

Environmental Considerations and Battery Supply Chain Circularity

Christopher J. Brooks, Ph.D.
Chief Scientist
Honda Research Institute, USA

June 13, 2023

Automobiles | Powersports | Power Equipment | Marine | HondaJet



“Be a company that society wants to exist.”

- Soichiro Honda



NEW 2050 GLOBAL environmental target of carbon neutrality is on the same level as Safety.

Honda's sustainability story goes back 50 years when our engineers embraced the challenge of developing the first CVCC.



1972

Honda announced CVCC, the first engine technology to meet U.S. Clean Air Act standards without the need for a catalytic converter.



1974

The 1975 model year Honda Civic CVCC was the first car to comply with the U.S. Clean Air Act solely through engine performance.



1986

The Civic CRX-HF was the first mass-produced 4-cylinder car to break the 50-mpg fuel economy mark.



1989

Honda becomes the first automaker in America to use waterborne basecoat paint in mass production, introducing the process in Ohio.

Lowest Emissions of All Full-Line OEMs

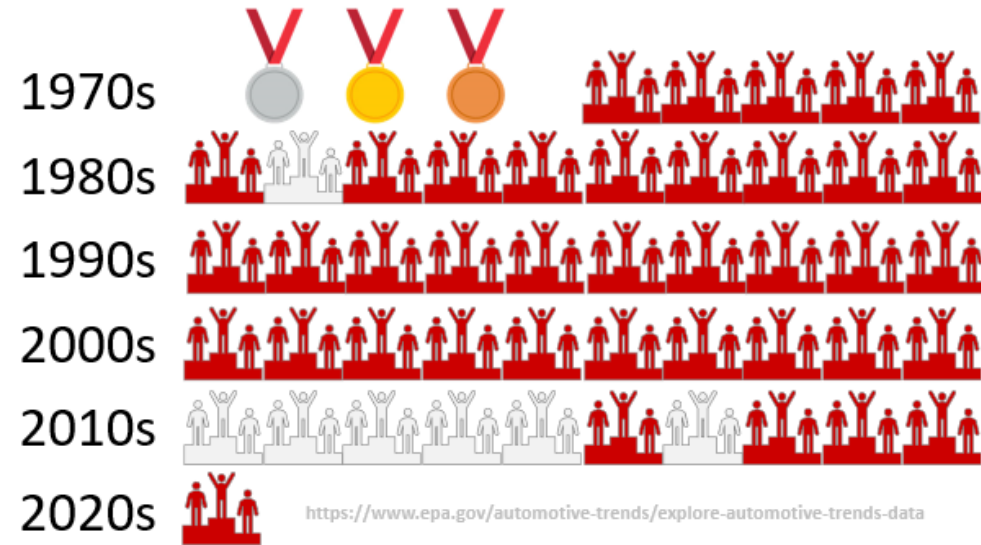
Honda	29.1
Subaru	28.5
Hyundai	28.4
Nissan	27.9
Mazda	27.9
Kia	27.7
Toyota	27
BMW	25.5
All OEMs	25.4
VW	25.0
Mercedes	23.4
GM	23.0
Ford	23.0
Stellantis	21.3

14.5%
better than
the industry
average

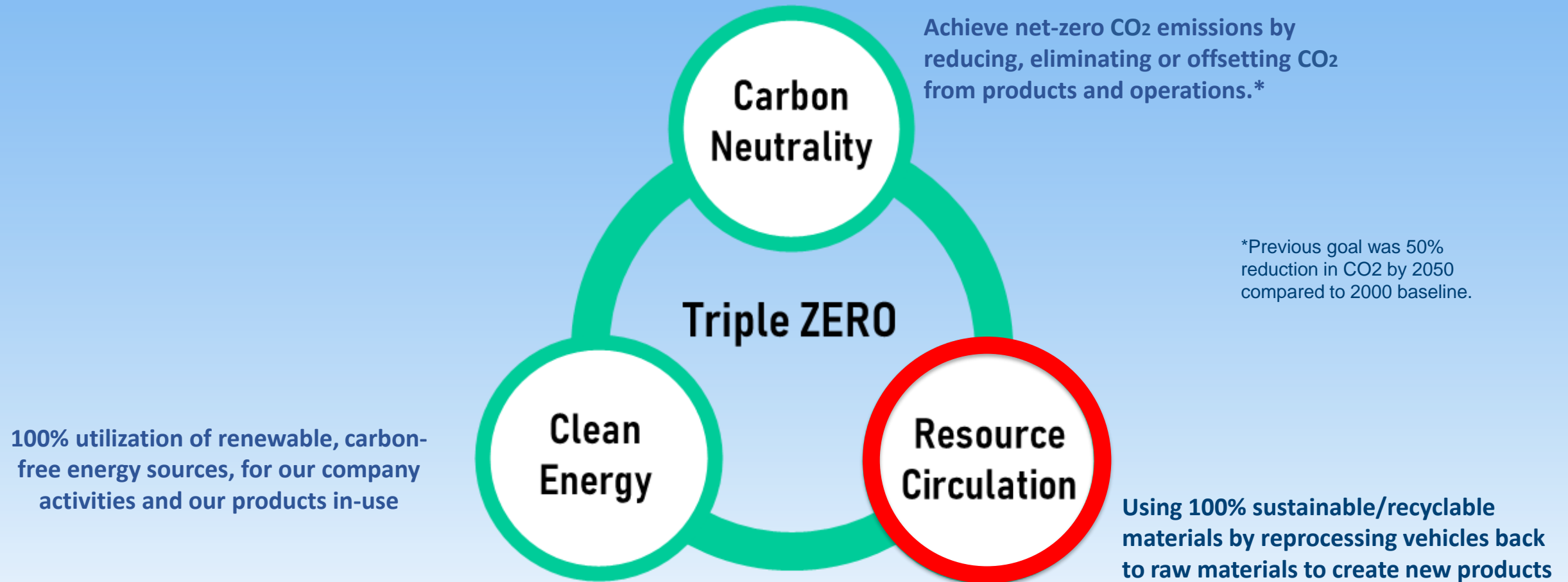
*Source: U.S. EPA Automotive Trends Report

Fleet Average Fuel Economy Top Three – 39 of the last 46 Years

Fleet Average Fuel Economy Top Three – 39 of the last 46 Years



Honda's global **Triple Zero** approach to achieve zero environmental impact by **2050**.



All separate categories and initiatives must be considered as a whole

Pathway to “Triple Zero” -- Resource Circulation








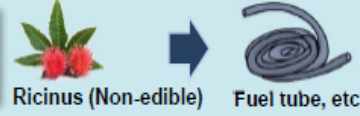
What is sustainable material?

Material with zero resources and waste risks within in the products lifecycle.

$$\text{Sustainable material rate} \% = \frac{\text{Sustainable Material Weight}}{\text{Weight of the product}} \times 100$$

Minimize environment impact, maximize lifetime of components while saving cost.

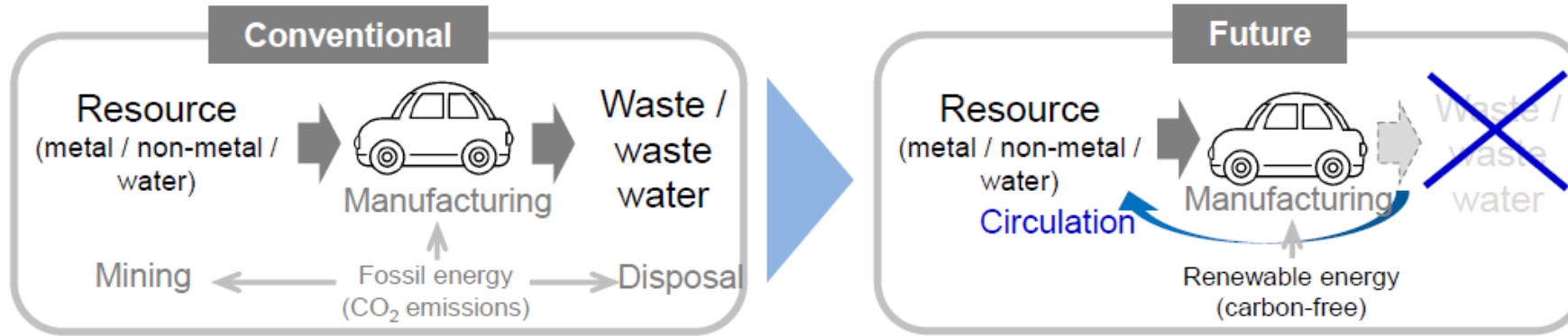
Traditional concept of sustainability: Opportunity to pivot definition

Classification		Examples in Honda	Definitions	
Recycling of exhaustible resources  	Reuse (Parts)		Reuse parts <ul style="list-style-type: none"> Reuse collected parts Use functional recovery parts (rebuilt parts, etc.) 	
	Recycling material (Materials) <div style="border: 1px solid black; padding: 5px; display: inline-block;">Expansion of recycling resources</div>	(Materials distributed in the market)	Battery 	Reuse waste materials distributed in the market <ul style="list-style-type: none"> Materials that can be highly purified when recycled Materials that can tolerate performance degradation due to impurities
			Copper (Harness) 	
			Aluminum (Die casting) 	
	(High grade)	Aluminum (Wheel) 	Reuse sorted/collected materials <ul style="list-style-type: none"> Ensure performance/quality ⇒ Collect from specific parts 	
Material replacement Replace materials from exhaustible resources	Biomass material <div style="border: 1px solid black; padding: 5px; display: inline-block;">Replacement with renewable resources</div>	11 Nylon (Tube) 	Utilize renewable resources such as those derived from plants <ul style="list-style-type: none"> Utilize within the range of renewable speed 	

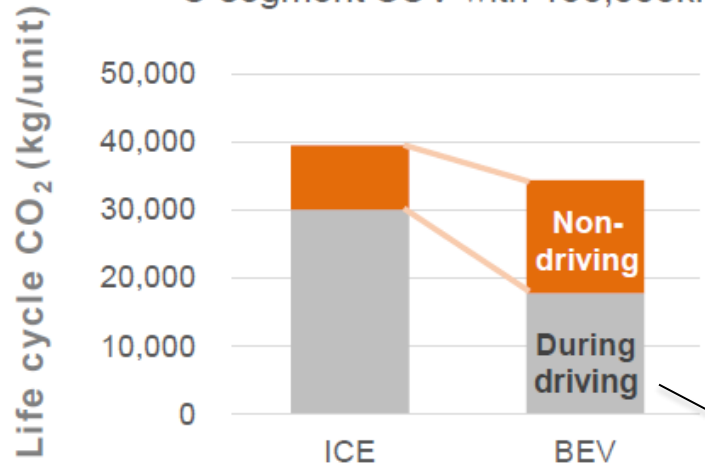
2050 Sustainable material targets can be achieved by reusing parts, recycling waste and utilizing renewable resources starting 2030. Focus has always been on recycled material or sustainable material content, not the device as a whole

Pathway to “Triple Zero” -- Resource Circulation

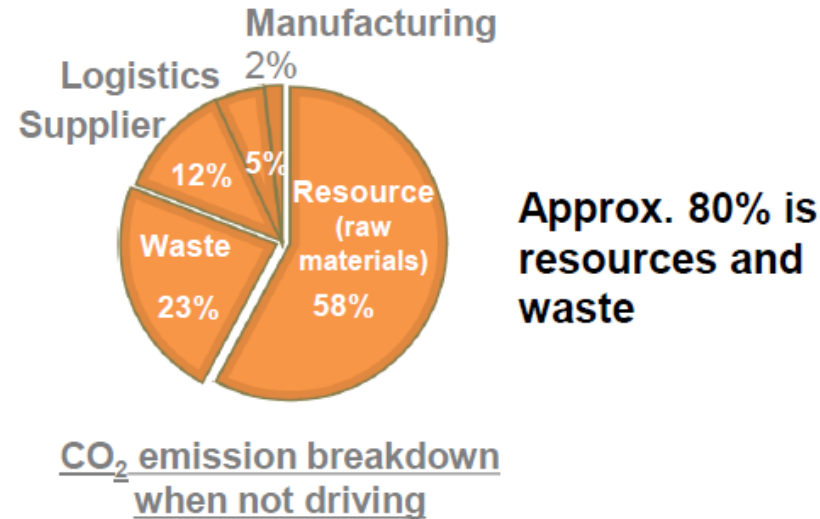
Lower environmental impact means lower CO₂ emissions in the process of resource mining and disposal



C-segment SUV with 150,000km@2030



Dependent on electric generation
Challenge: Energy storage



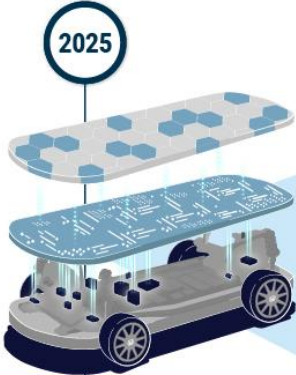
Although AHM focuses on corporate CO₂ and through the end of life, transforming into a circular ecosystem is critical to achieve our total carbon neutrality. Since BEV's have a larger initial footprint compared to ICE, resources are critical for carbon reduction. Battery is the major contributor

Honda Electrification Strategies

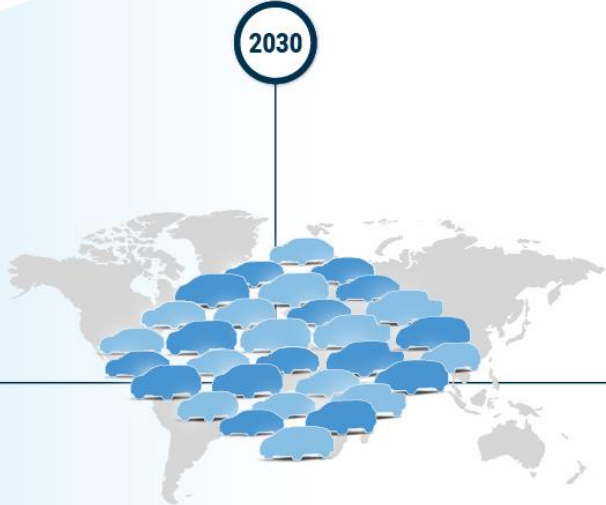
HONDA The Power of Dreams

Our Electrified Future.

Based on our global commitment to carbon neutrality by 2050, Honda will deploy its own innovative technologies and create strategic partnerships to achieve the annual EV sales goal of 2 million units globally by 2030.



Honda e:Architecture EVs
Developed by Honda globally
Production includes Honda plants in North America, starting in Ohio



Total electrified sales in North America reaches 40%

2024



Honda Prologue and Acura ZDX

Co-developed by Honda & GM
Production in North America



Fuel Cell Electric Vehicle

Developed by Honda globally
Global production at the Performance Manufacturing Center

2027



Affordable EVs

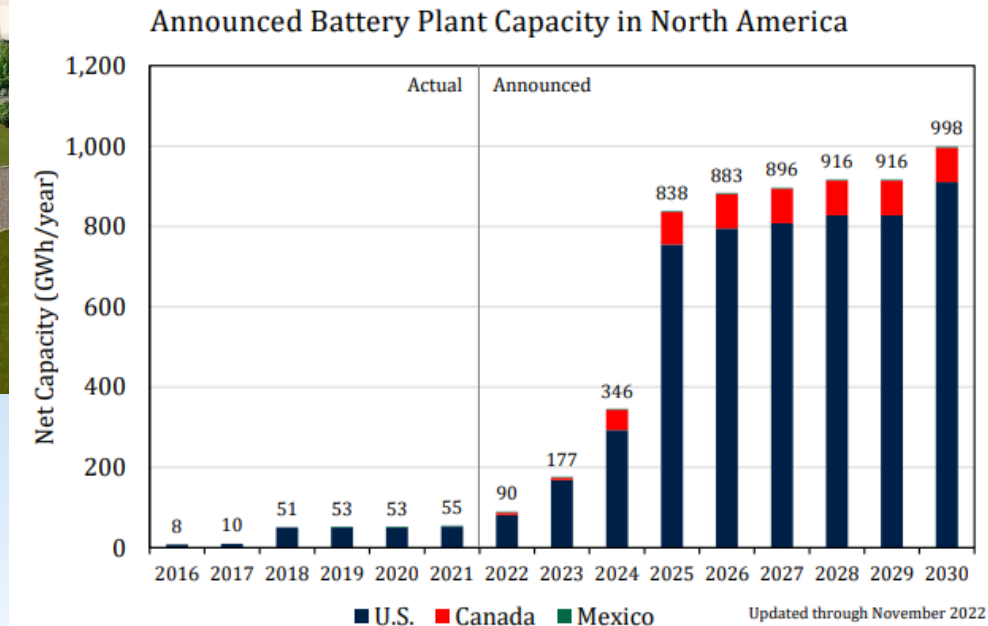
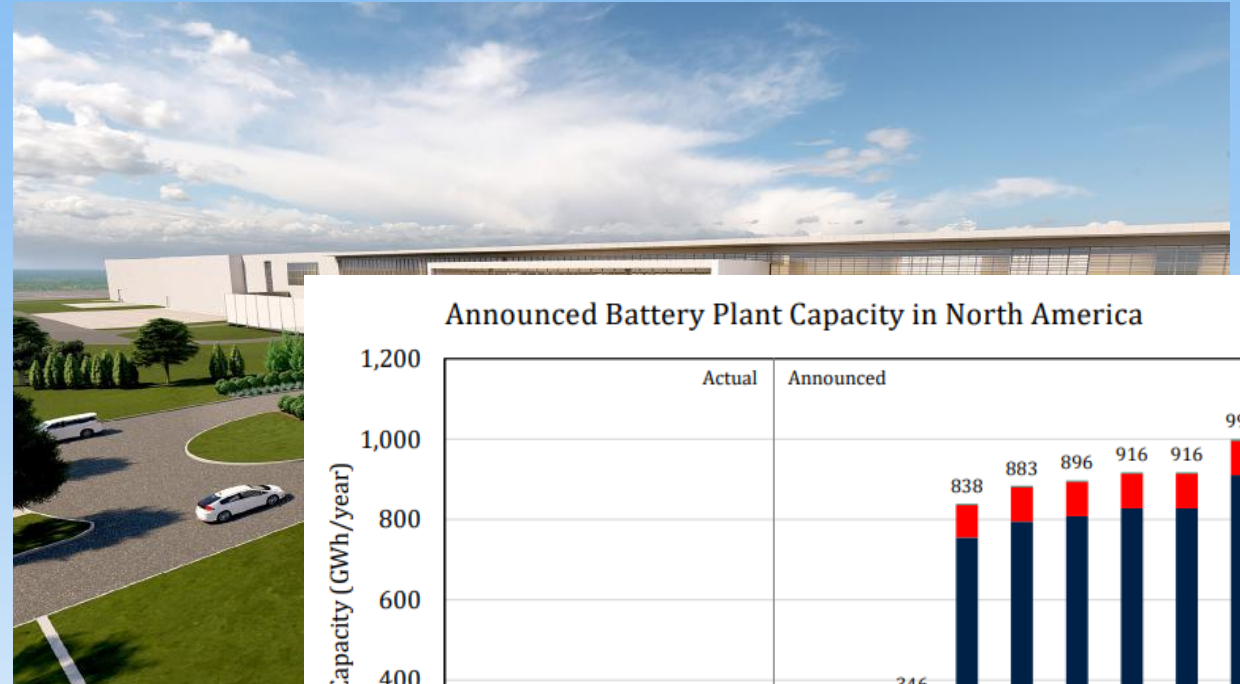
Co-developed by Honda & GM
Production includes Honda plants in North America

Additional updates to this timeline will be made as plans are further developed.

Joint Venture EV Battery Plant

Honda and LG Energy Solution's (LGES) joint venture (JV) battery plant will produce lithium-ion batteries that will exclusively power Honda and Acura EVs built in Honda auto plants.

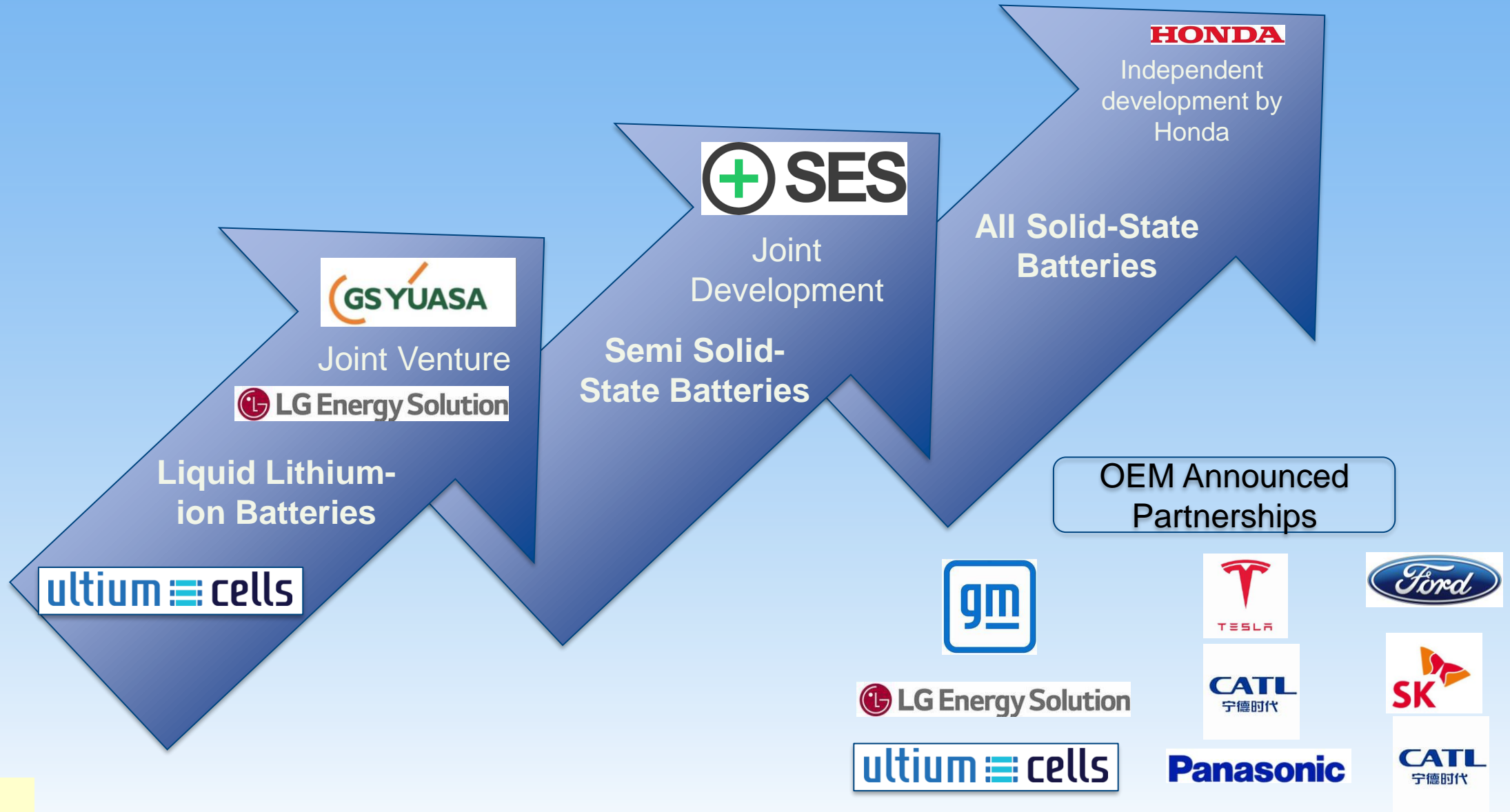
- As part of the new EV Hub, Honda and LGES recently held the official groundbreaking ceremony for the new joint venture EV battery plant to be located in Fayette County, near Jeffersonville, Ohio.
- The two companies have committed to invest \$3.5 billion in the new JV facility. The overall investment of the two companies in the JV facility is projected to reach \$4.4 billion.
- The new facility, which will total over 2 million square feet, is scheduled to be completed by the end of 2024.
- With plans to create 2,200 jobs, the plant aims for approximately 40GWh of annual production capacity for the pouch-type lithium-ion batteries.



Industry Challenge:

800+ GWh of announced US battery production by 2030, all will need battery material resources

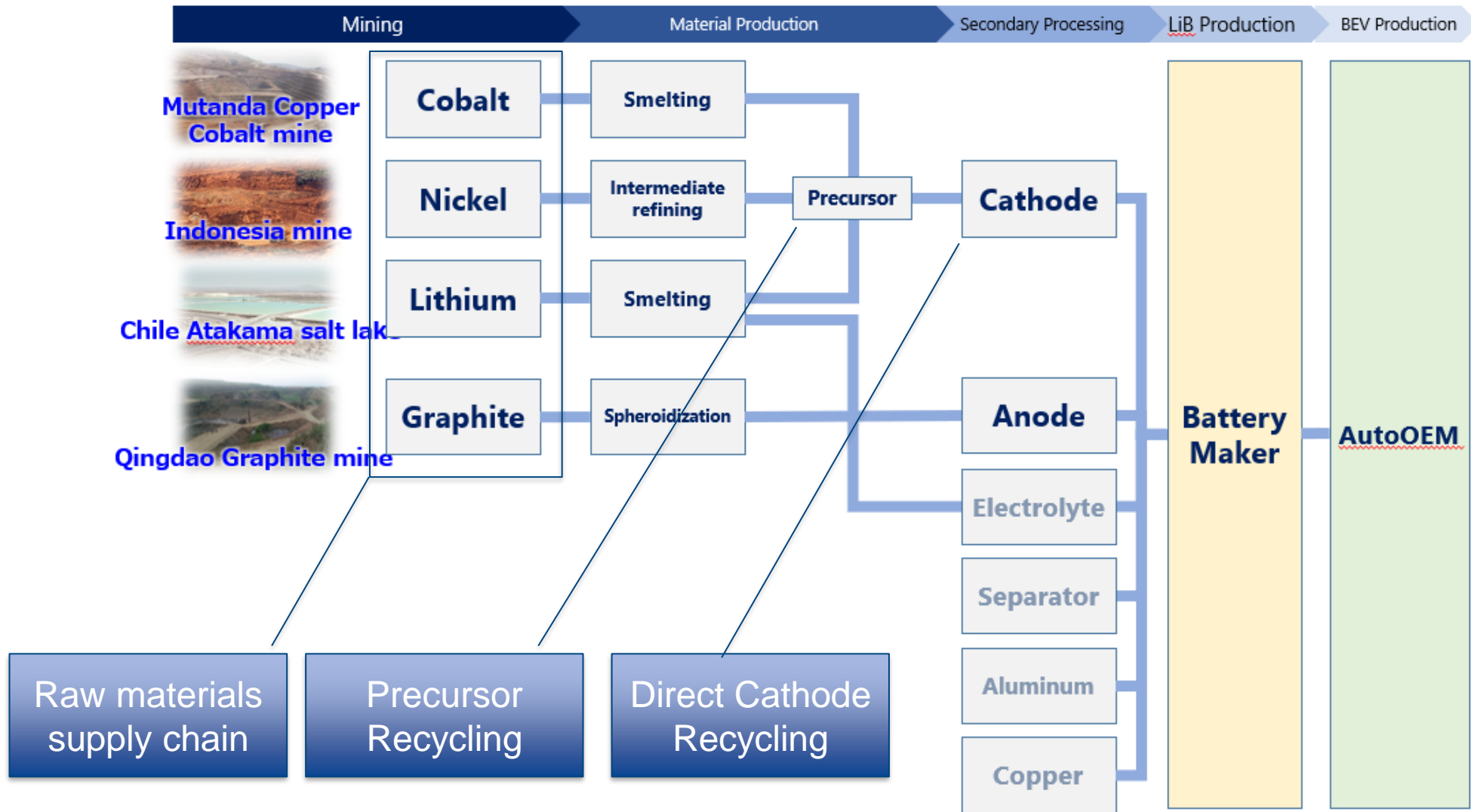
Honda Battery Related Roadmap



Industry Challenge:

Most Auto OEM's will have a diversified battery portfolio, how will this affect circulatory?

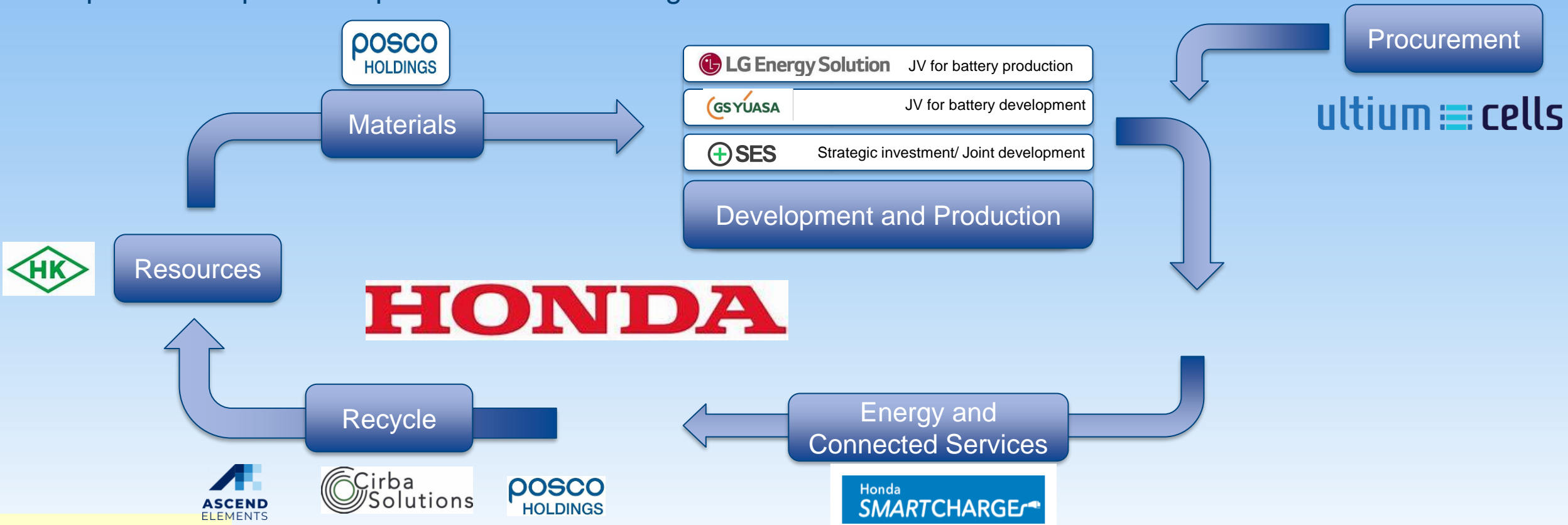
Battery Value Chain Framework



Honda approach to be at the center of the value chain, not simply a buy/sell model

By leveraging a strategic partnership with Hanwa Co., Ltd., Honda will ensure stable procurement in the medium to long term, of essential metals such as nickel, cobalt and lithium.

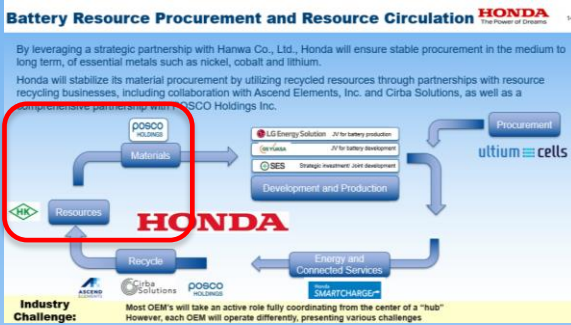
Honda will stabilize its material procurement by utilizing recycled resources through partnerships with resource recycling businesses, including collaboration with Ascend Elements, Inc. and Cirba Solutions, as well as a comprehensive partnership with POSCO Holdings Inc.



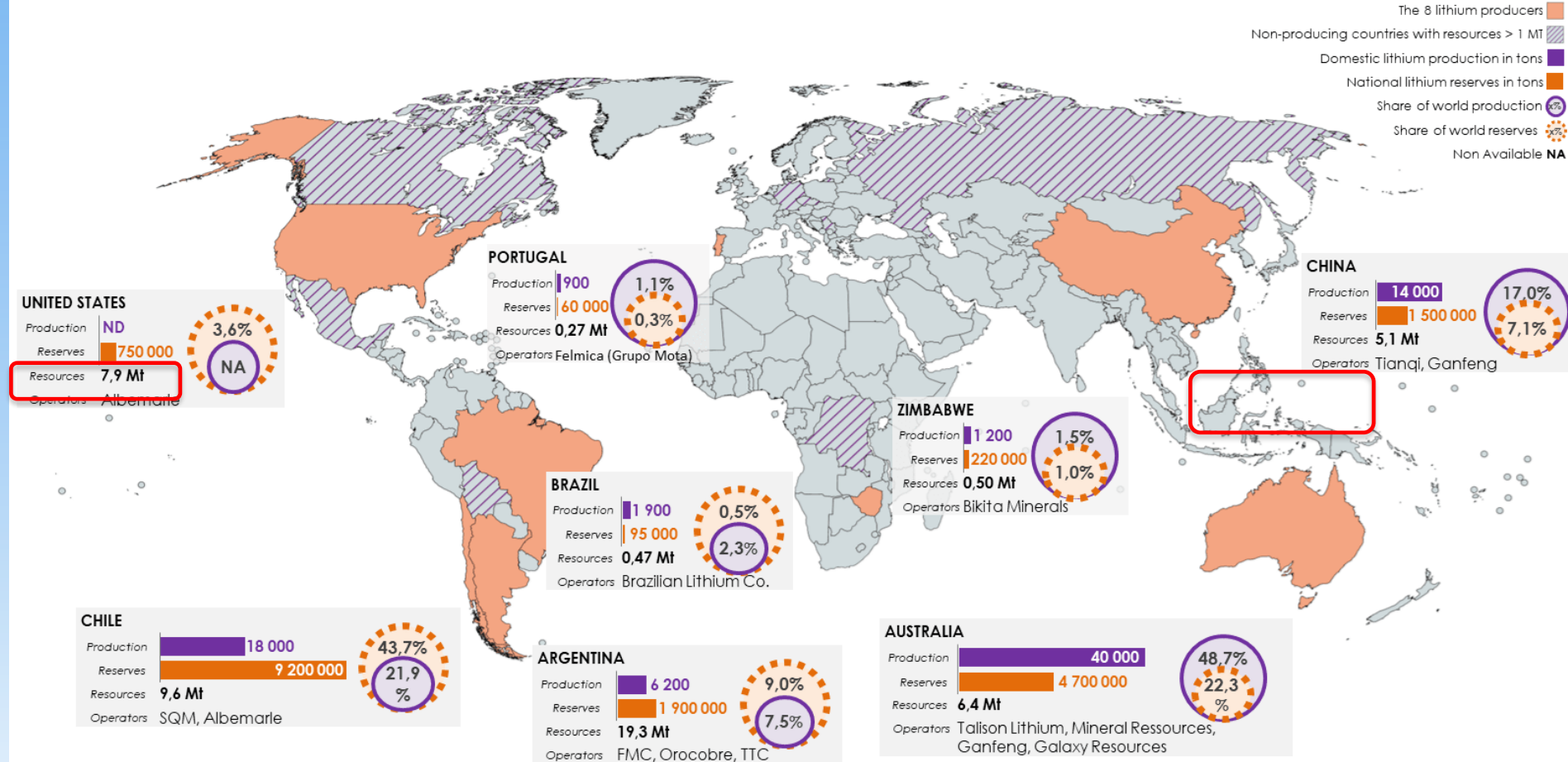
Industry Challenge:

Most OEM's will take an active role fully coordinating from the center of a "hub" However, each OEM will operate differently, presenting various challenges

Battery Resource Procurement: Li as an example



GLOBAL LITHIUM PRODUCTION AND RESERVES IN 2020 (t)



Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2021
Map created by IFP Energies Nouvelles with Mapchart.net

US HAS SIGNIFICANT LITHIUM RESOURCES Estimated at 7.9Mt

US Opportunity:

Coupled with government incentives, there is an opportunity to increase N.A. Lithium production from proven reserves

Battery Resource Procurement: Li as an example

Hard Rock Mining and Evaporation Ponds have environmental implications



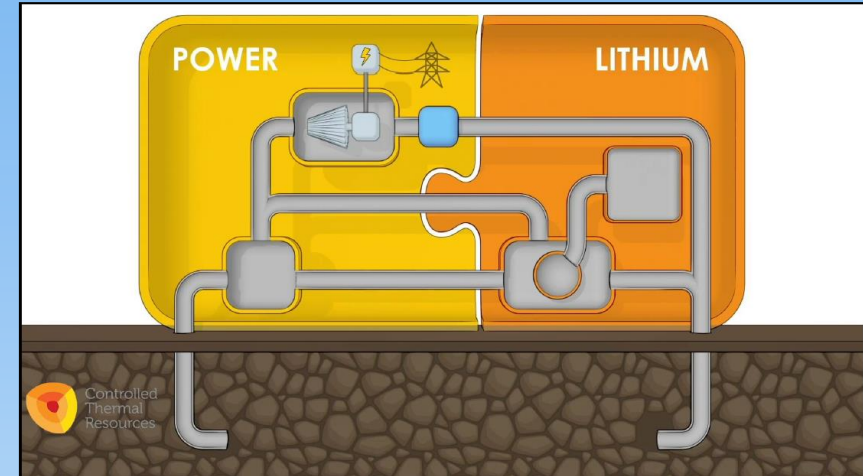
Australia



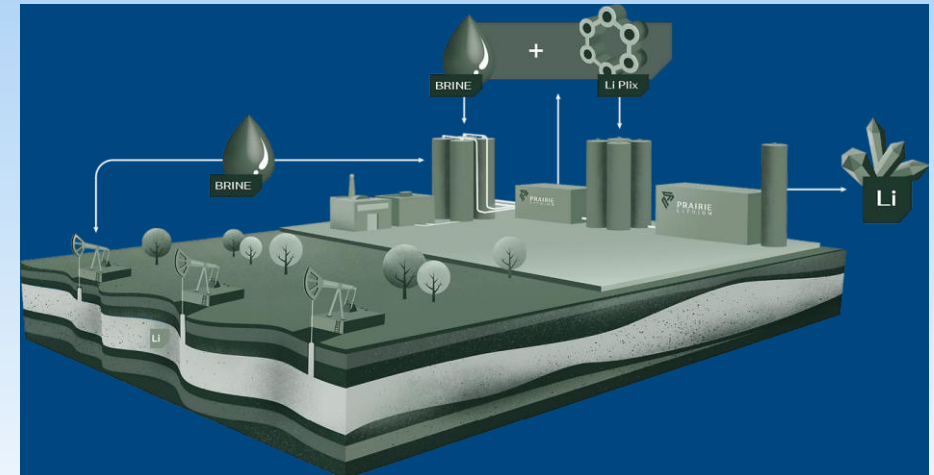
Chile

**Geothermal
Brine Streams**

Possible alternative lithium recovery methods with less environmental impact to mining and evaporation ponds



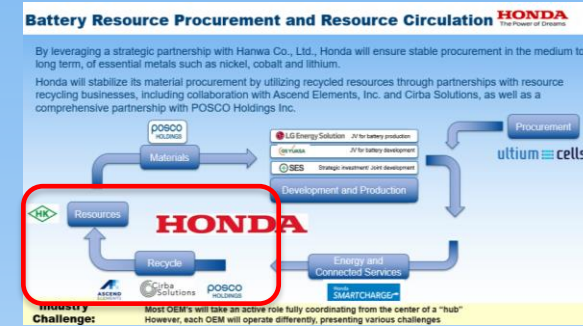
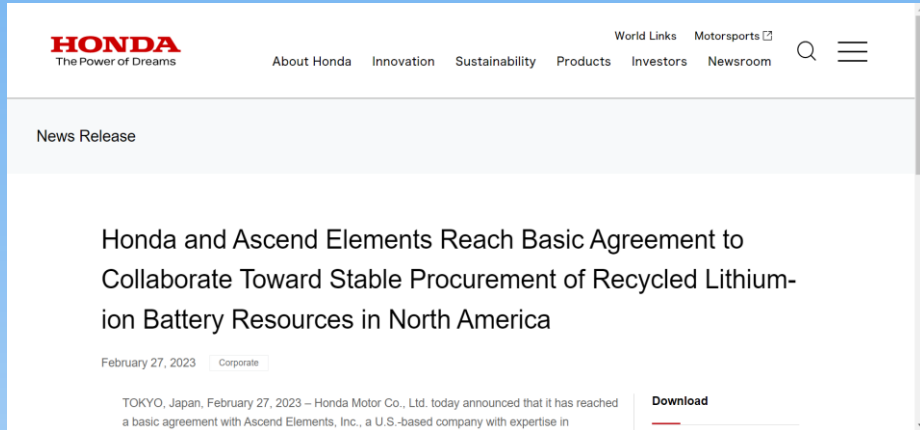
**Oil/Gas
Brine Streams**



Industry Challenge:

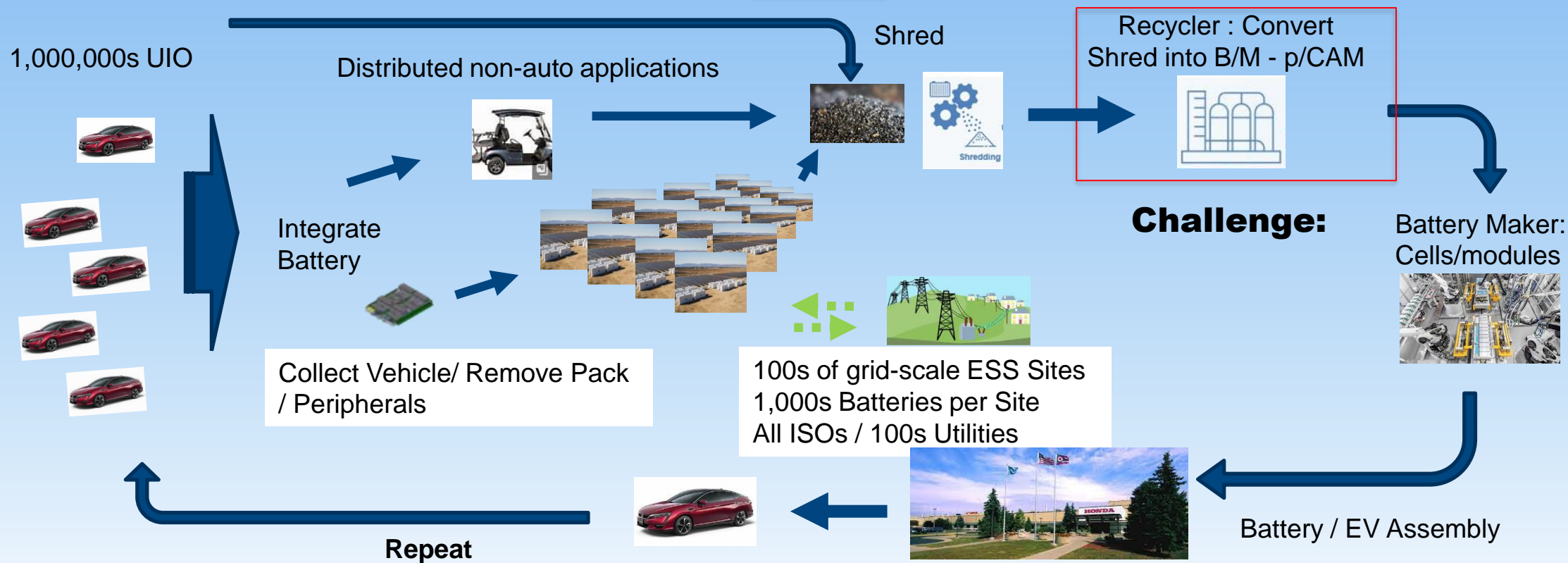
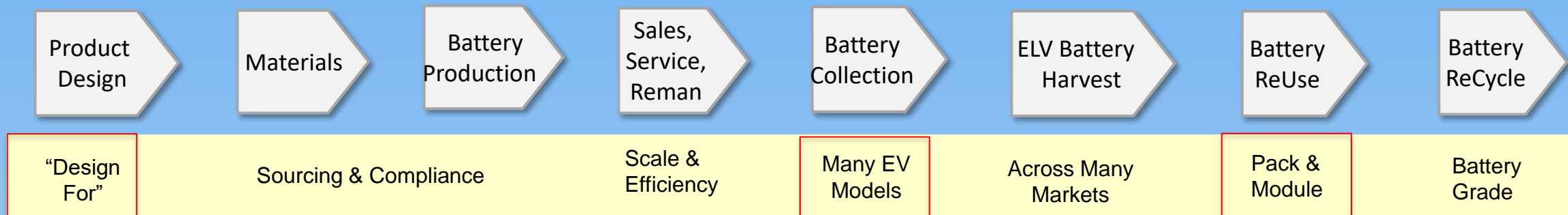
We must develop domestic sources for the critical raw materials with minimal impact to the environment

Battery Resource Circulation: Recycling



Two different approaches to returning critical resources such as Nickel, Cobalt and Lithium to the battery supply chain

Ideal EV Battery Value Chain Overview



EV Battery value chain upstream of EV Sales has developed with volume to soon enable development of downstream execution of a closed 'energy loop'

Holistic Approach to Energy and Mobility

Strategy – Pathway to “Triple Zero”



Electrification of automobiles and motorcycles



Mobile Power Pack

Expand electrified products with swappable batteries



Expanding the use of hydrogen fuel cell stacks

Expand use of renewable energy through infrastructure-linked smart power when charging products

Electricity

Hydrogen

Carbon-neutral fuels
Hydrogen & carbon-neutral fuels



Multi-pathway of energy

Create products from 100% sustainable materials

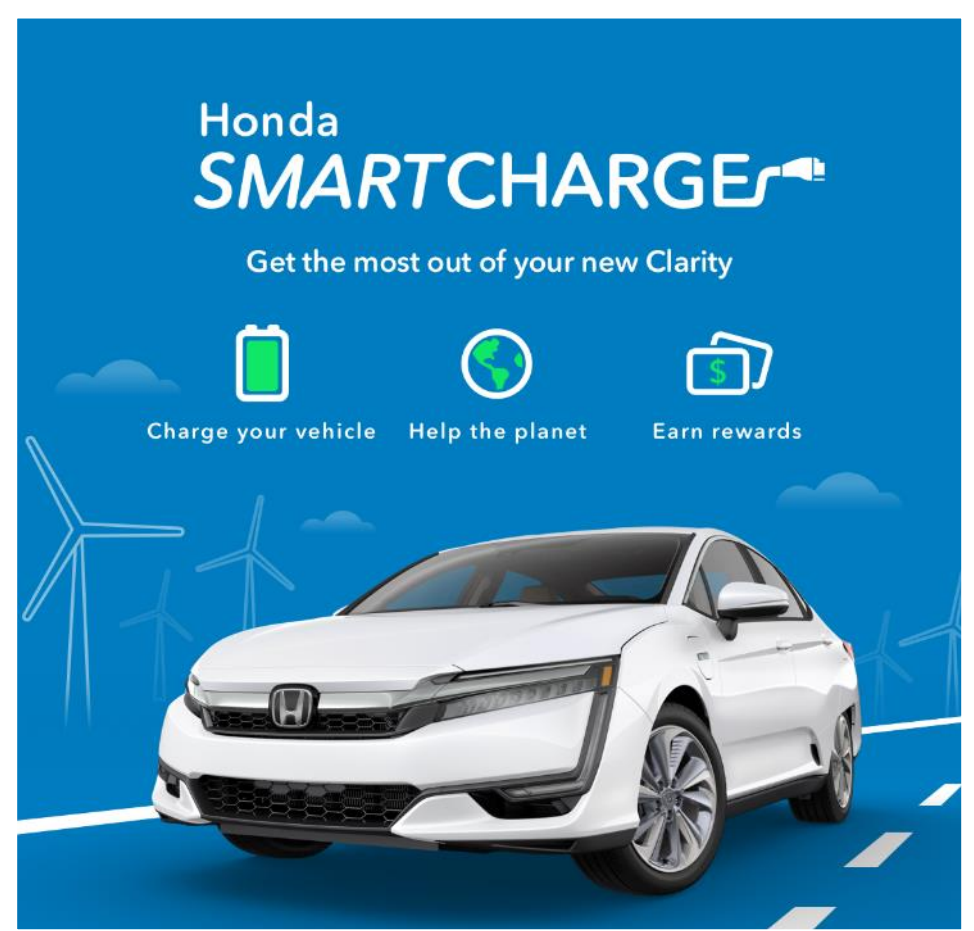


Resource circulation

Research on more effective ways to reuse and recycle batteries

Carbon reduction and electrification go hand in hand. Stored energy has to balance with mobility for battery raw materials

Honda SmartCharge allows Clarity BEV and PHEV customers to charge their electric vehicles in a way that seeks to maximize their use of renewable energy and minimize their contribution to peak energy demands, all while earning rewards.



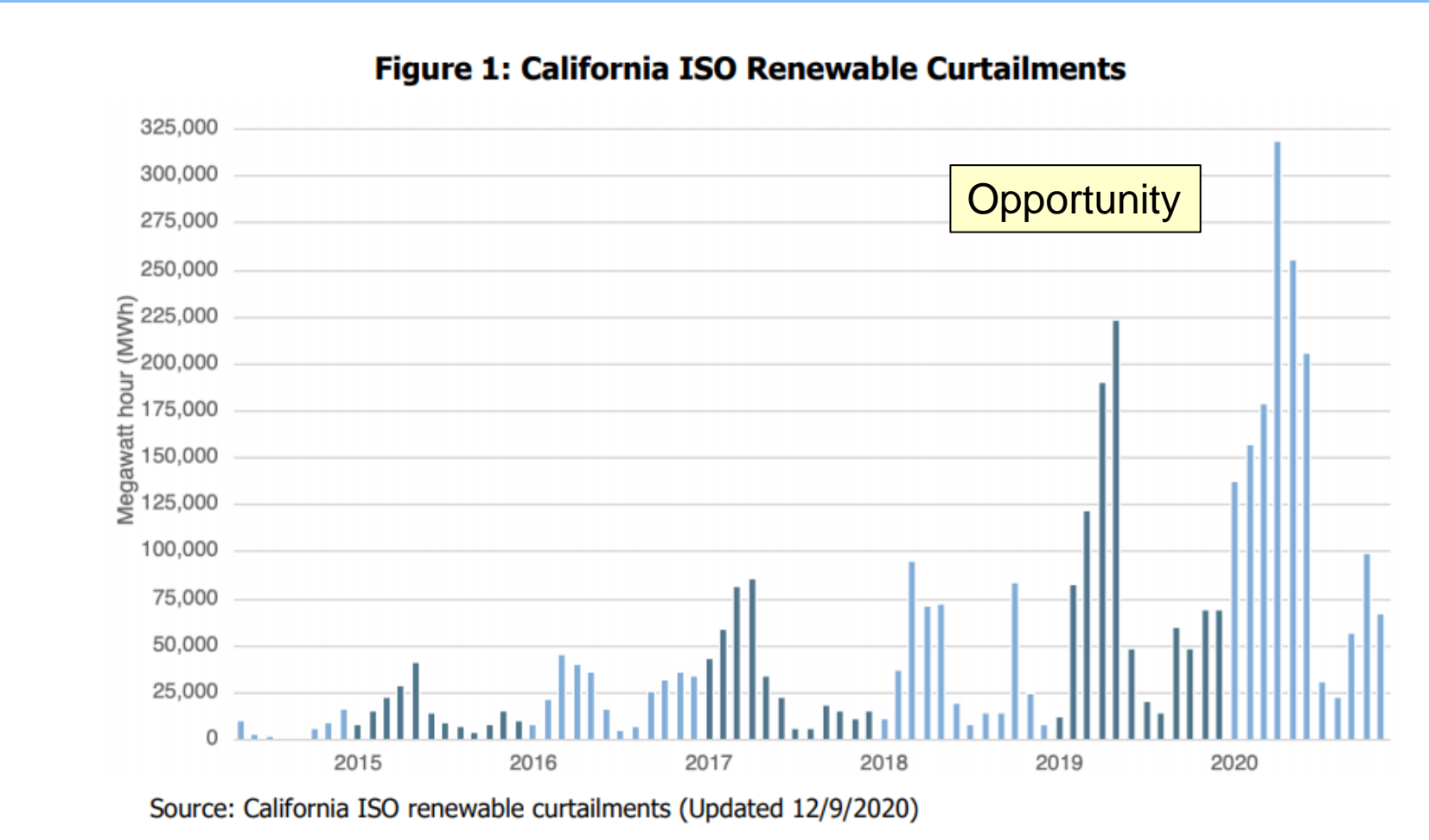
Opens up V2G and V2X opportunities

Industry Challenge:

How are smart opportunities integrated into different OEM/EVSE/Building and Grid Systems

Renewable Energy Generation → Storage / V2X Opportunity

Renewable energy generation capacity needs to be ~3x to 5x of average demand. But curtailment harms the business model! **Need massive energy storage** → Hydrogen, V2X, Generation Responsive Demand



Challenge: Where are the battery materials most valuable in the future (in vehicle...second application...supply chain)

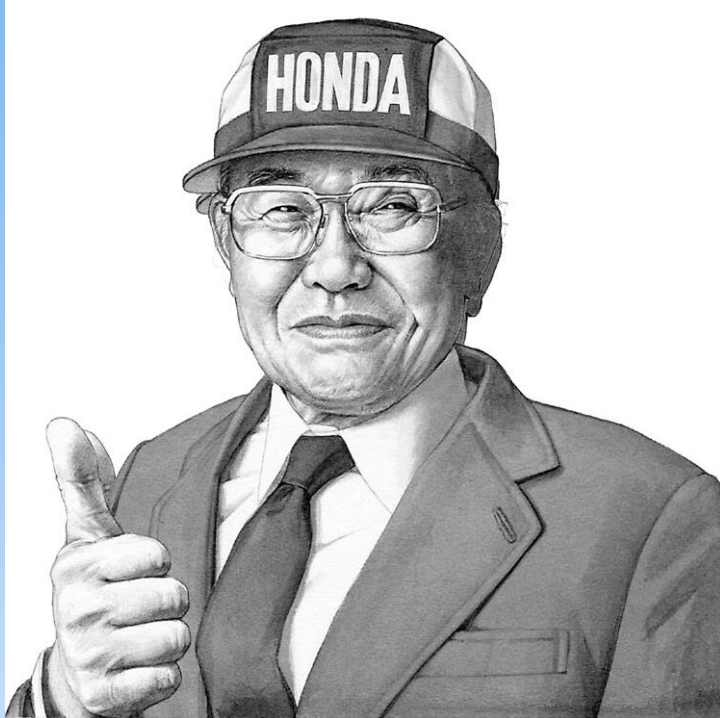
Stationary Fuel Cell Power Station

In 2023, Honda began demonstration operation of a stationary fuel cell (FC) power station that supplies clean and quiet emergency backup power to the data center on the company's campus in Torrance, Calif.

- The FC unit has a capacity of approximately 500 kW and reuses the fuel cell systems of previously leased Honda Clarity Fuel Cell vehicles.
- Future stationary FC units intended for commercialization will utilize Honda's next-generation fuel cell system jointly developed with General Motors.
- In the coming years, Honda will begin applying a next-generation stationary fuel cell system to Honda manufacturing facilities and data centers globally.



Challenge: Where are the battery materials most valuable (in vehicle...second application...supply chain) in the future



“Instead of being afraid of the challenge and failure, be afraid of avoiding the challenge and doing nothing.”

- Soichiro Honda

Questions?