NEW MIRAI:
POWERING UP PRODUCTION

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Hydrogen & Fuel Cells The Time is Now 16/11/21


BEYOND ZERO

TOYOTA ENVIRONMENTAL CHALLENGE 2050

6th Environmental Plan 2015 reducing

- Resources
- Emissions
- Energy
- Impact

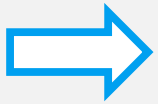
ONE SIZE DOESN'T FIT ALL

DIFFERENT NEEDS

AT DIFFERENT TIMES

IN DIFFERENT PLACES

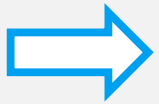
CUSTOMER & ENVIRONMENTAL REQUIREMENTS

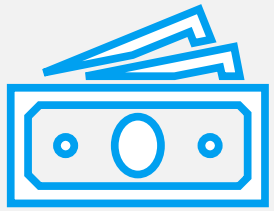


Global Applications = mass production & adoption

Circular Economy Sustainable raw materials, rebuild, reuse, recycle

Renewable power to charge on demand or stored



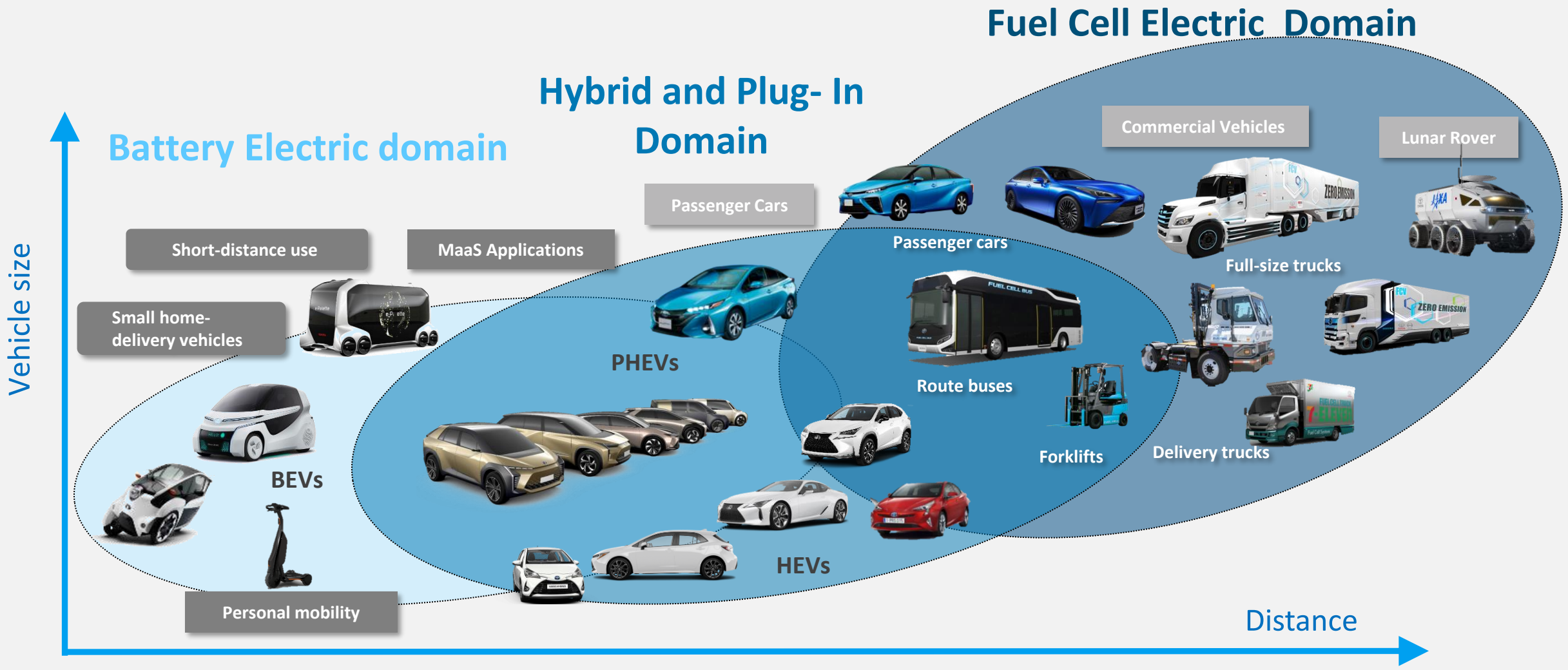


Good Total Cost of Ownership

Non disruptive, convenient

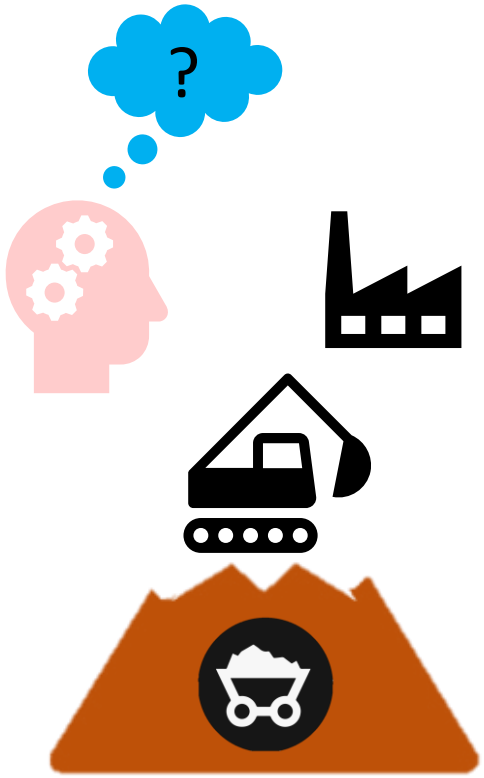
Utility: range and load capacity

TOYOTA'S ROADMAP TO SUSTAINABLE MOBILITY



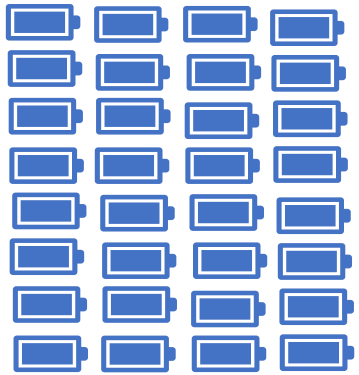
THE RESOURCE, BATTERY & ENERGY DILEMMA

What should we do?

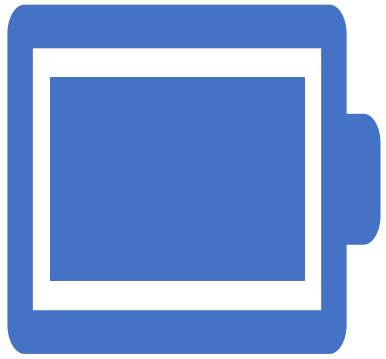


How do we reduce environmental damage from exploitation, & use of finite raw materials & production resources sustainably

30 + HEV FCEV batteries



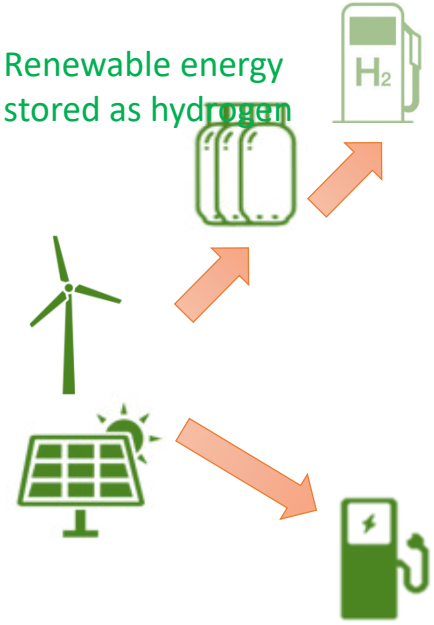
Or



1 large BEV battery

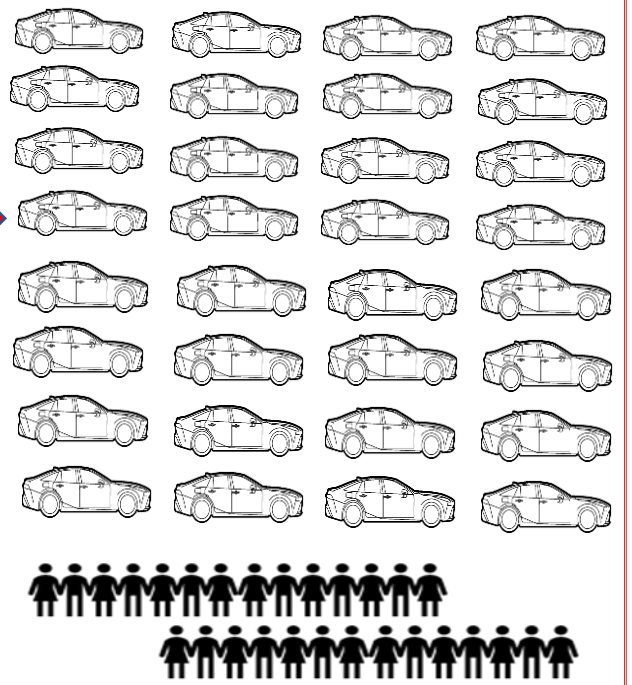
All need on demand refuel

Renewable energy stored as hydrogen



Renewable energy cannot always be available on demand for BEV charging

30 + Fuel Cell
Zero tailpipe emission cars



1 BEV
Zero tailpipe emission car

Fuel Cell can reuse or ~100% recoverable & recyclable

Li difficult & costly to reuse or recycle safely

THE ALL-NEW HYDROGEN FUEL CELL

MIRAI

WITH 29 YEARS
OF FCEV DEVELOPMENT

1996

FCEV FUEL
H_2 Stored in adsorbing alloy

2001

FCHV-4 FUEL
Hydrogen stored in high-pressure tanks

2002

FCHV
Toyota-made tanks, 1st FCV homologated

2011

FCV-R FUEL
Mirai precursor

2020

NG MIRAI
5.4 kW/L world record

1992

START
Fuel Cell Division created

1996

FCHV-3 FUEL
Hydrogen (adsorbing alloy)

2002

FCHV-5 FUEL
Hydrogen generated on-board by reforming on gasoline

2009

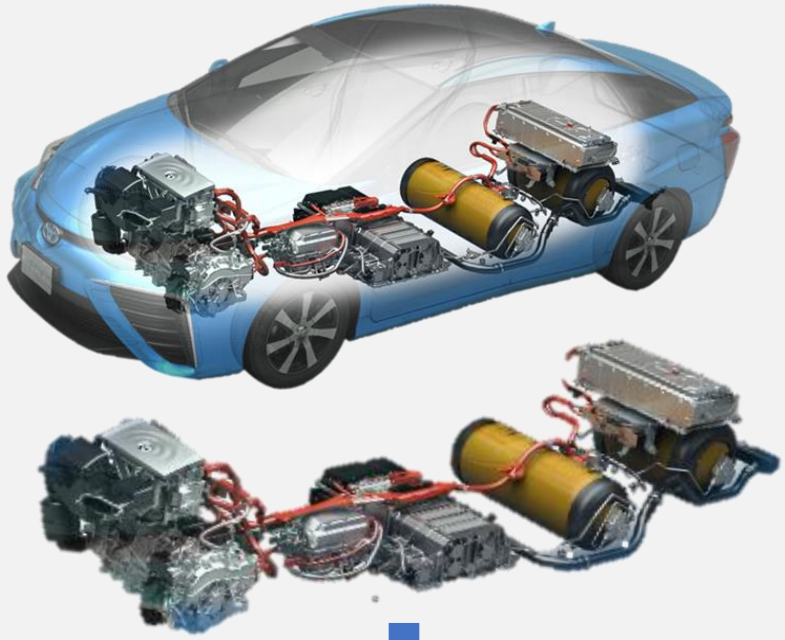
FCHV-adv FUEL
New stack, stainless steel cells

2015

MIRAI
Revolutionary Titanium stack, 3.5 kW/L world record

NEW GENERATION MIRAI

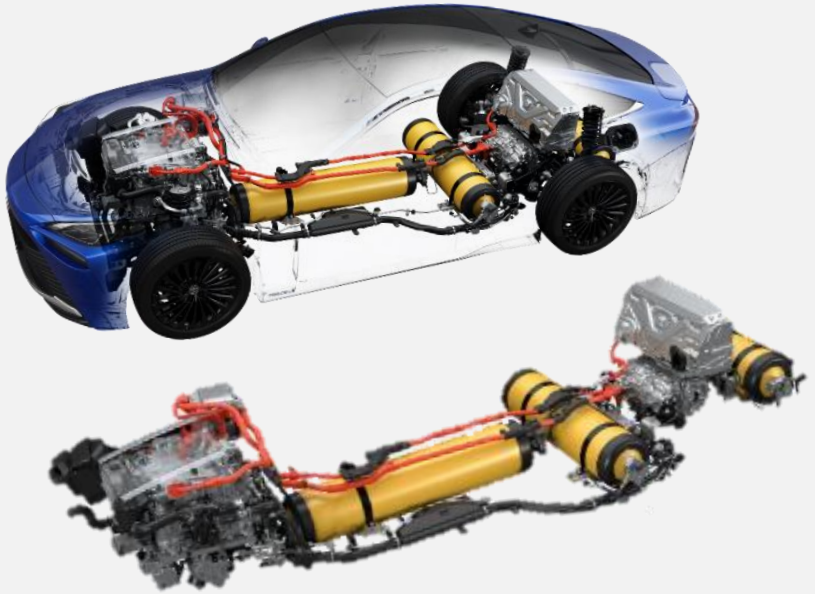
1st Generation



£66,000
Front wheel drive
113kW system output
2 tanks 300 miles

5 years

2nd Generation



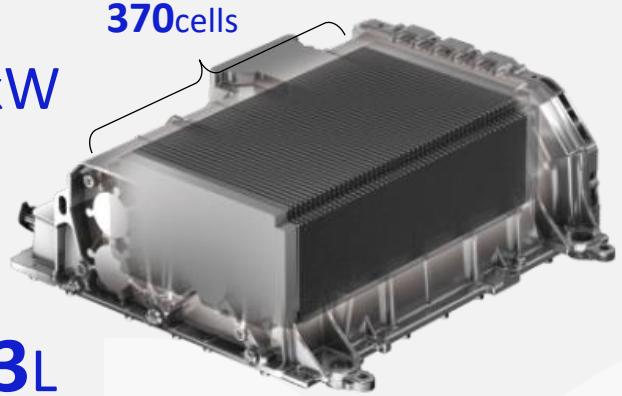
£50,000
-25% price
Rear wheel drive
134kW system output
3 tanks 400 miles

EVOLUTION OF FC STACK

【1st gen. FC stack】

370cells

114kW

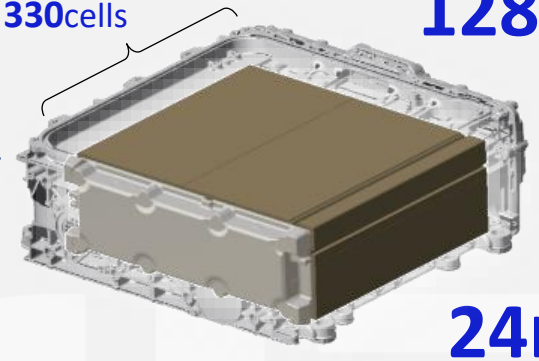


33L

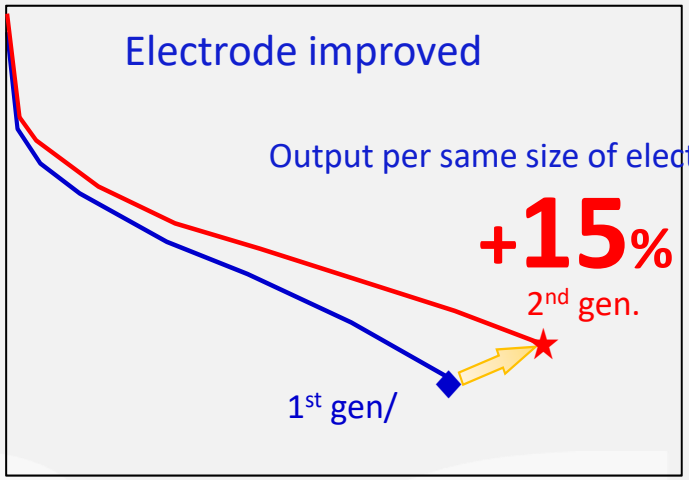
【2nd gen. FC stack】

330cells

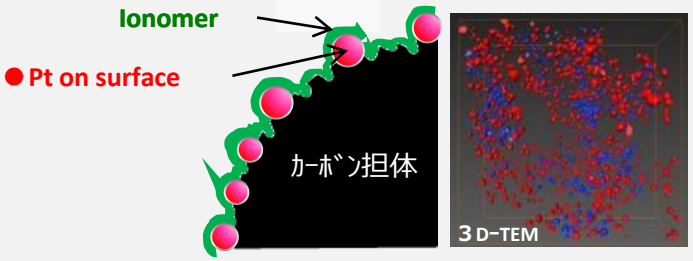
128kW



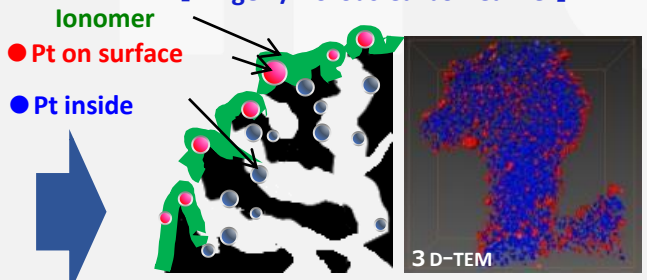
24L



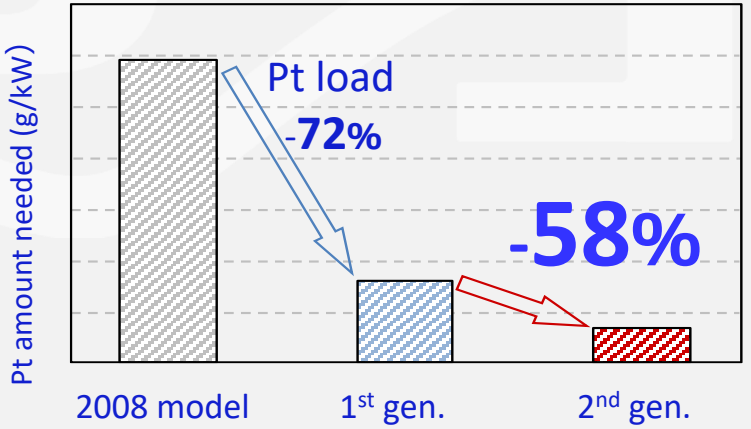
【1st gen. / Solid Carbon Carrier】



【2nd gen / Porous Carbon Carrier】



Adopted Porous Carbon carrier. Reduced needed Pt

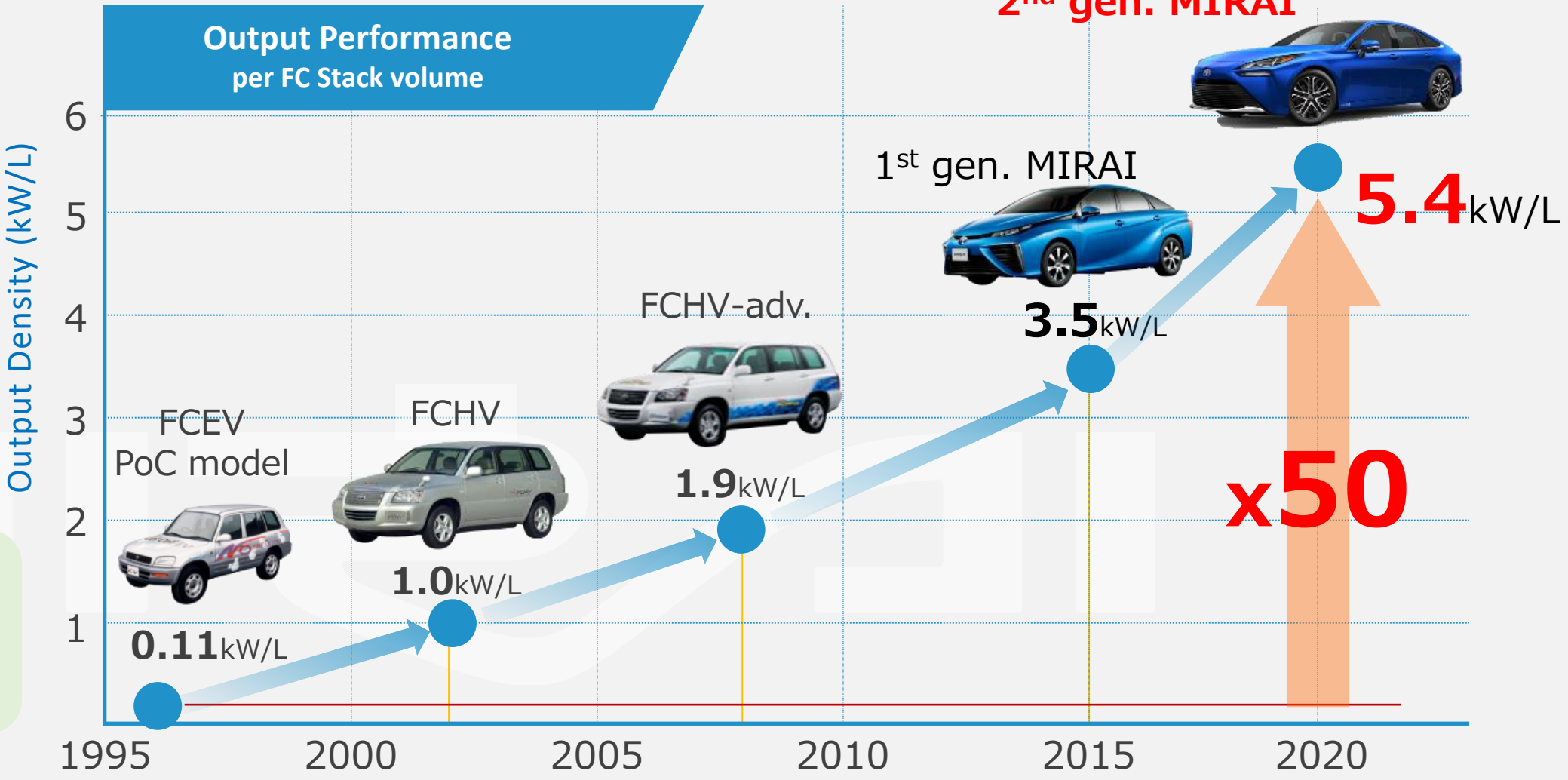


Better performance with less catalyst

PERFORMANCE IMPROVEMENT

Output Density

$$= \frac{\text{Max power(kW)}}{\text{Stack volume(L)}}$$



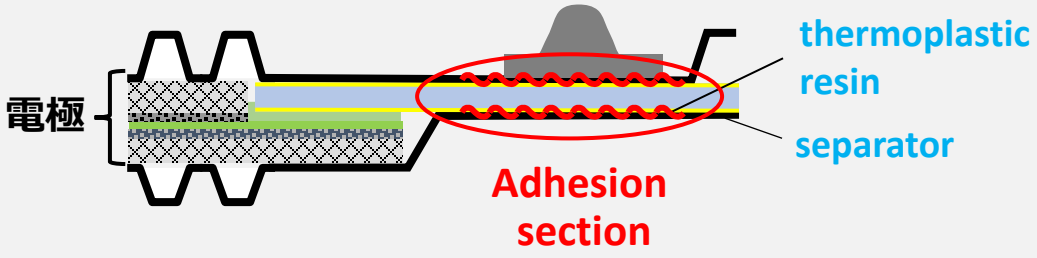
Output Density : x 50 higher in 24 years

PRODUCTION OF 2ND GEN. STACK

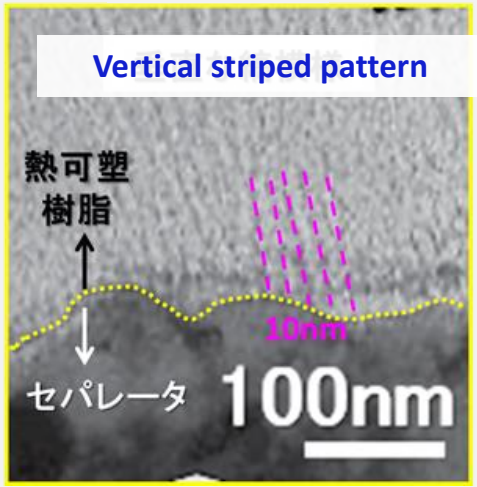
CELL ASSEMBLY PROCESS

Originally developed thermoplastic resin adopted as sealing material

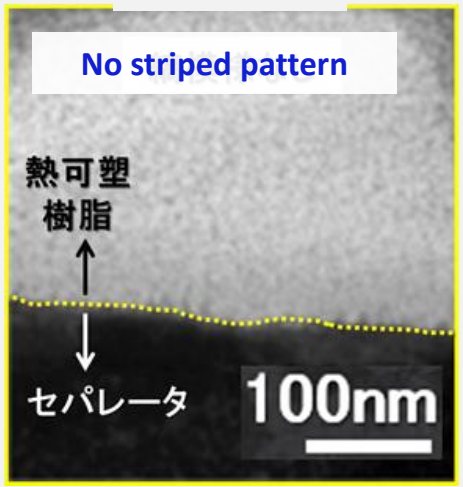
Cycle time: 15 min. ⇒ few sec.

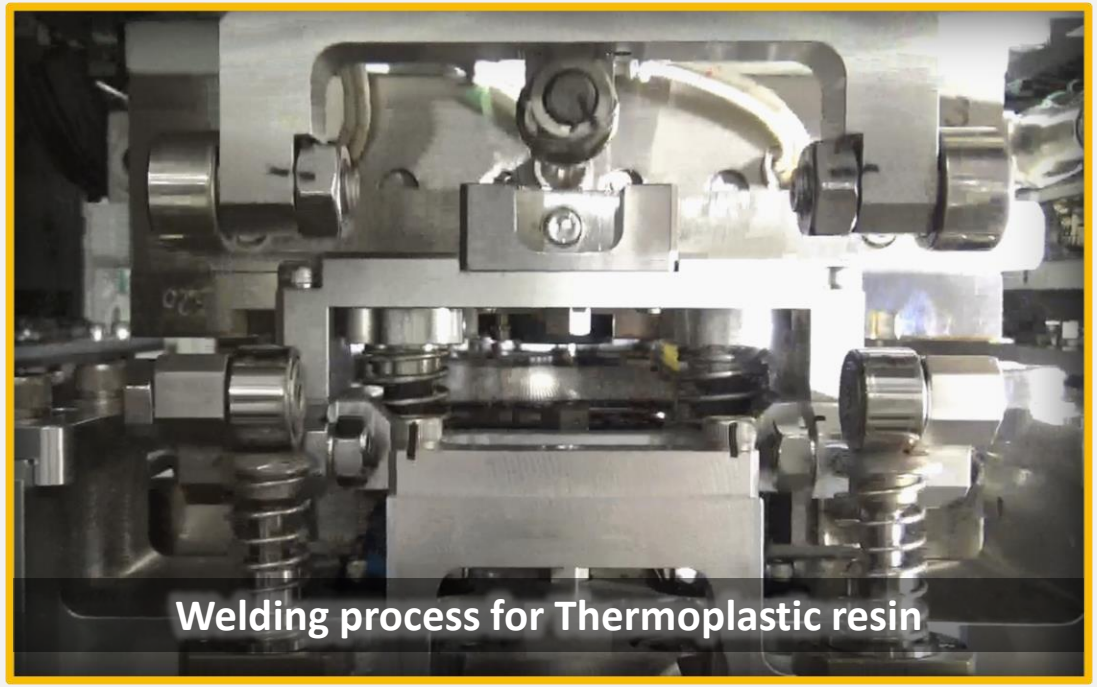


Good

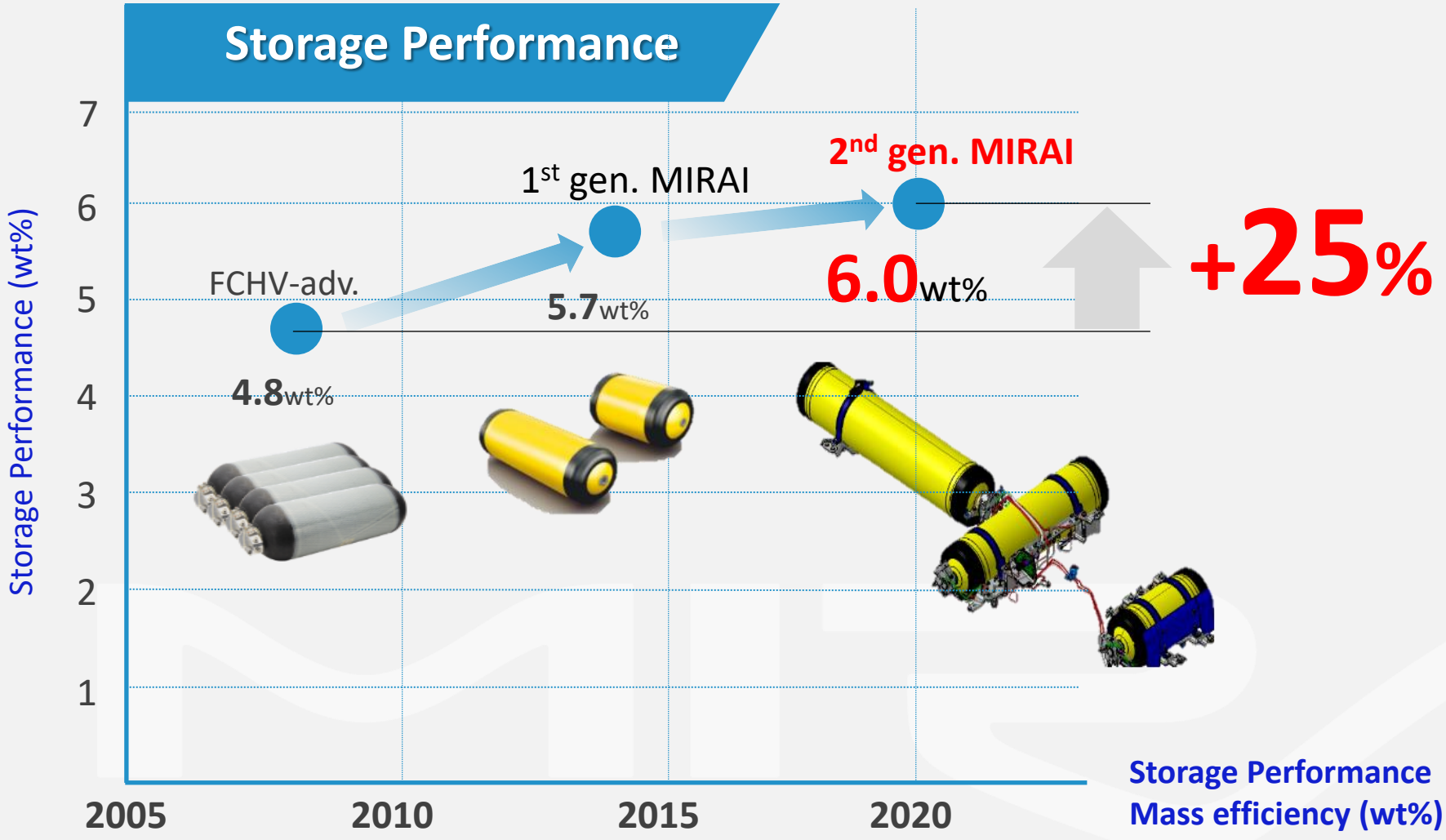


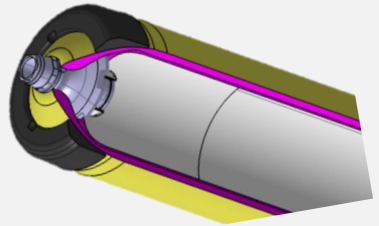
Bad



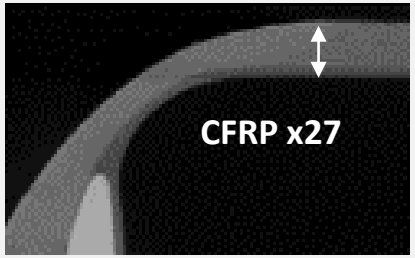

Welding process for Thermoplastic resin

TANK STORAGE PERFORMANCE

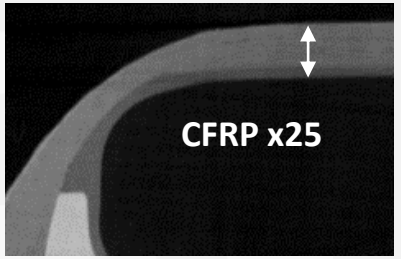




GEN 1



GEN2



Storage Performance
Mass efficiency (wt%) =
Hydrogen mass / Tanks mass

Storage performance: +25% in 12 years

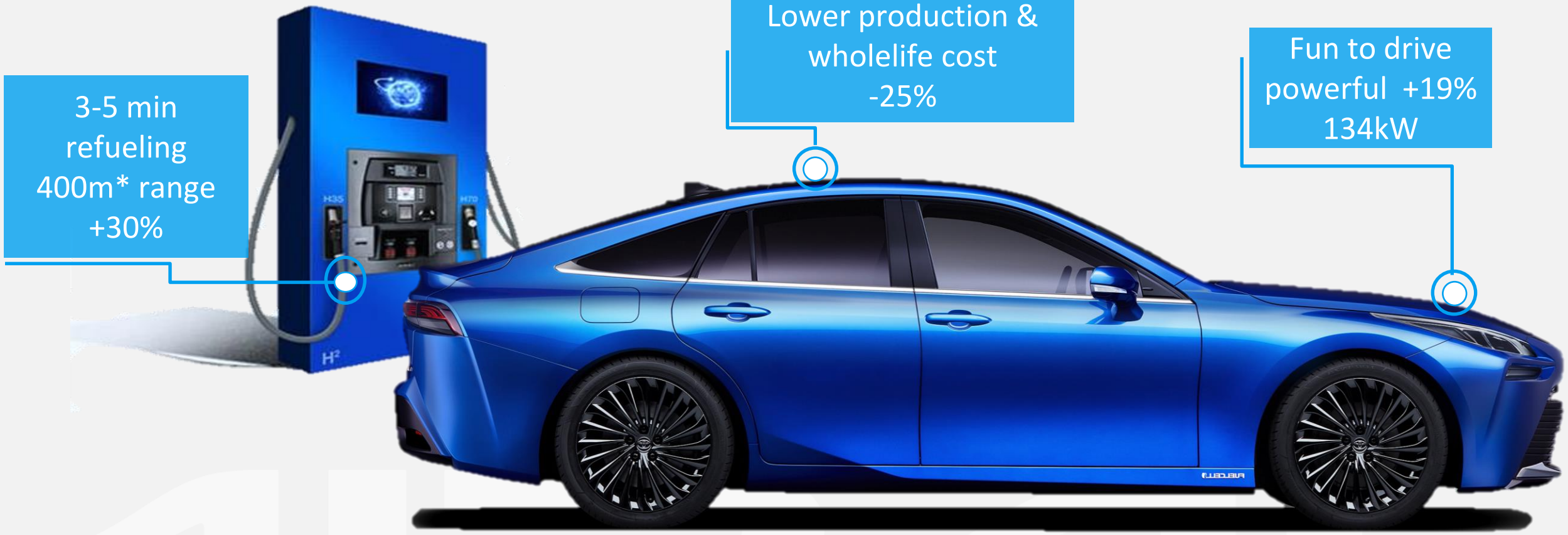
MASS PRODUCTION

FCEV THE ULTIMATE ZERO EMISSION SOLUTION

3-5 min refueling
400m* range
+30%

Lower production & wholelife cost
-25%

Fun to drive powerful +19%
134kW



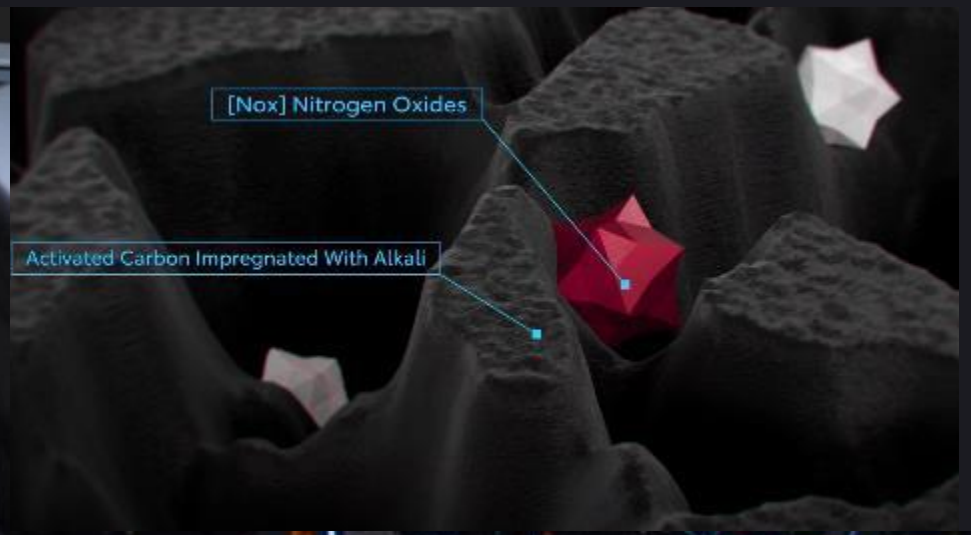
*Depending on driving style

*"The **tranquillity** is remarkable"*

car

WORLD RECORD
845 MILES ON 1 TANK

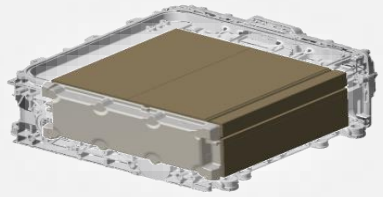
AIR CLEANER : REMOVES PM2.5,NOX SOX



VEHICLE EFFICIENCY IS NOT THE SAME AS POWERTRAIN EFFICIENCY : **WEIGHT IS KEY**

Mirai 128Kw >400 mile range (real world)
FCV specific component weight = **~190 kg**

Battery 45kg



Fuel Cell module 52kg

Tanks 87kg
Hydrogen 5.6 kg

Tesla 85 kWh 260 mile range battery pack weight = **~ 540 kg**

Double the range > 800 miles = x2 tanks + x2 hydrogen = **~285 kg**

Double the range ~ 520 miles = x2 battery **= ~1080 kg**

Fill in minutes vs Charge in hours

TOYOTA CAETANO FUEL CELL BUS

TOYOTA CURRENT H_2 FUEL CELL POWERED APPLICATIONS

Class 8 Heavy trucks Kenworth 44T

Hino 33T

25T HGV

Fuel Cell Bus

LCV

Tractor unit

Forklift

Maritime

Fuel Cell powered charging station

Mobile Energy Truck

Rail


TOYOTA
woven city
A FULLY CONNECTED ECOSYSTEM POWERED BY HYDROGEN & FUEL CELLS

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