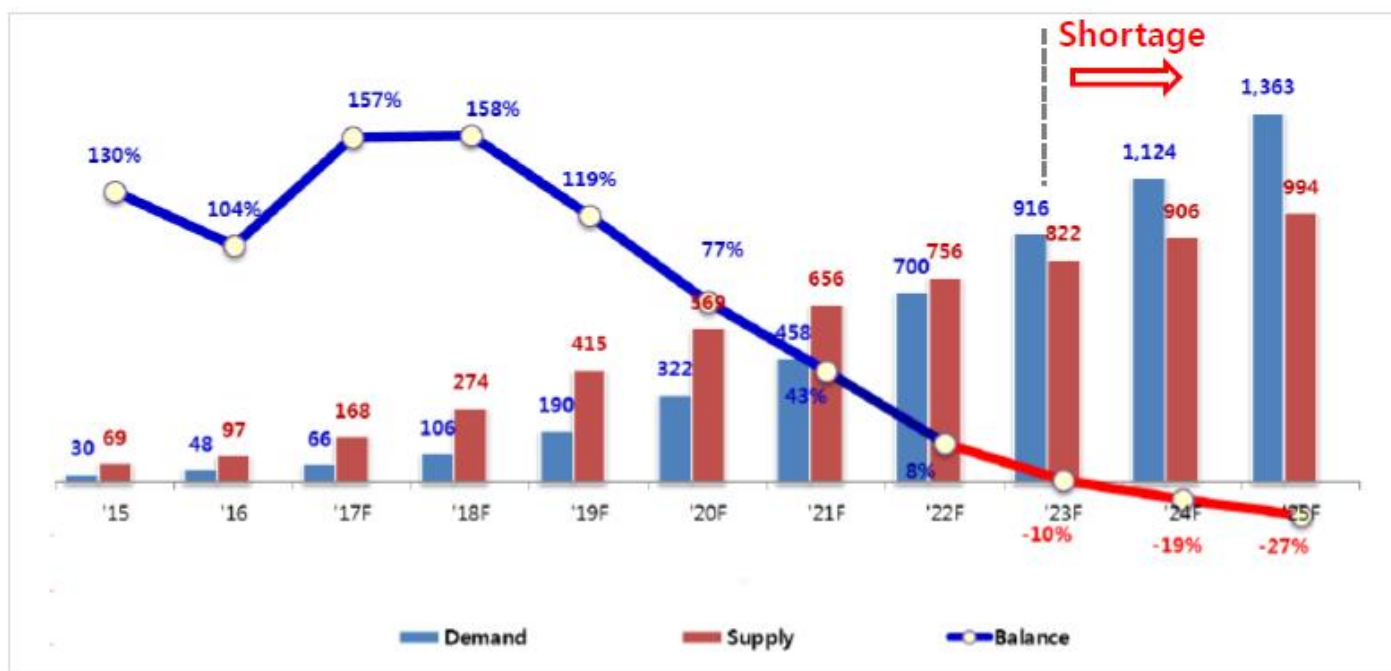
Source; Energy Information Center

Shortage of Li-Ion Battery

- EV Market Growth and Battery Capacity Increase makes Supply of Battery Extremely Short in Near Future

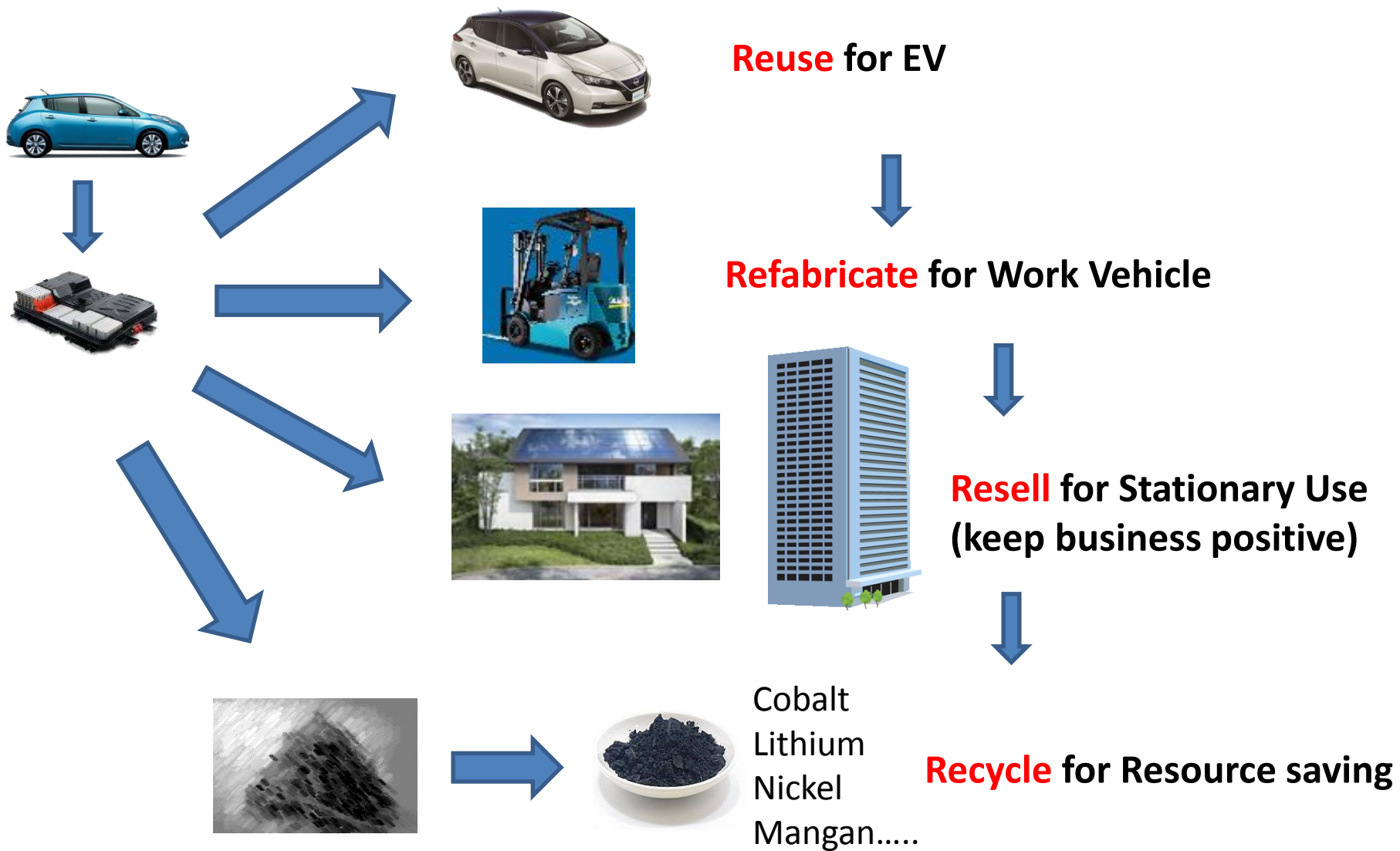
LiB Demand & Supply

Unit : GWh

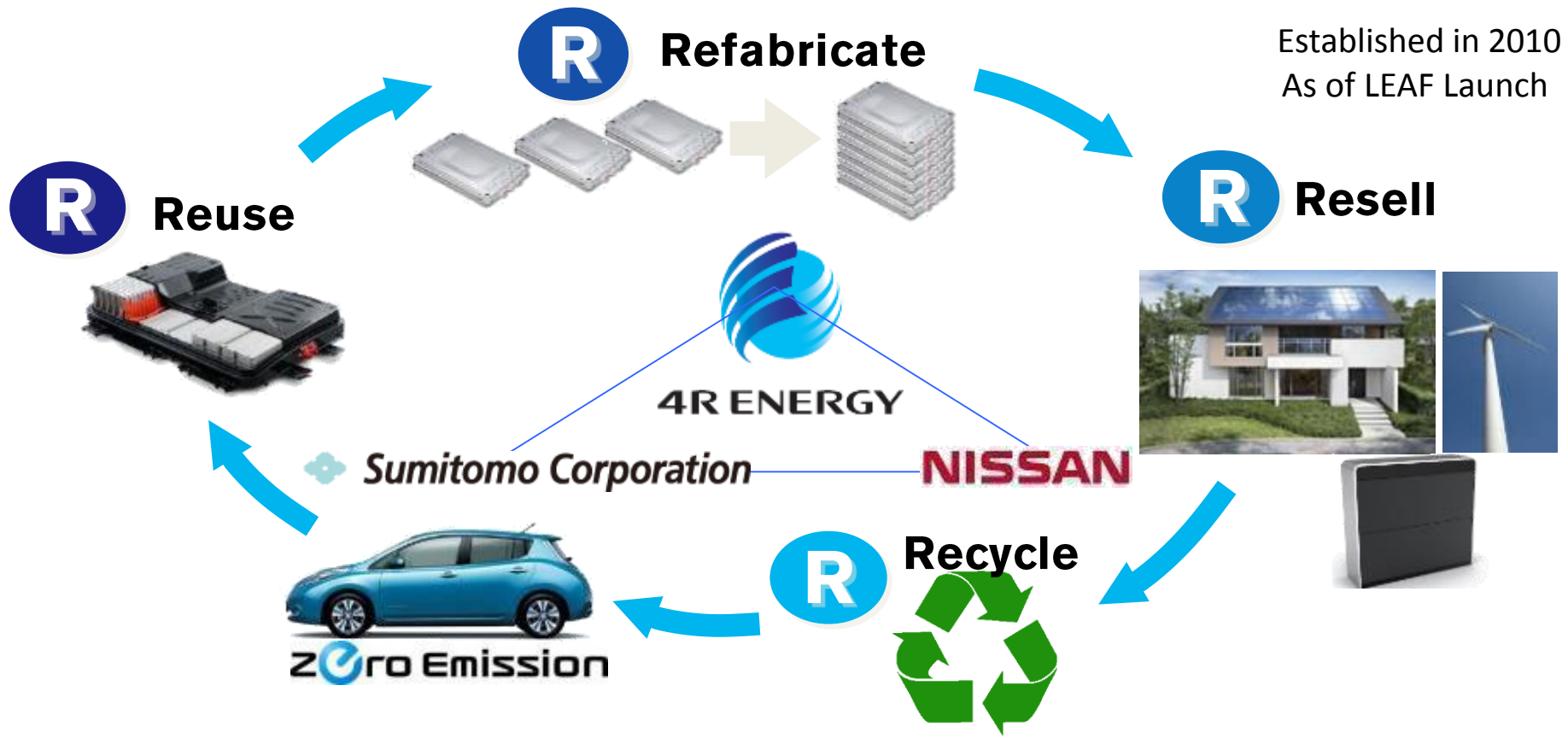


Source: SNe Research

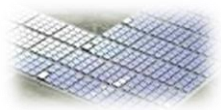
Need Battery be Re-



Life Cycle Management Scheme of LIB



<Reuse Bat R&D Proj.>



1MW Mega solar

<Business Feasibility Proj.>



Key Issues of EoL Management of LIB

For Global Efficient Management Scheme of LIB

1. Establish the **Commercial Flow** of Used LIB
2. Create the **Market** for the Secondary Used LIB
3. **Guarantee the State of Health** of LIB
4. Improve the **Recycle/Reduce Technology** of LIB
5. **Revise the Regulation, Standard, Social System**
if needed

To be Sustainable,

- Cost does Matter to Motivate the Stake Holders
- Definition of Cooperative Area and Competitive Area
- Common Information Sharing Network Works

1. Commercial Flow –Example in Japan

Japanese stake holders are agreed to Establish the Voluntary Scheme below

- Decide responsible organisation (National, Regional, Private)
(National Ministry of Environment will take a whole leading role for LIB recovery/disposal scheme. No double report to regional office.)
- Assign the possible capable LIB carrier for this process
- Assign the disposer of LIB with its unit cost by region
- Agree the transportation unit cost per size by region

Further cost down is expected and agreement will be revised accordingly

1. Another Ideas for the Efficient Flow

- Lease the Battery in the Vehicle
- Add Some Deposit at the Initial Launch of EV
- Establish an Common Entity cost burdened by
 - ✓ Vehicle OEM and/or
 - ✓ Battery Manufacture and/or
 - ✓ Battery Reseller and/or
 - ✓ Government or another Official Organization (by Tax)
- Regulate the Scheme for Mandatory Collection or Penalty Scheme
- Keep Voluntary if Secondary Market Price Grow

2. Create the Market

To Increase the Secondary Use of LIB

■ Governmental Initiations

- ✓ For National Resilience System
 - Bury the Used LIB for the Emergency Use
- ✓ For Wider and Finely Energy Network
 - Electric Provide Vehicle instead of Wired Network

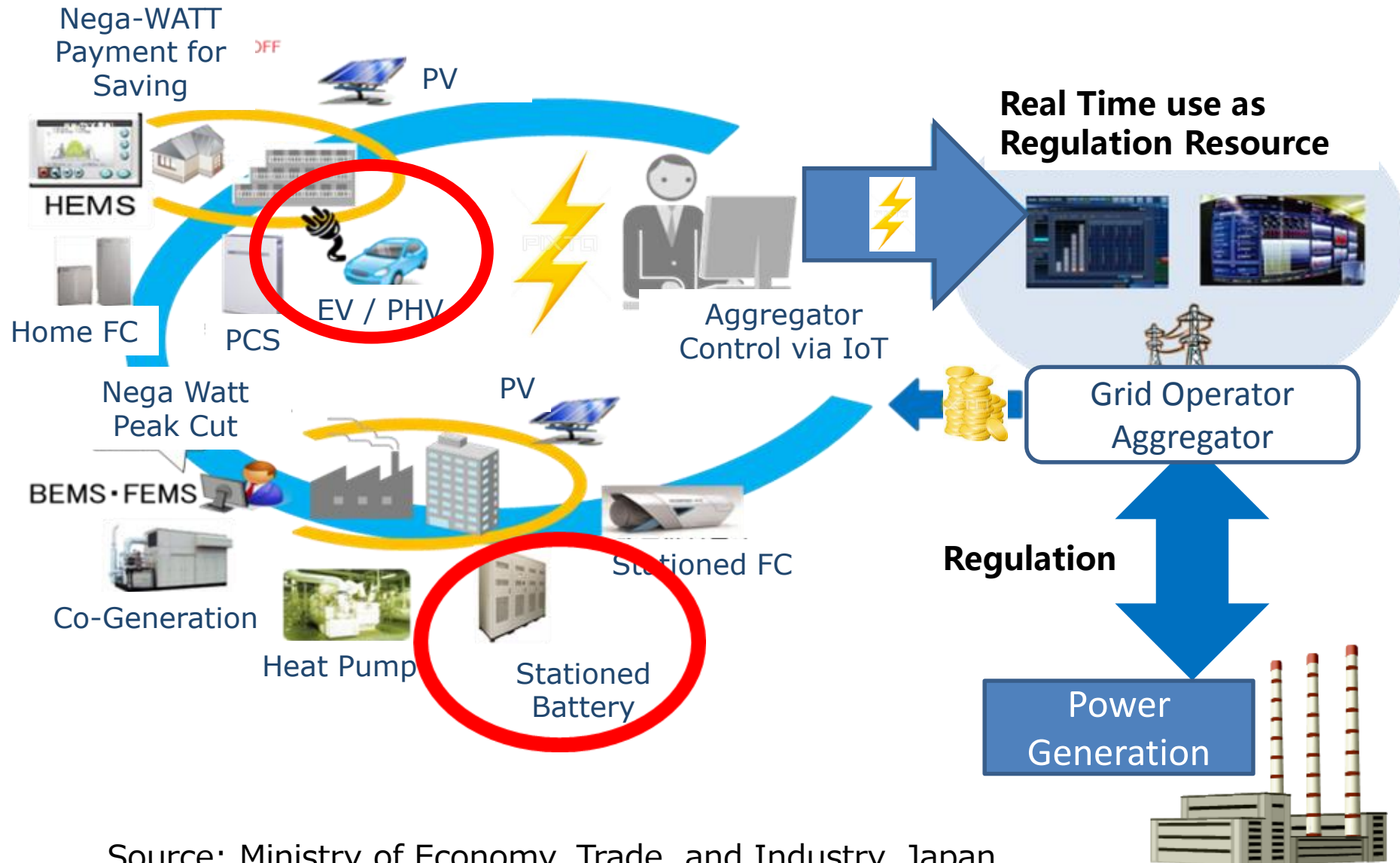
- ✓ Penalty and Awards for Balanced Cost

■ Accelerate the Competition of Market

- ✓ Create the Marketable Trade Scheme



2. Create the Market Example; Virtual Power Plant



Source; Ministry of Economy, Trade, and Industry, Japan

2. Trial Case of Nissan

- With 4R Energy, Nissan Tries the Case for 24 Used EV Battery Packs as an Energy Storage Device from August, 2015.
- Battery Provide Electricity at Peak (Peak Shift)
In Other Case, Aggregator will use as Adjustment such as Frequency Control

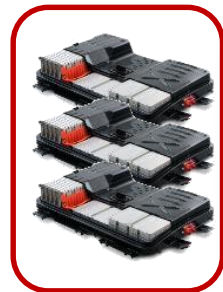


Large electrical energy storage facility
Capacity: about 400kWh; Power: 250kW

- Charger Equipped Used Battery for its Peak Cut



Power grid



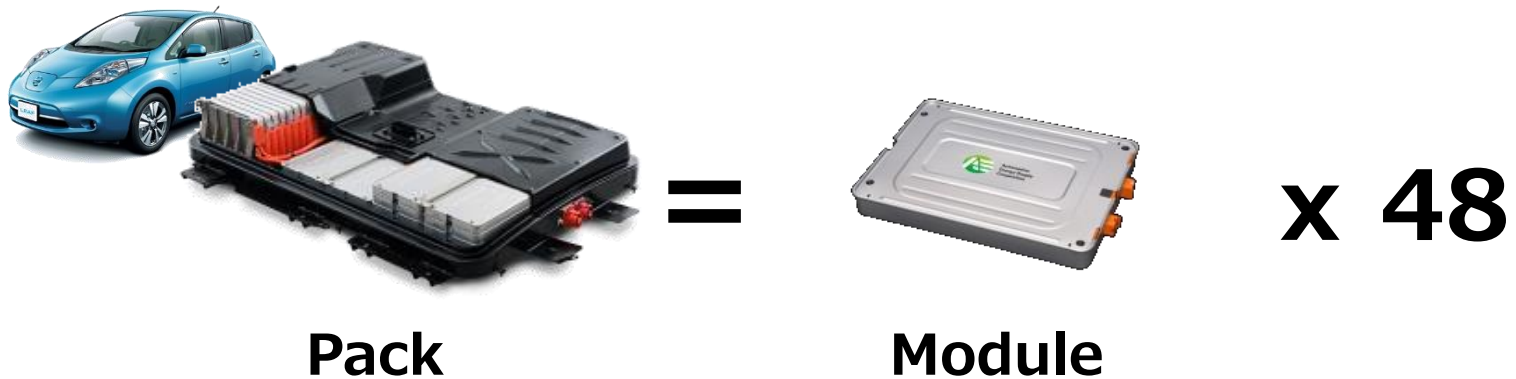
Reuse Battery on ...



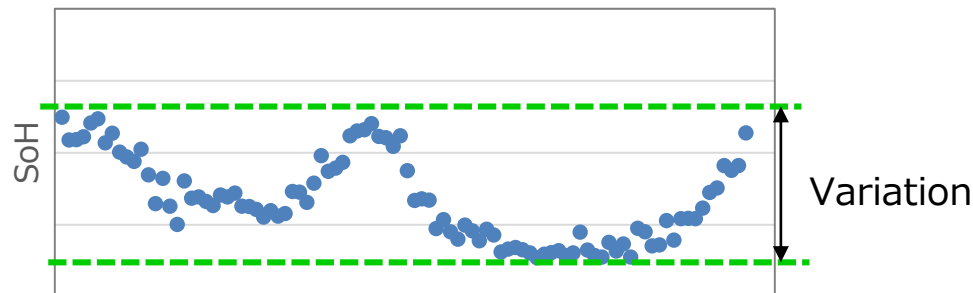
High power charger
Multiple chargers



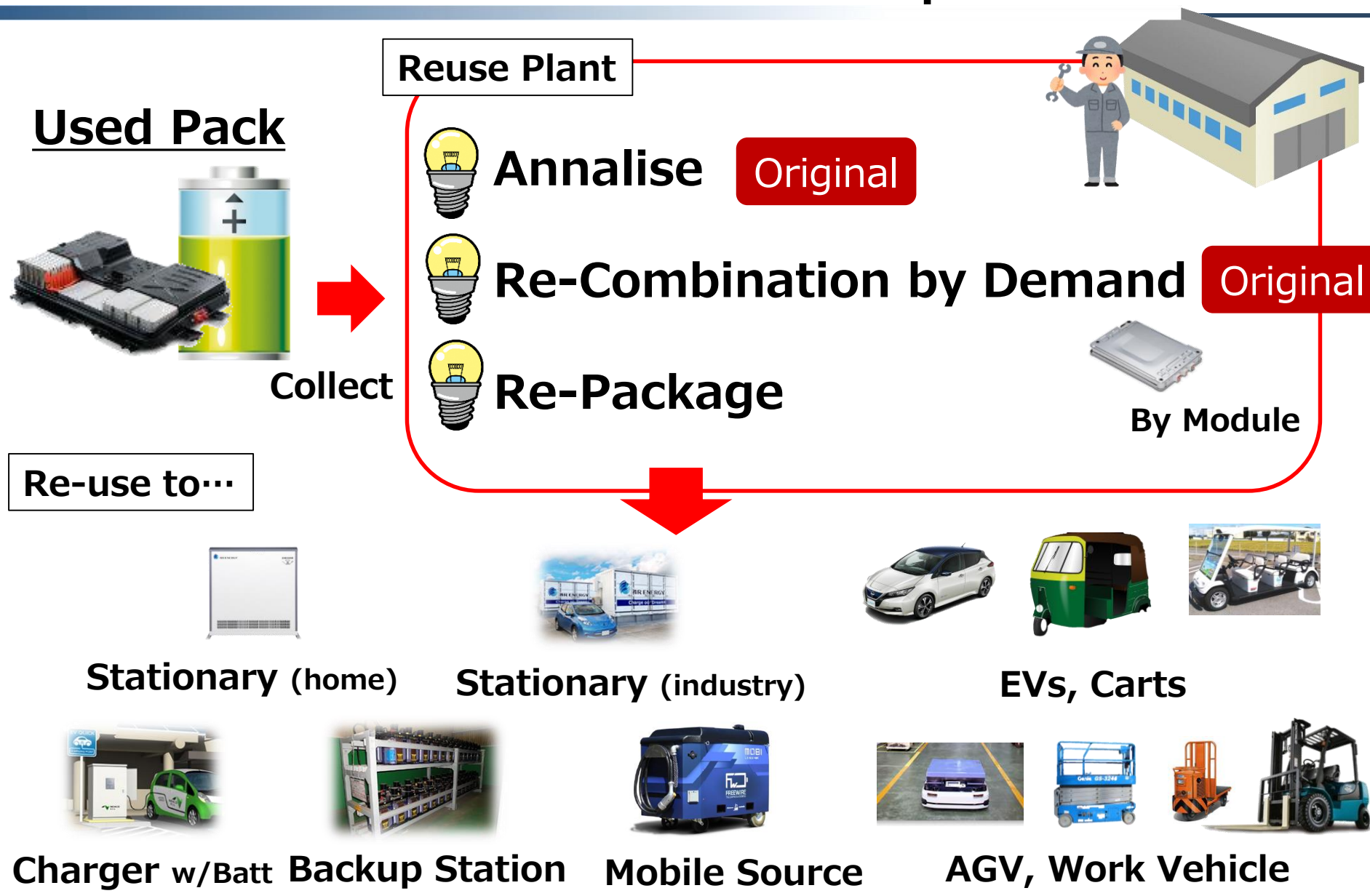
3. LIB Reuse Process –LEAF Example



- Grasp Each State of Health for 48 Module
 - Replace the Module(s) Accordingly to the Requirement
 - Safety Performance Prioritised
 - Cost Down is Expected
- } Anti Inferior Process



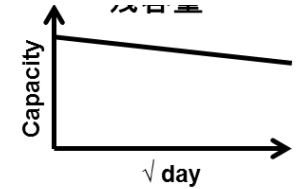
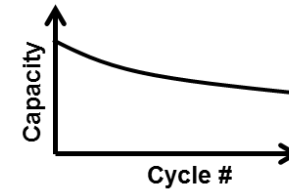
3. LIB Reuse Flow –LEAF Example



3.To Guarantee the SoH of LIB

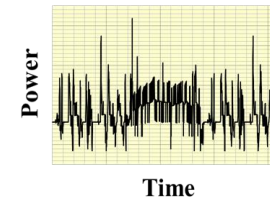
■ Cell Data (Design Factor)

- Heat Factor
- SOC Factor
- Storage Factor
- Charging Factor

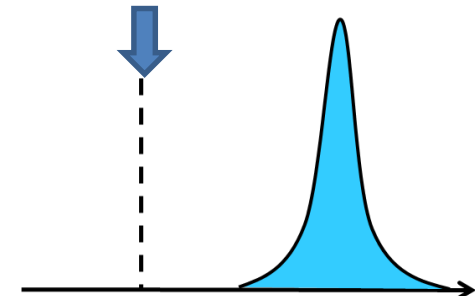


■ Actual Data (Real Market)

- SOC
- Used Duration
- Number of Quick Charging
- Thermal History



■ Gradation / Certification Based on the Correlation of Above



3. Field data of LEAF Battery

To Collect Real Usage Data in the Market, Nissan Use Telematics with the Agreement of EV User

Data center



EV/battery data

Data except EU

Monitored:BCR	50,297 cars	JP:24,173 US:24,026 CA:1,728 EU:0 AU:2 others:368
:Pre-BCR	37,481 cars	JP:18,167 US:18,217 CA:640 EU:0 AU:459
Trip Total	251,591,239 times	
Distance Total	2,740,554,683 km	LEAF drove to and from Sun 9.1 times
Max. Distance	237,154 km	Washington others
Quick Charge	6,600,310 times	
Normal Charge	35,829,881 times	
Energy Total	327,921,530 kWh	Save 22,627M yen * (Energy cost 1/8) 15 km/l, 140 yen/l, 9 yen/kWh

The data shows only statistical trend.

Example of User Interface

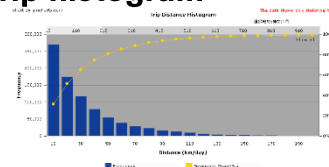
update: Mar 27, 2016



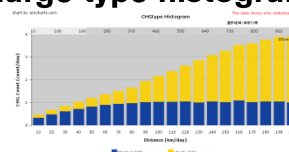
Vehicle



Trip histogram



Charge type histogram



4. Recycle / Reduce Technology

Still Competitive Area, but Need to Find Common Area

- Reduce the Rare Material Usage
 - ✓ High Nickel, Less Cobalt
 - ✓ Lithium Reduction
- Worth to Recycle Collection of Precious Metal
- Easy Process (Dismantle) Design at Pack, Module Level
 - ✓ Cost Effective Process Development
 - ✓ Easy to Understand Criteria for Process Easiness
 - Common Criteria is Required for Common Dismantlers to make Reuse / Recycle Decision

5. Revise the Regulatory System

- Revise the Current Existing Regulation/Standard only if
 - ✓ Safety is Secured
 - ✓ Real World Data Shows Few Risk (Vibration, Rotation, Water)
 - ✓ Cost and Efficiency is Balanced
 - ✓ Technically Available and Reasonable
- Establish Permanent Regulatory Scheme
 - ✓ System for Battery Leasing (Quality Assurance etc)
 - ✓ Sustainable Flow Related Regulation
 - ✓ Quality (SoH) Certification / Gradation Scheme
- Establish Temporary Scheme
 - ✓ Incentives / Subsidy to Make the System on Track
 - ✓ Information Exchange Opportunity as 3rd Party
 - ✓ Supporting Commodity and Standardisation if any

Summary

- EV Market Growth will Come for Sure and Rapidly
- Lathium-Ion Battery will be Main Player for more Decades, but Serious Supply Shortage will be the Issue
- Reduce the Rare Material, Market Creation for Reuse Battery, and Recycle Technology
- Five Key Issues to be Considered
 1. Establish the Commercial Flow of Used LIB
 2. Create the Market for the Secondary Used LIB
 3. Guarantee the State of Health of LIB
 4. Improve the Recycle/Reduce Technology of LIB
 5. Revise the Regulation, Standard, Social System

Thank You for Your Attention
Merci de votre attention



3. LIB Reuse Actual Process –LEAF Example

Collection



Measure and Grading



Storage



Reuse / Reproduce



Various Needs



Inspection / Delivery

