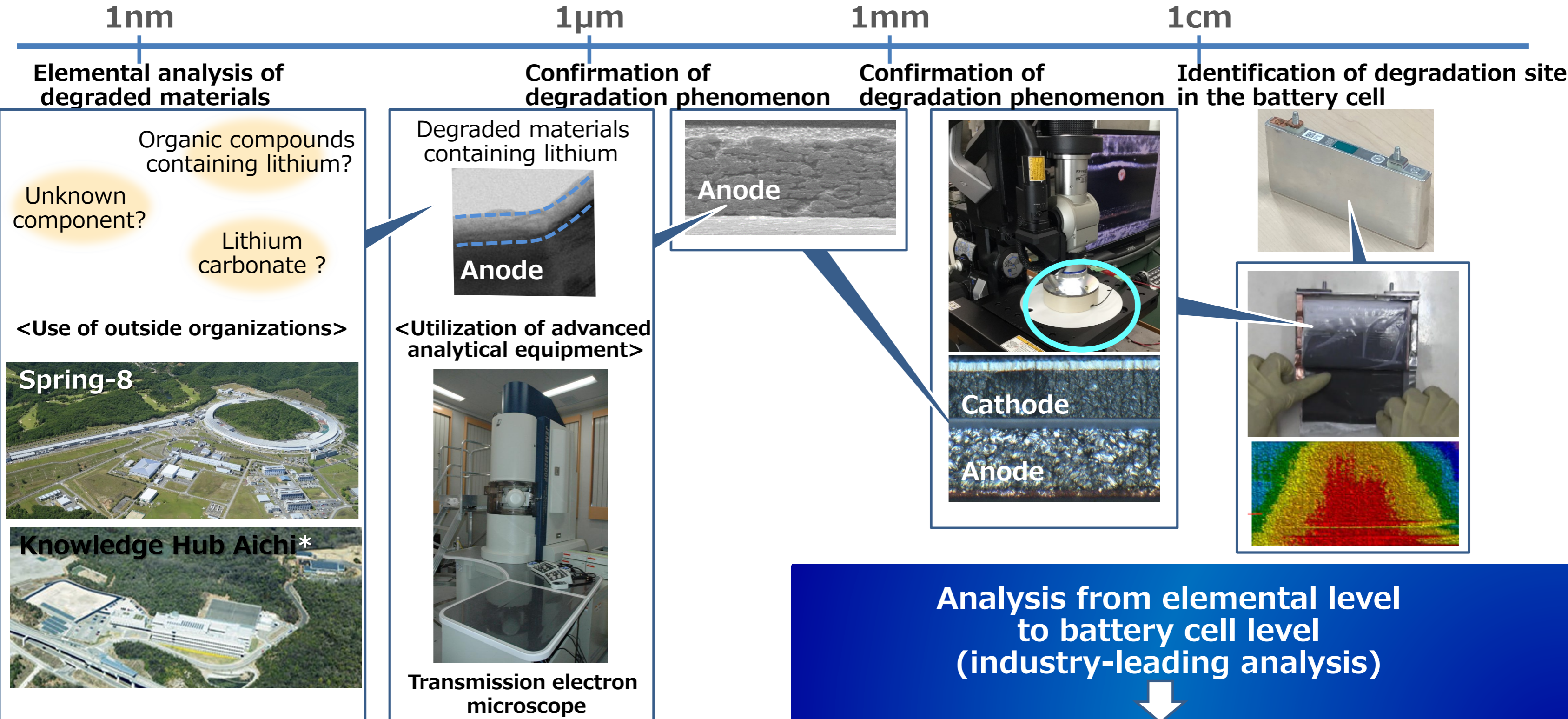


Battery development environment: Design based on principles

<An example of initiatives toward long service life>



*Source: Knowledge Hub Aichi <http://www.chinokyoten.pref.aichi.jp/>

An example of a vast experiment

<An example of initiatives toward long service life>

Battery Life Prediction

<Battery use conditions based on vehicle running data>

Temperature

60°C

•

•

•

25°C

•

•

•

-30°C

•

•

•

×

Charging amount (SOC: State of charge)

100%

•

•

•

×

Electric current *

•

•

•

*Depends on battery type and degradation status

×

State of degradation

Initial stage

•

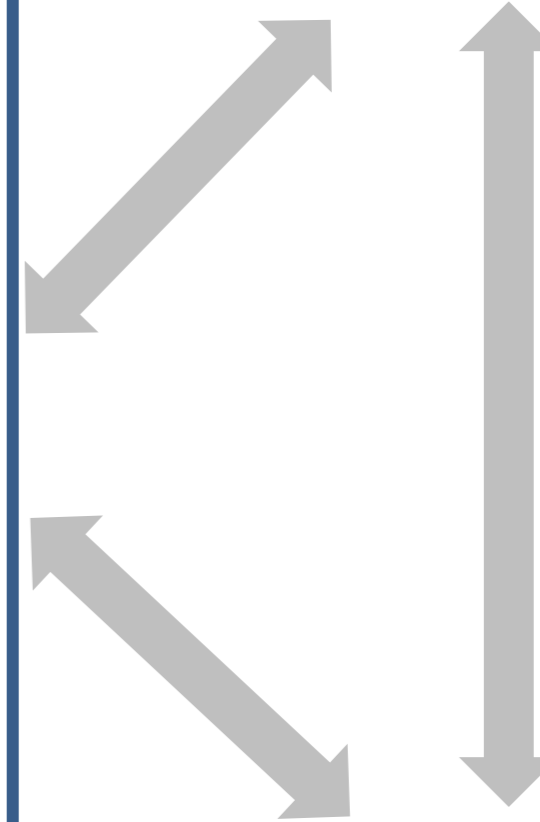
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Terminal stage

Analysis

Various analyses from elements to battery cells



Safety evaluation

- Legal test
- In-house standard test

Evolution of battery development environment

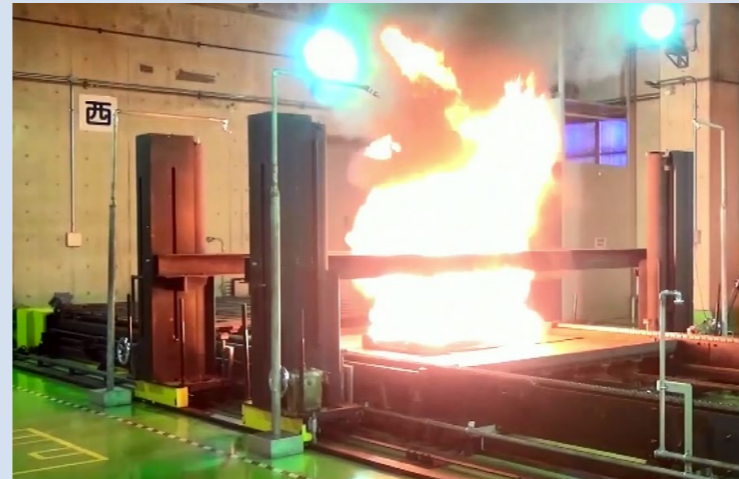
Real-world data generation and accumulation



Experimentation



Cell evaluation equipment

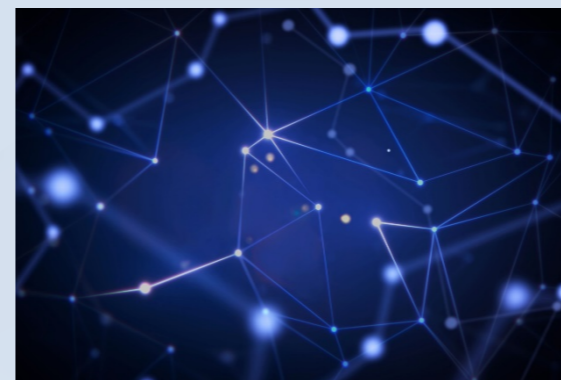


Example of battery pack test

Simulation



AI·DX



- **Discovery of innovative materials**
- **Advanced manufacturing**

Example of integrated vehicle and battery development

Battery cell and system evaluation at in-house facilities

Actual
vehicle
running
data

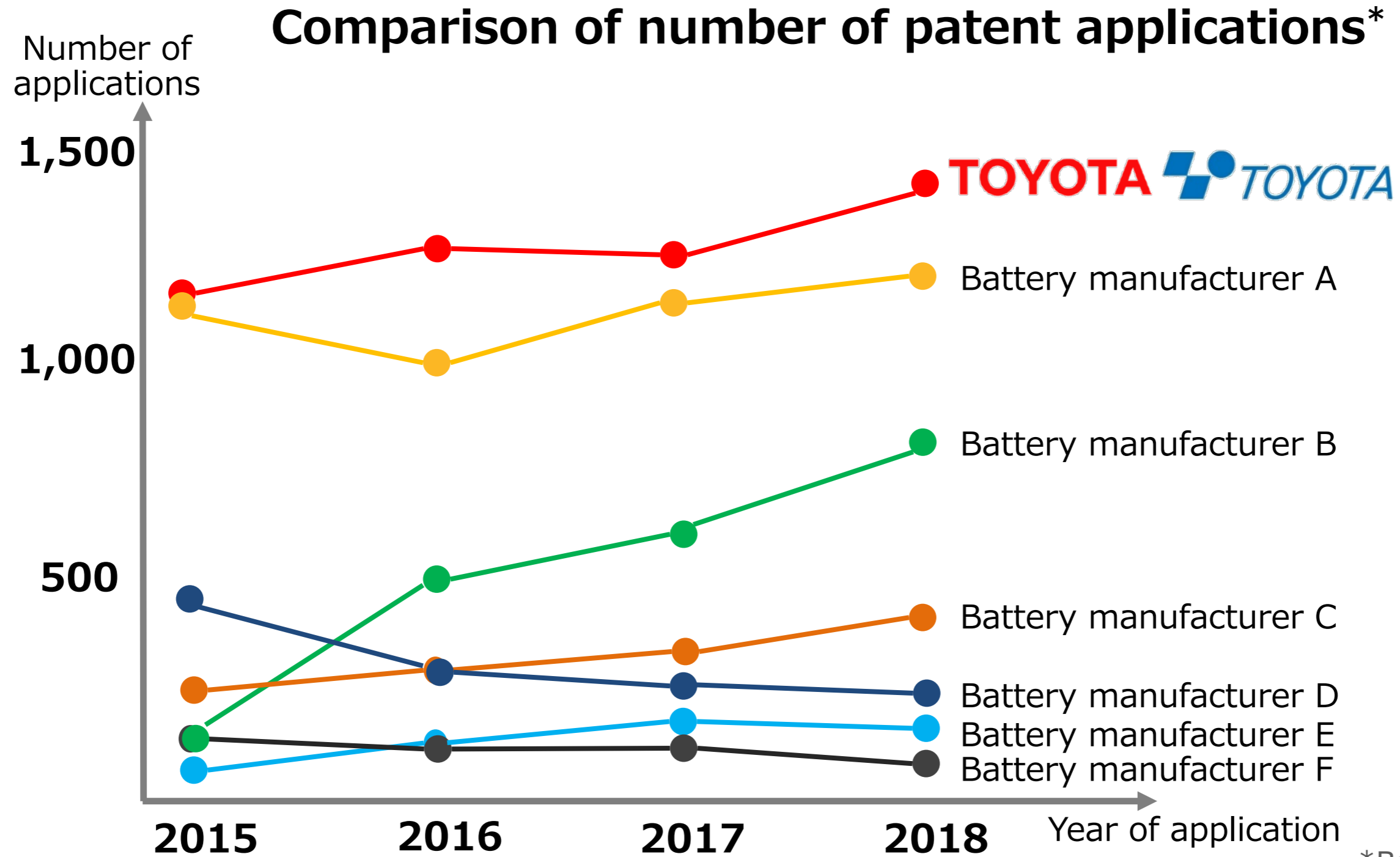


Running test

Temperature, voltage, current, capacity
Acquisition of data on resistance, output, etc.

- Understanding battery use environment based on vehicle running data
- Quick improvement of control system based on battery evaluation results

Number of patent applications



The Toyota Group has one of the highest number of battery-related patent applications in the industry.

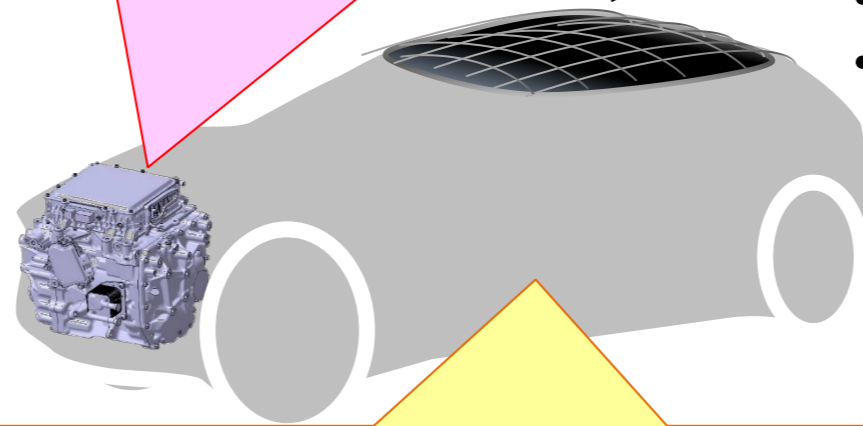
Future BEVs: Toward further improvement of electricity efficiency

- Optimal efficiency design and control of the entire power train system
- Further expansion of energy regeneration

Improvement of electric power train loss

High efficiency solar cells

- Ultra light weight
- High efficiency
- Expansion of area



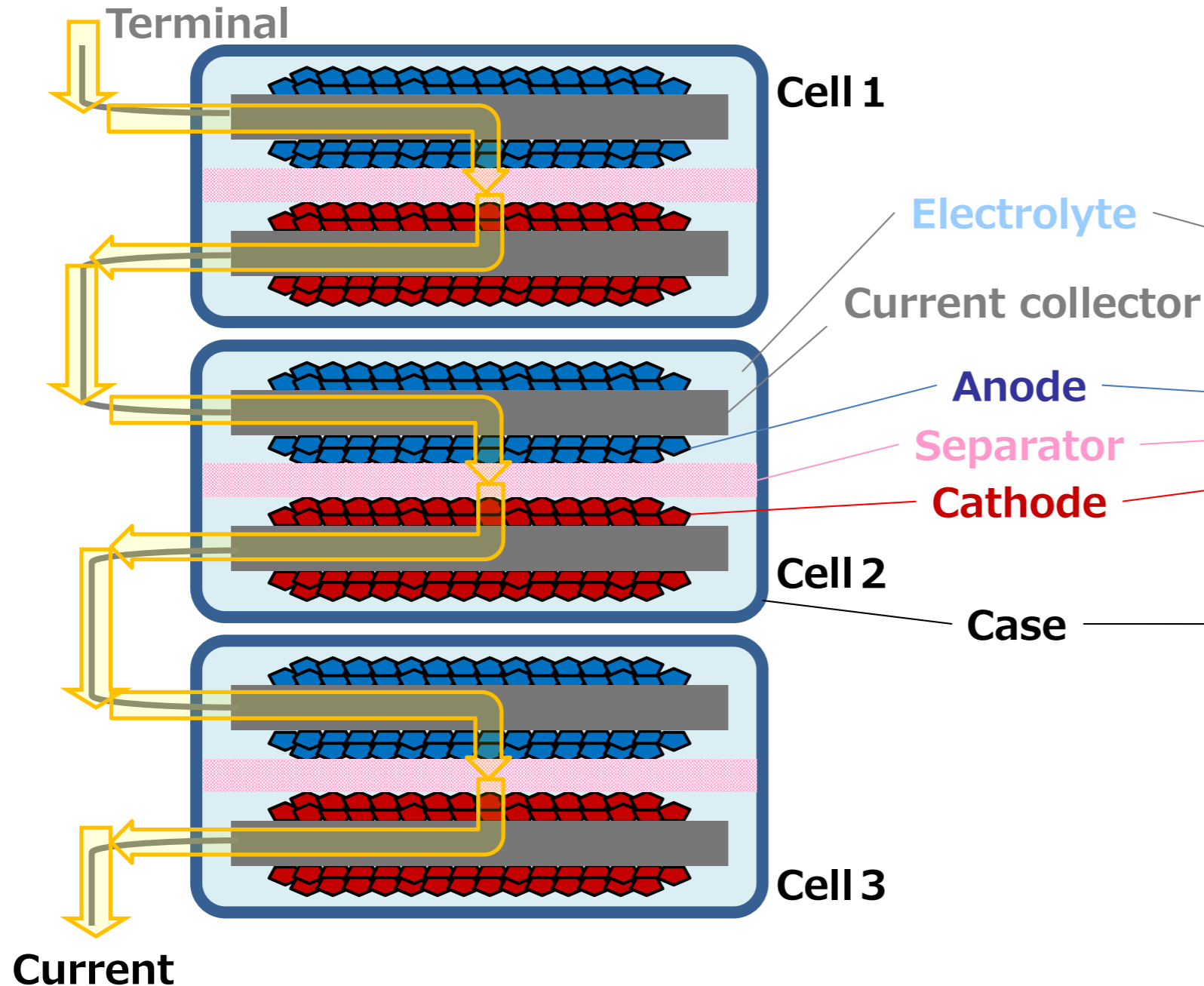
Improvement of vehicle loss

- Optimum energy and thermal management of the entire vehicle and components
- Reduction of vehicle running resistance to match the electric vehicles

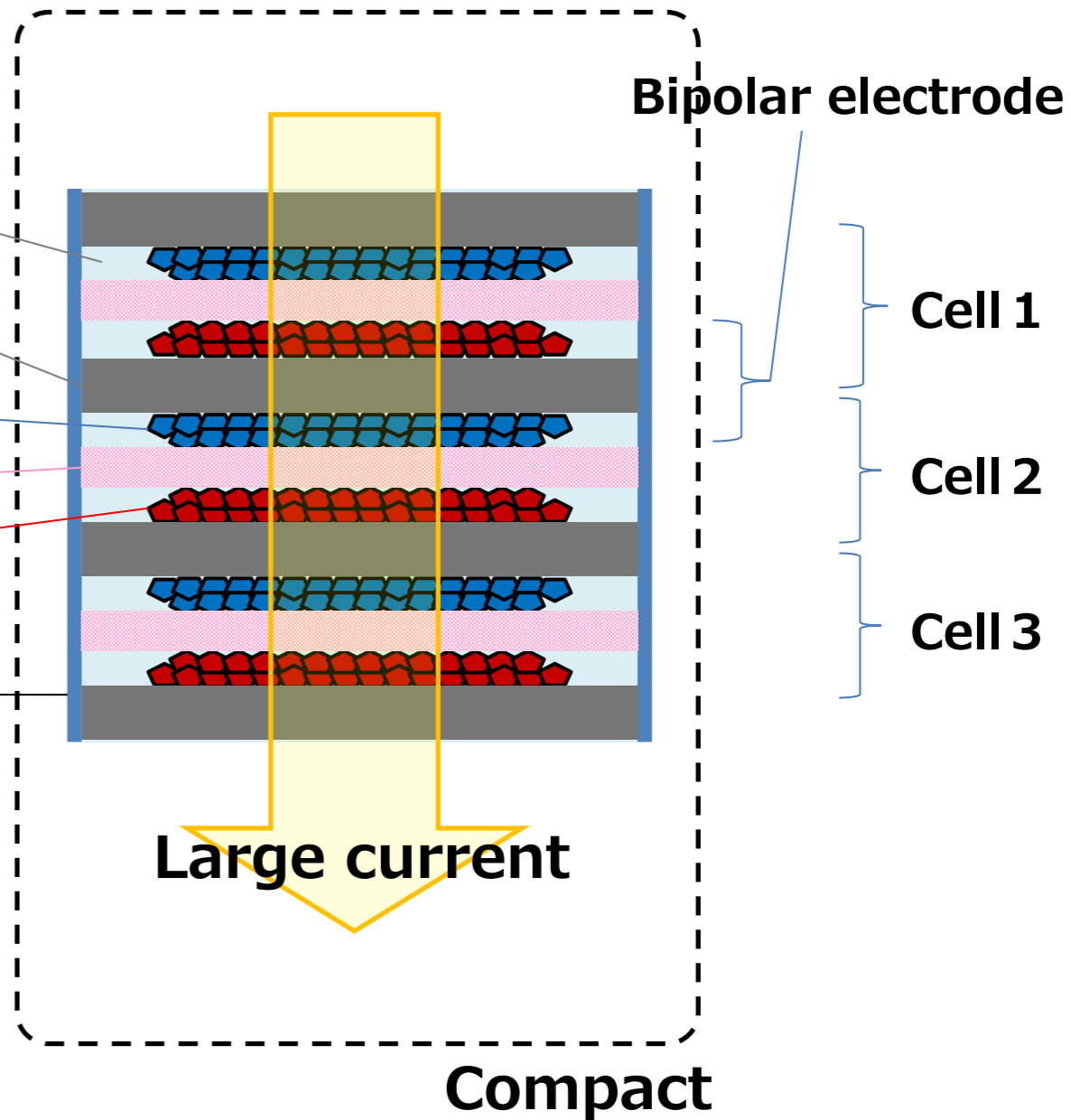
Toward BEVs, pursuing further development of electricity efficiency improvement through technology cultivated through 18.1 million HEVs

Bipolar nickel-metal hydride battery

Conventional battery



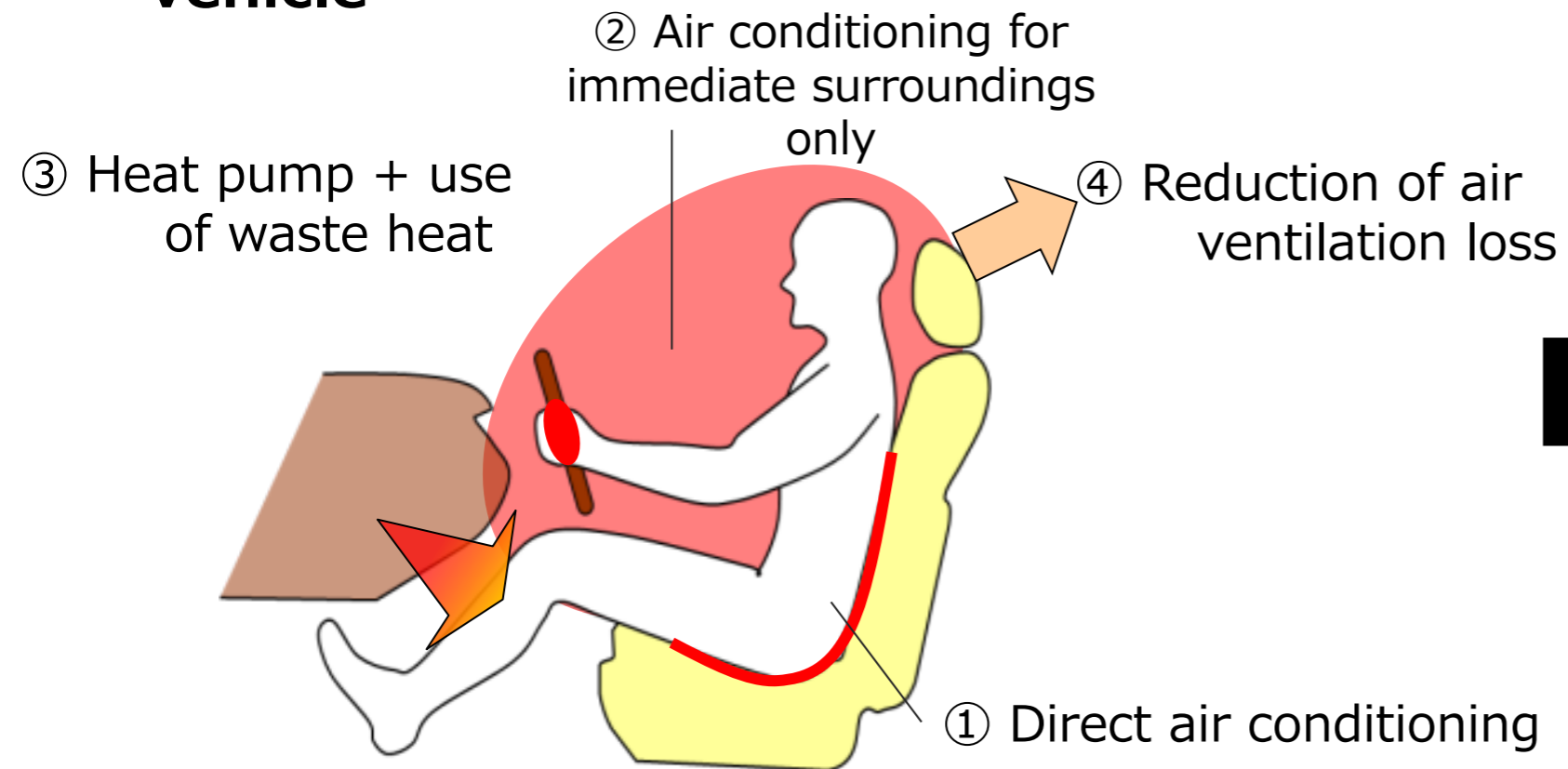
Bipolar battery



Improving power efficiency: Reducing waste and efficient use of energy

Items to improve power efficiency

- Evolved thermal system for the entire vehicle



- Reduction of tire rolling resistance
- Weight reduction
- Improvement of aerodynamics

Among best in class:

- Practical cruising range in winter
- Appropriately-sized batteries at reasonable prices