“Series EV-E301” Rolling Stock

Catenary and Battery-Powered Hybrid Railcar

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Rolling Stock Technology Center, Transport and Rolling Stock DEPT,

East Japan Railway Company

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JR-EAST EAST JAPAN RAILWAY COMPANY ACCUM ENERGY ACCUMULATING VEHICLE

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ACCUM
ENERGY ACCUMULATING VEHICLE

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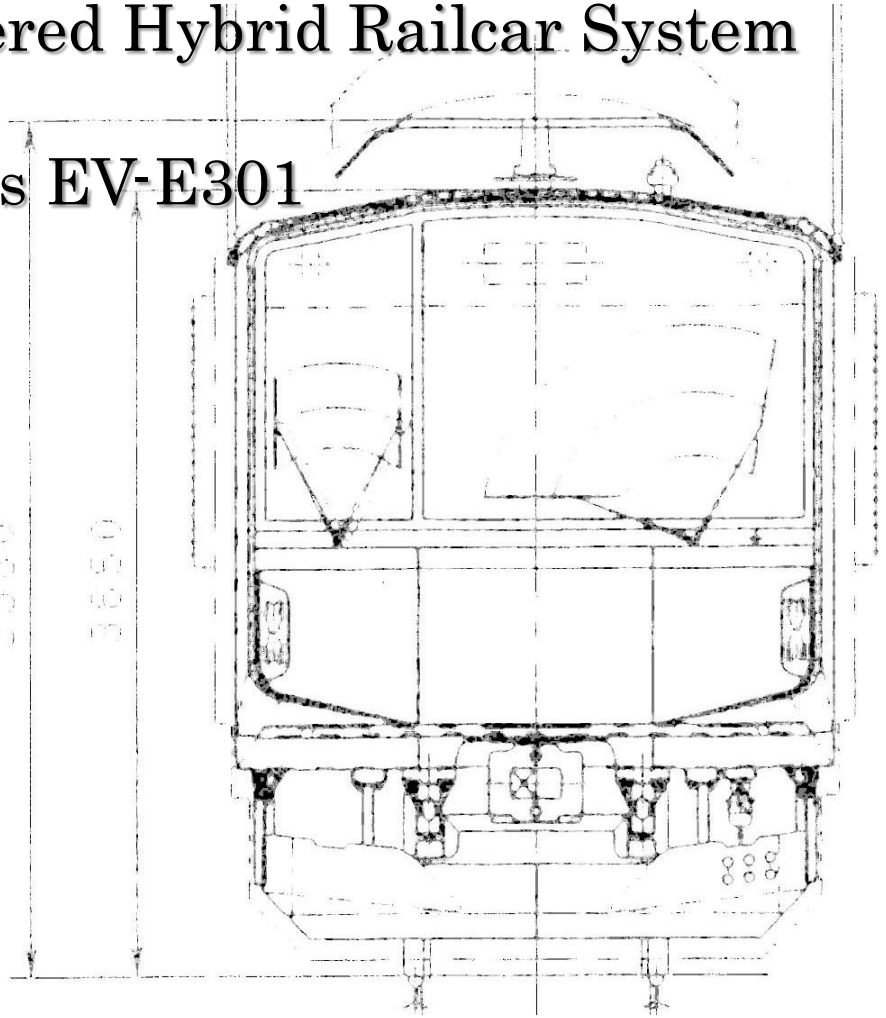
7 Future Effort



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Background

1-1 Purpose of Development

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■ In non-electrified section,

- The improvement of energy efficiency
  —Effective use of regenerative power
- Reducing the environmental impact
  —Reducing CO_2 emissions
  —Eliminating exhaust gases and noise from diesel engine
- Reduction in maintenance of the cars by reducing laborious mechanical parts (such as engines and transmissions)
- The improvement of rolling stock operation efficiency
  —The cars can run on both electrified and non-electrified sections.
- The improvement of acceleration and deceleration performance of cars

1-2 Hybrid Railcars of JR EAST

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■Diesel Hybrid Railcar

Kiha E200 Type

- Commercial operation ：2007
- Line：Koumi Line

Series HB-E300

- Commercial operation ：2010
- Line：Gono Line, Tsugaru Line, Ominato Line etc.

1-3 Development of Catenary and Battery-Powered Hybrid Railcar

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Commercial Development Period (2012－2014)

15 March 2014 Commercial Operation Start

2014

R&D Period (2008－2012)

2012

ACCUM

2008

1-4 Operation Area of Series EV-E301

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■ Electrified section(Tohoku Line)
between Utsunomiya and Hoshakuji
Distance：11.7km

■ Non-electrified section(Karasuyama Line)
between Hoshakuji and Karasuyama
Distance ：22.4km

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Catenary and Battery-Powered Hybrid Railcar System

2 Overall Composition of Catenary and Battery-powered Hybrid Railcar System

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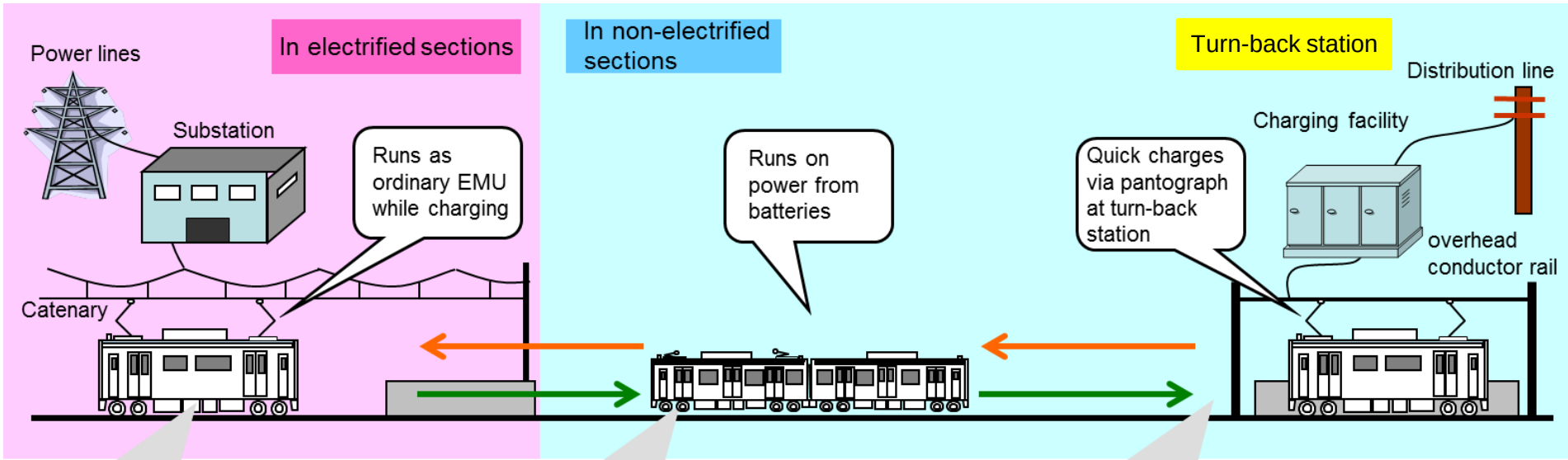
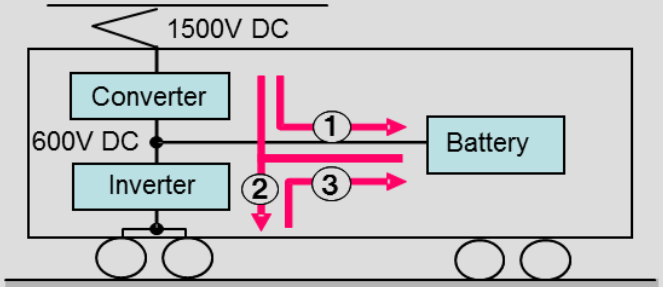
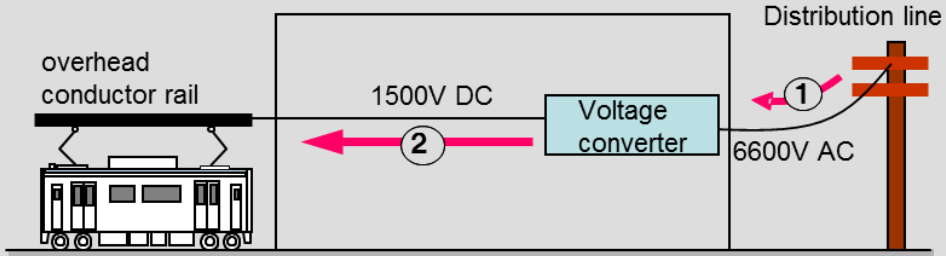


Overview of rolling stock system



① Charges battery from catenary via pantograph
② Drives motor by either catenary or battery
③ Charges battery with regenerative energy
(Regeneration to catenary possible in electrified sections.)

Overview of charging facilities system



① Power received from power company distribution line instead of dedicated power lines
② Stepping down and rectification at voltage converter and power feeding to car from overhead conductor rail

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Unique Mechanism of Series EV-E301

3-1 Main Circuit System Composition

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Overall composition of main circuit system

■ Series EV-E301

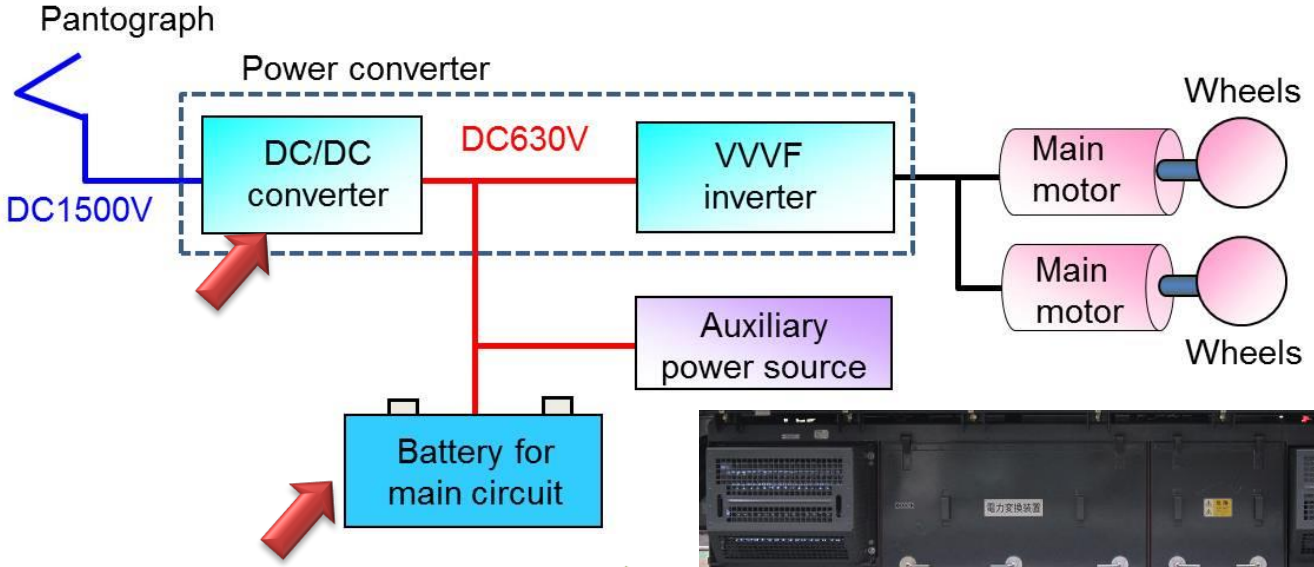
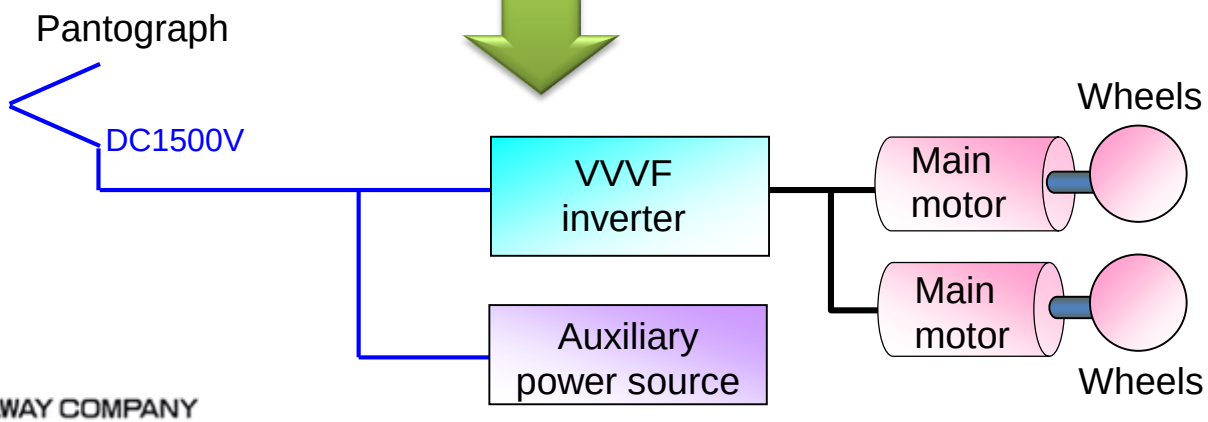
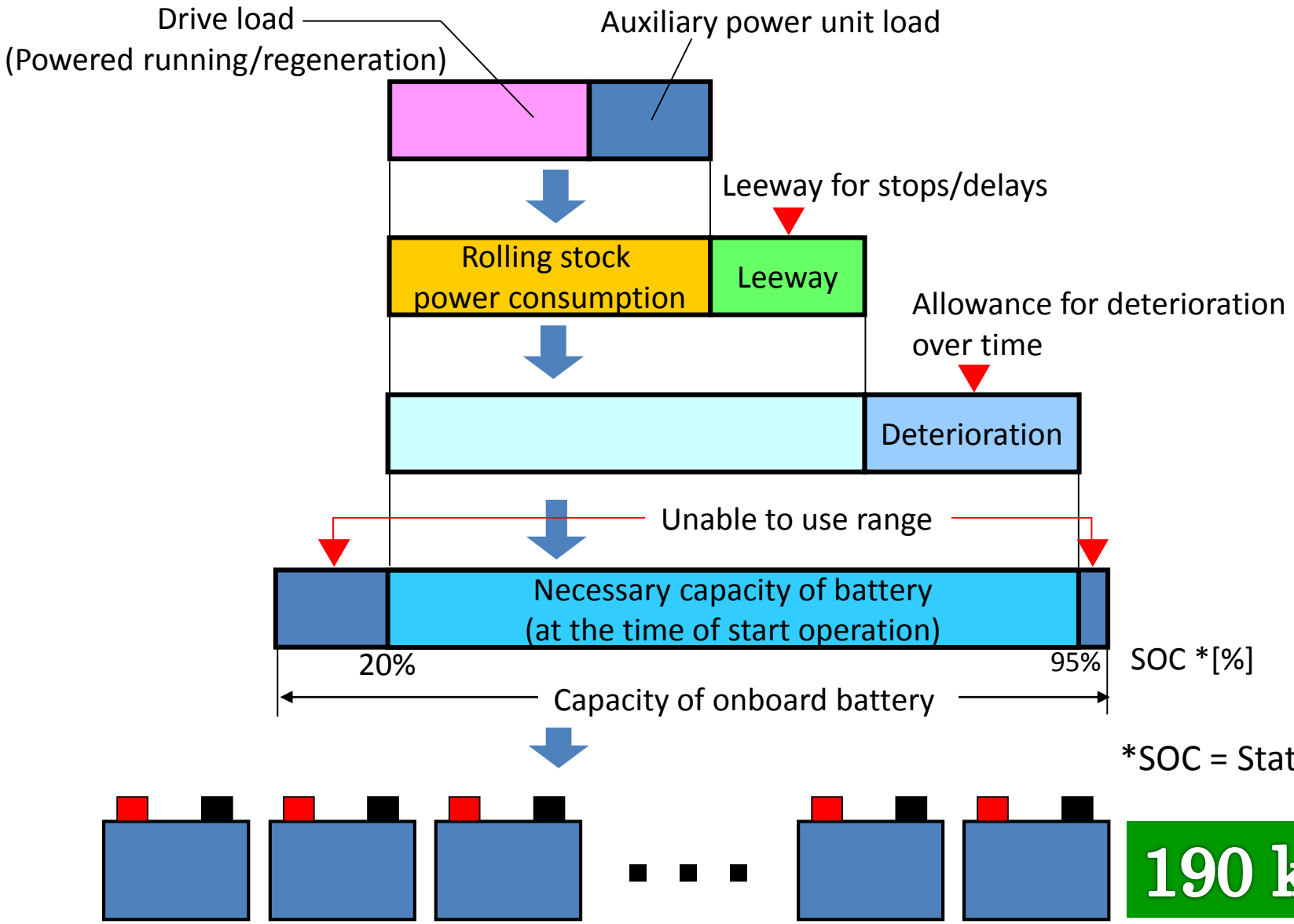


Photo : Power converter

■ Typical DC train



3-2 Setting Battery Capacity



3-3 Equipment for Identifying Type of Overhead Lines

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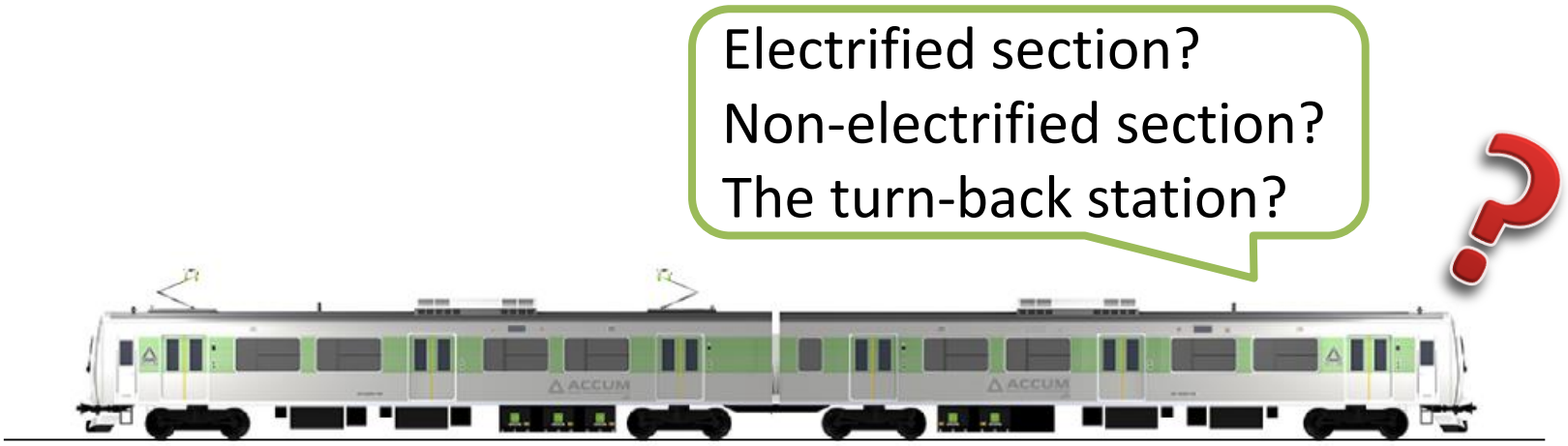

Series EV-E301 has equipment to automatically identify overhead line type.

case1	Catenary	Electrified section
case2	Without Overhead Line	Non-electrified section
case2	Overhead Conductor Rail	Turn-back Station(Charging Facility)

- Pantograph Control
- Powering and Braking Control
- Limit of value of collected current through pantograph

3-3 Equipment for Identifying Type of Overhead Lines

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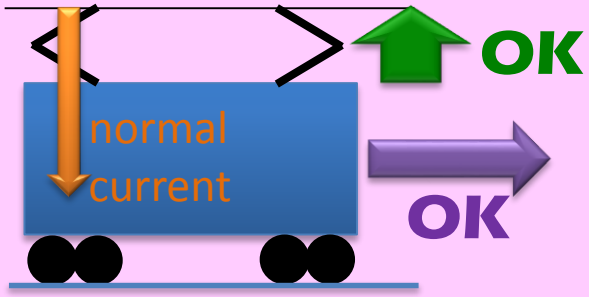
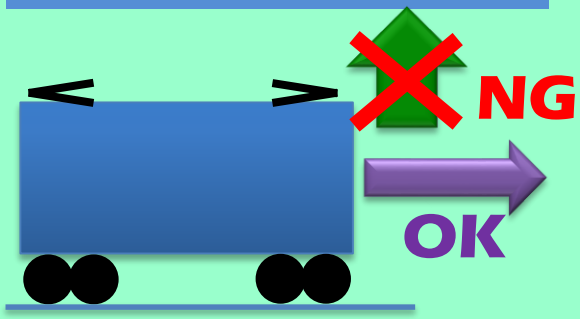
Example of the car control

Electrified section



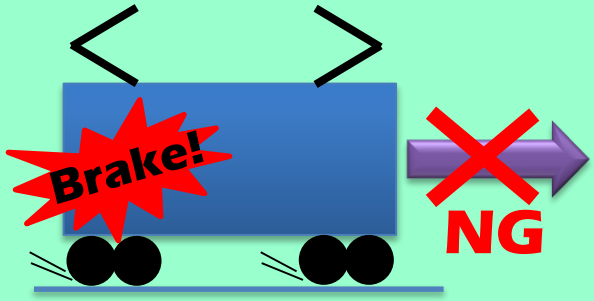
- Raising pantograph ⇒possible
- Powering ⇒possible
- Value of collected current ⇒normal current

Non-electrified section



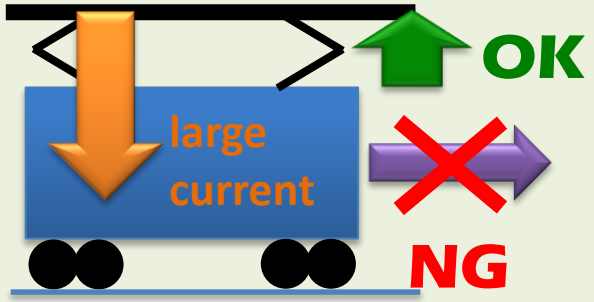
- Raising pantograph ⇒impossible
- Powering ⇒possible

If the pantograph is raised,



- Powering is impossible
- Apply the emergency brake

Charging facility (Turn-back station)



- Raising pantograph ⇒possible
- Powering ⇒impossible
- Value of collected current ⇒large current

3-4 Method of Mounting Batteries

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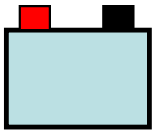
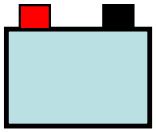
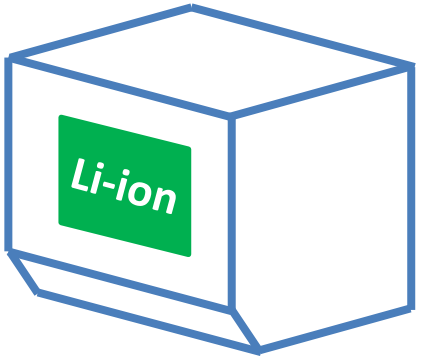


1 module(0.864Wh)



1 module(0.864Wh)

×22 module



1 box

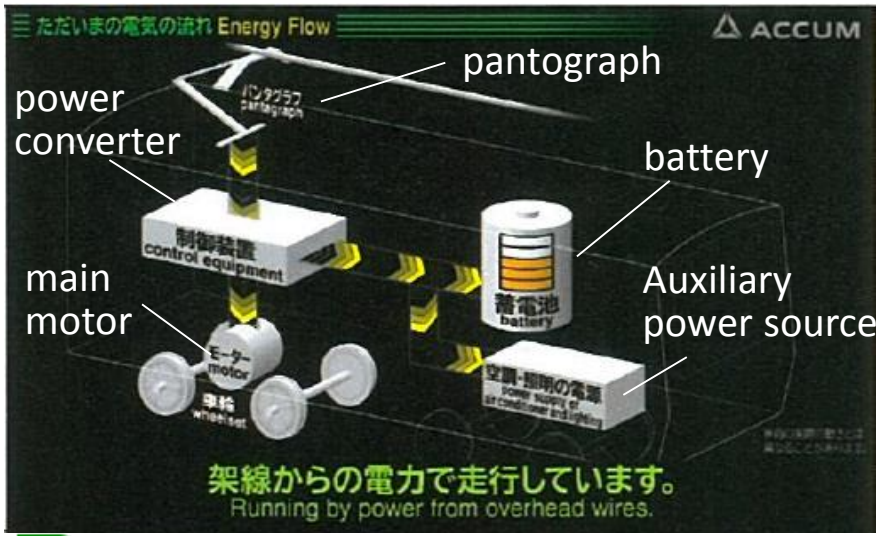
3-5 Passenger Cabin Energy Monitor Display

Passenger cabin of Series EV-E301 has a monitor display showing energy flow between the equipment.

■ Example of the display

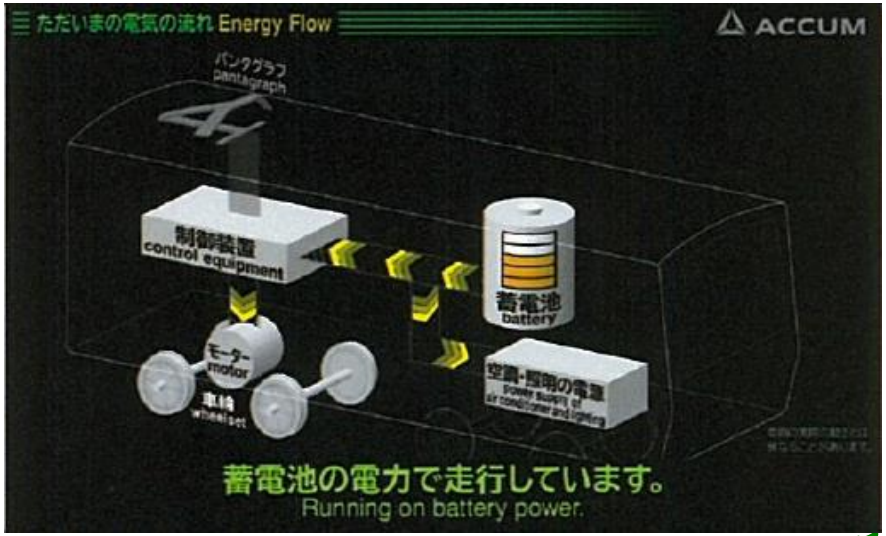
Electrified section

・pantograph raised ・powering



Non-electrified section

・pantograph lowered ・powering



4

Main specifications

4-1 Main specifications

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EV=Energy storage Vehicle

Car type		EV-E301	EV-E300
Classification code		Mc	Mc'
Passenger capacity(number of seats)		133(48)	133(48)
Weight (t)		40.2	37.7
Car body	length × Width × Height(mm)	19,570 × 2,800 × 3,620	
Bogie center distance (mm)		13,800	
Bogies	Gauge (mm)	1,067	
	Type	Bolsterless	
	Wheel base (mm)	2,100	
	Wheel diameter (mm)	φ860	
	Drive system	Parallel cardan system	
Electric system		1,500V DC / 630V DC	
Train performance		Maximum running speed 100km/hStarting acceleration 0.556m/s^2 (2.0km/h/s)	
Control system		VVVF inverter control	
Main circuit battery		Lithium-ion battery 95kWh	Lithium-ion battery 95kWh
Brake system		Electric command air brakes with regenerative braking (with load compensating control)	
Traction motor		3-phase squirrel-cage induction motor Continuous rated output: 95kW	
Auxiliary power supply		Static inverter; Auxiliary rectifier	
Safety devices		ATS-P	

4-2 Nickname of Series EV-E301

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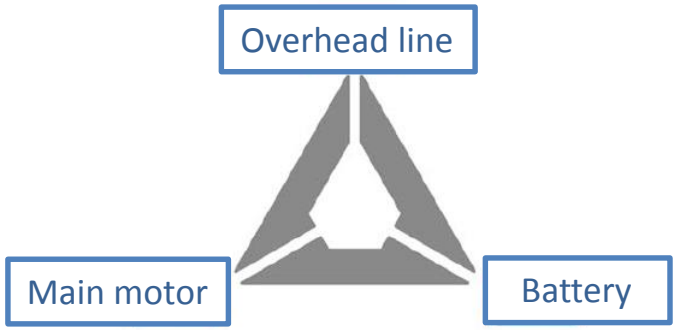
Why was the car nicknamed 'ACCUM' ?

➡ The nickname was chosen by the public.

ACCUM
ENERGY ACCUMULATING VEHICLE

ACCUM = Accumulator

Symbol mark



Imaging the flow of energy between 'Overhead line' , 'Battery' and 'Main motor'

5

Design concept

5-1 Exterior Design

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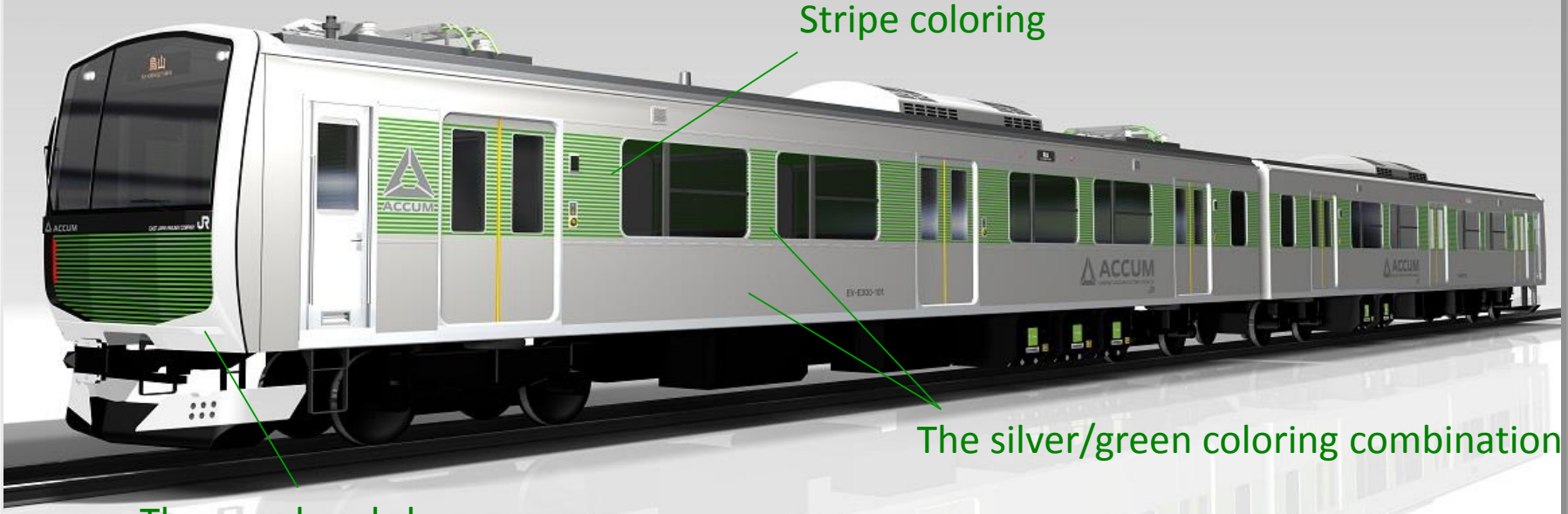
Total Concept: **"Spirit of Innovation" "Environmentally Friendliness"**

■Spirit of innovation

The new car head shape／Stripe coloring creates a sharp impression

■Eco-friendliness

The silver／green coloring combination on the car body



5-2 Interior Design

ACCUM ENERGY ACCUMULATING VEHICLE

Total Concept: **"Spirit of Innovation" "Environmentally Friendliness"**

■Spirit of innovation

Indirect LED lighting arranged continuously ／New ceiling shape

■People-friendliness

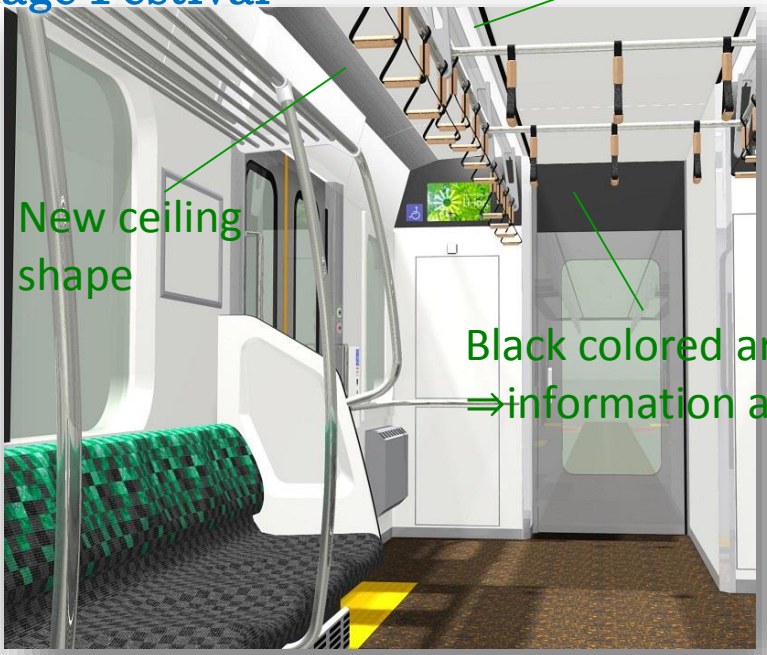
Sufficient space for wheelchair user ／

Color combination for separating information area

■Features of the Karasuyama Line

・"Green"of seat : The landscape of the four seasons along the line

・"Orange"of floor : The vibrancy of "Yamaage Festival"



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Outline of Series EV-E301

6-1 Car Body

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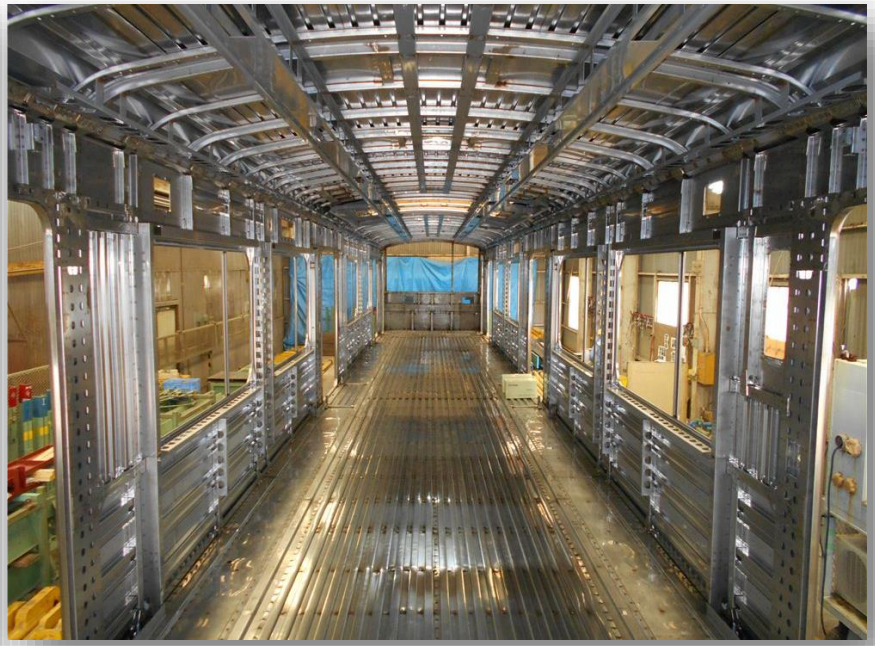
Light-Weight Stainless Steel Construction

- Straight body
- The reinforced head structure
- Weight reduction structure
  (Replacing stainless steel parts with aluminium alloy)



6-2 Passenger Cabin

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6-2 Passenger Cabin

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■LED Room Light

■LCD-type information display

■Wheelchair Space

6-3 Crew Cabin

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6-3 Crew Cabin

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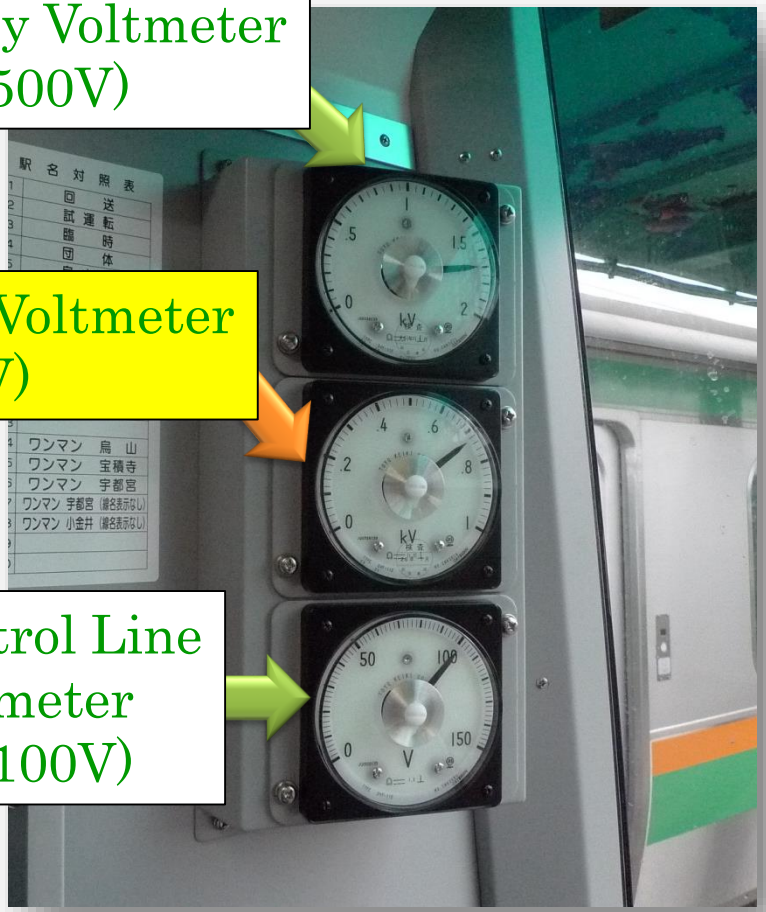
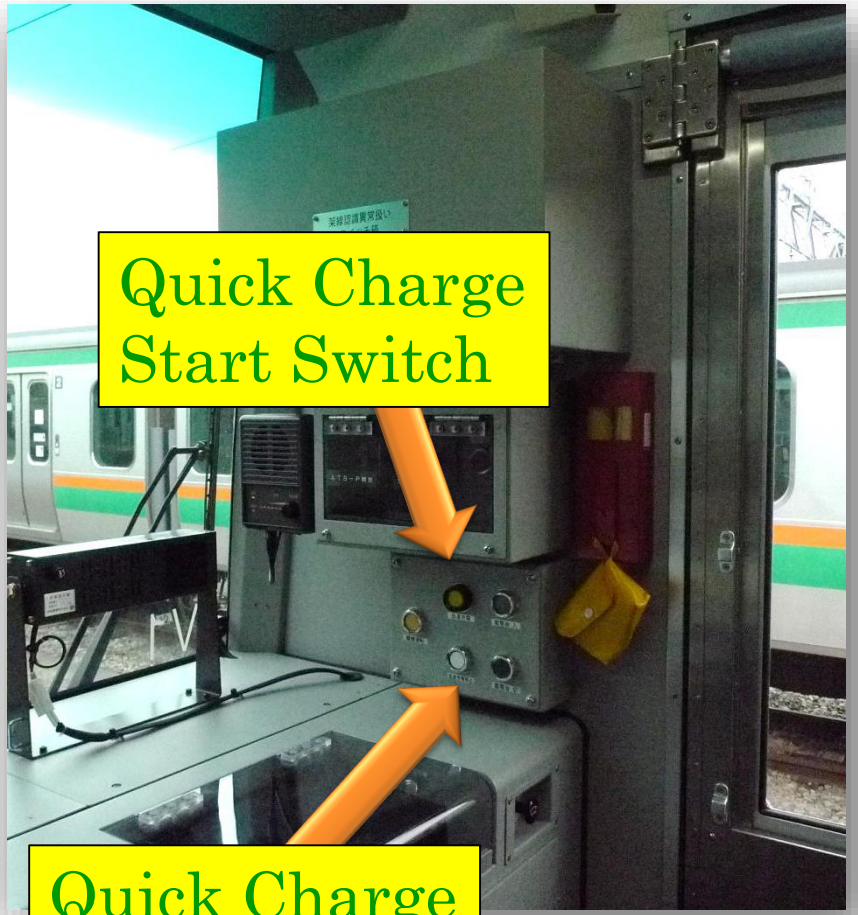
Trolley Voltmeter (DC1500V)

Battery Voltmeter (DC630V)

Control Line Voltmeter (DC100V)





Quick Charge Start Switch

Quick Charge Stop Switch

6-4 Equipment Layout on Roof

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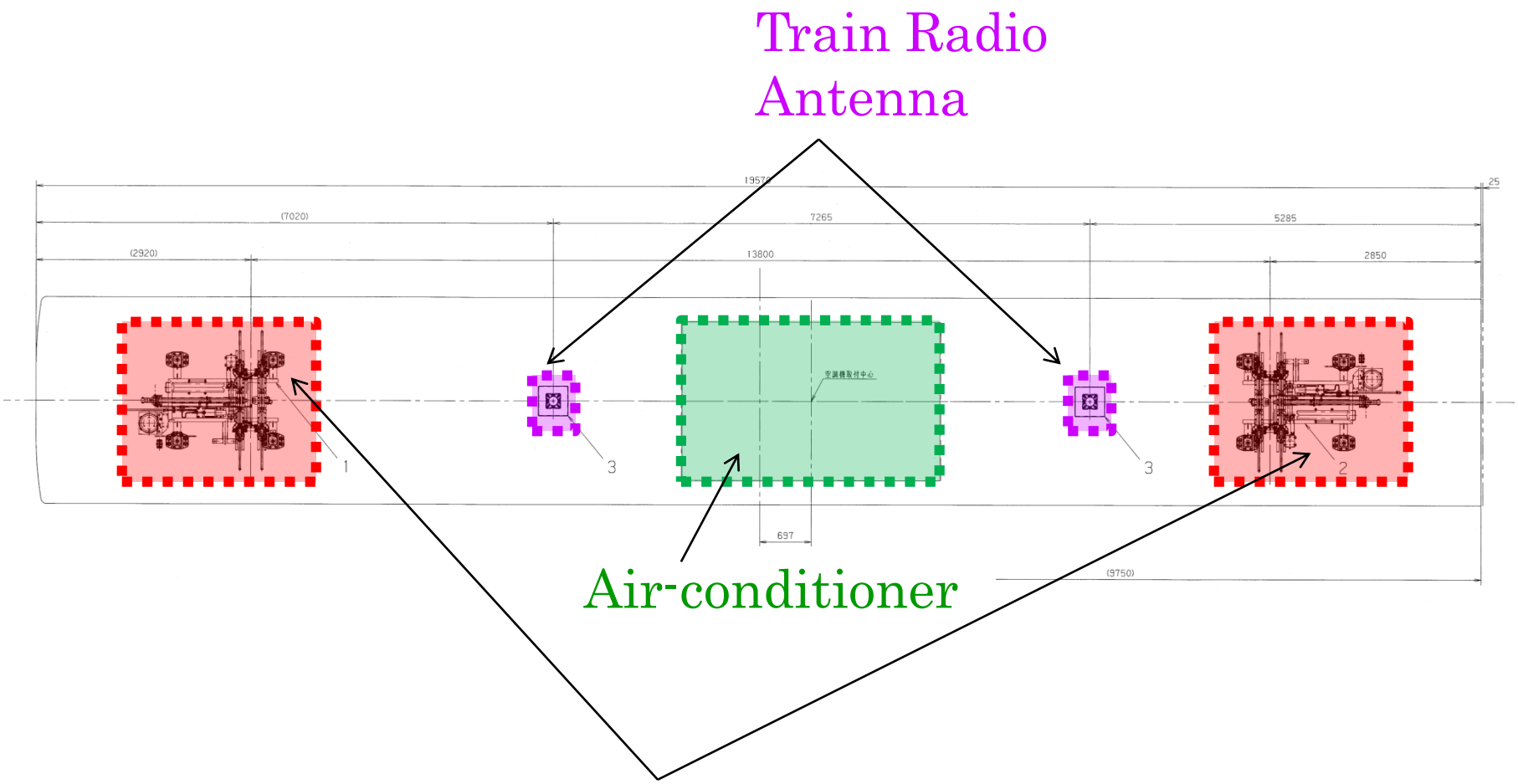

6-5 Equipment Layout under Floor

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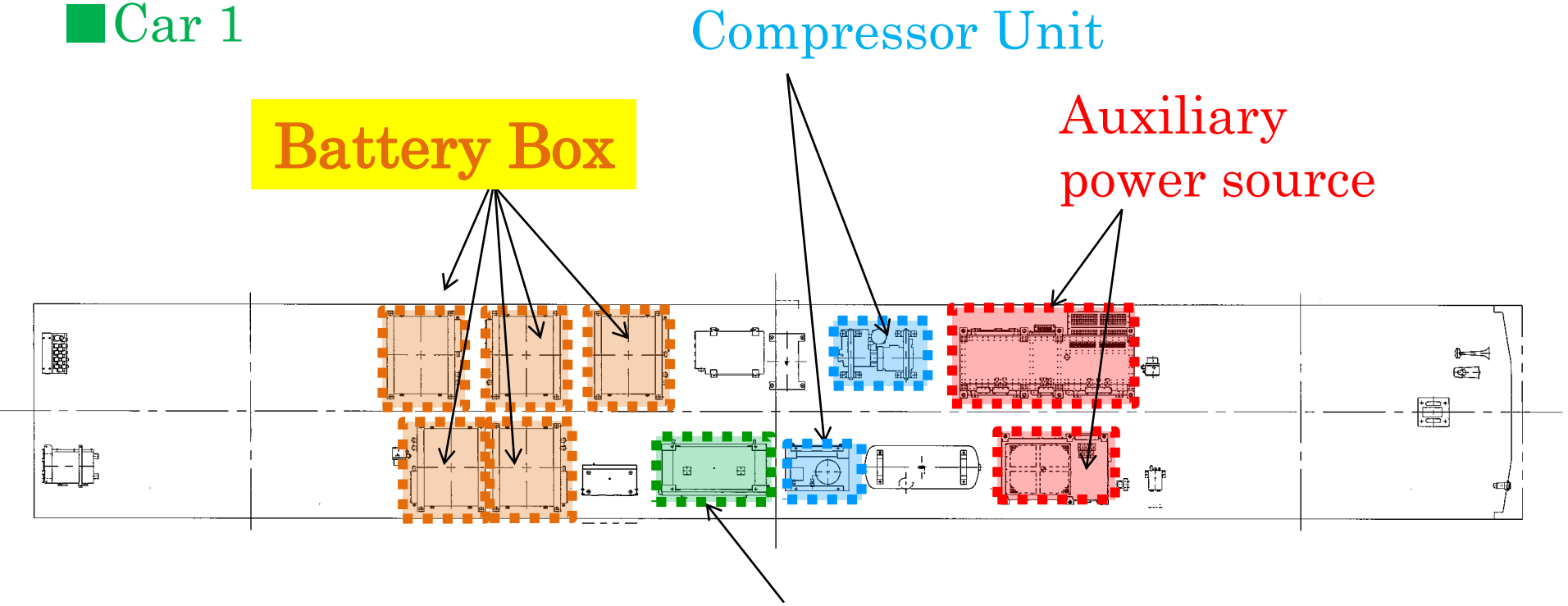
■ Car 1



6-5 Equipment Layout under Floor

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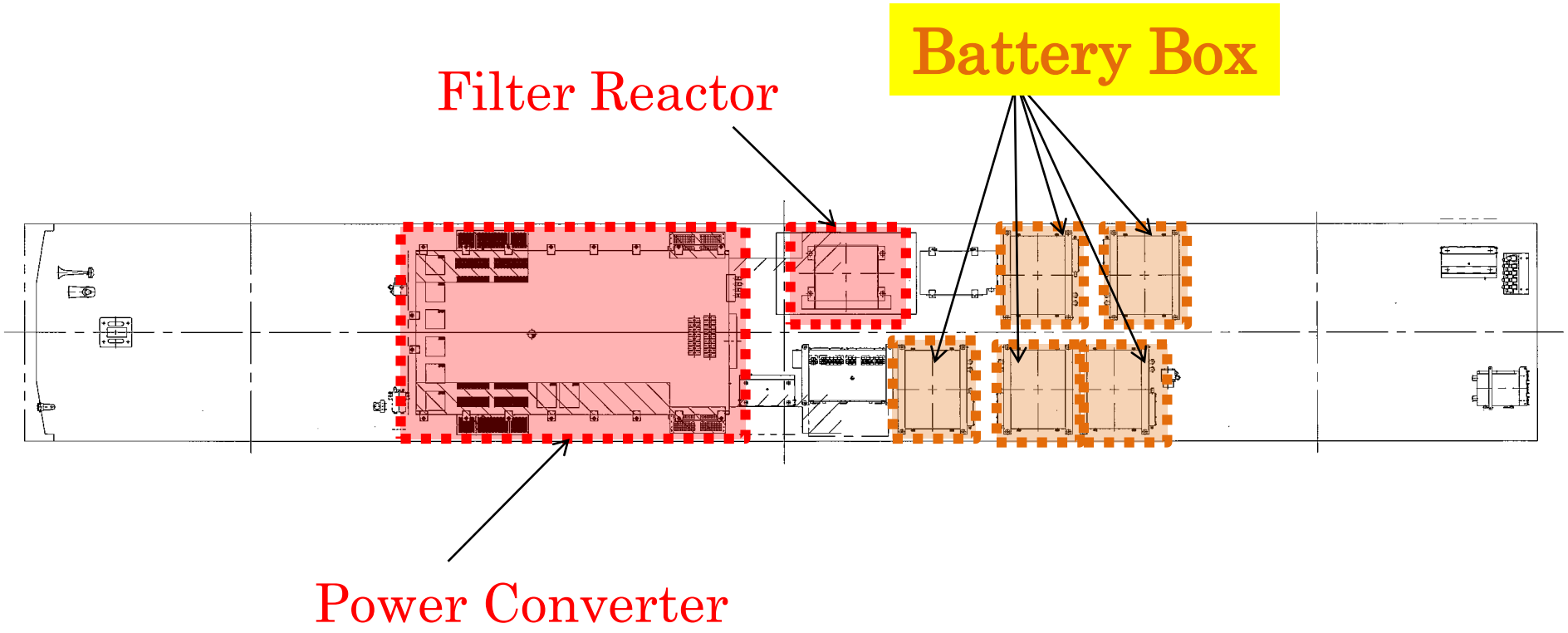
Car 2



7

Future Effort

7-1 Assumed Effect

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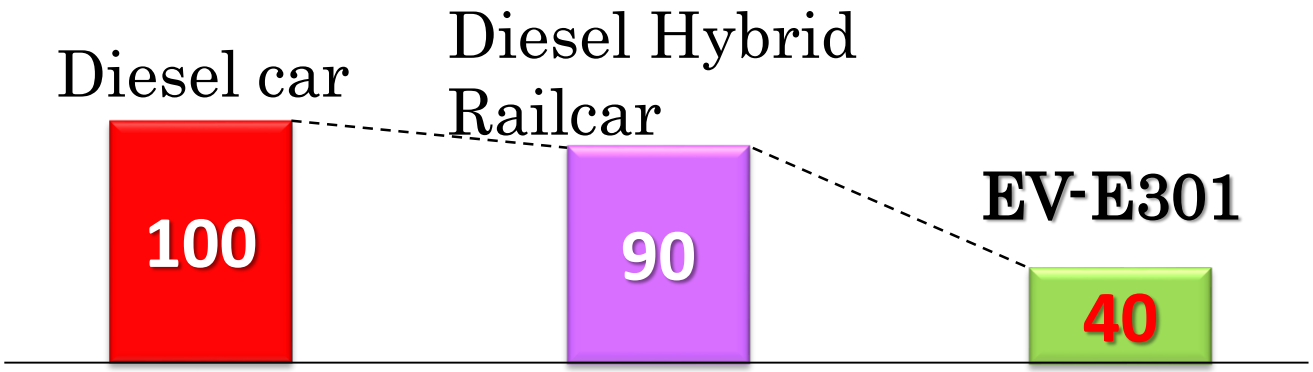
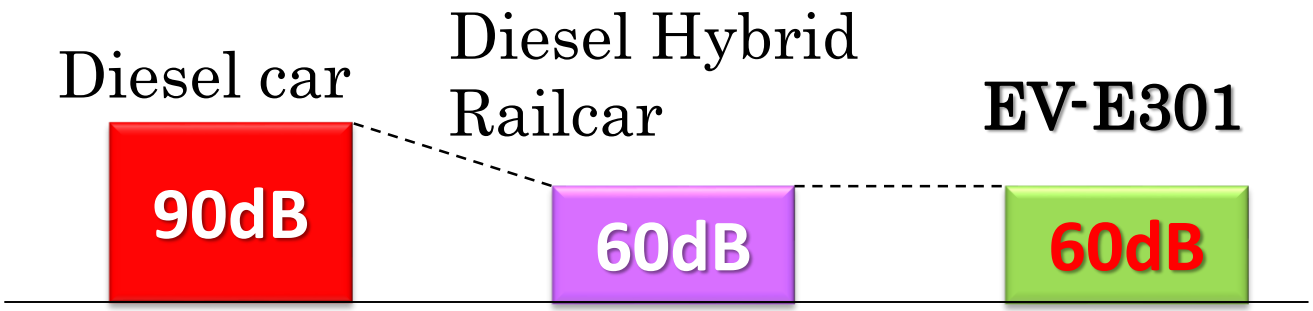
Effect of reducing CO_2 emissions



Effect of reducing noise

(When the car stopped at the station.)



7-2 Future Effort

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- Acquiring data about the battery in the summer and winter season (temperature, SOC, etc.)
- Replacing all diesel cars running Karasuyama Line with Series EV-E301

Quick charge at Karasuyama station

Running in the non-electrified section