MITSUBISHI ELECTRIC
Changes for the Better

Energy and Environmentally-friendly Solutions for Railway Systems of the Mitsubishi Electric (MELCO)

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Tokyo, Japan

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Changes for the Better

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1. Corporate Overview

1. Corporate Overview

Mitsubishi Electric Corporation (MELCO)

**Head Office: Tokyo Building, 2-7-3 Marunouchi,
Chiyoda-ku, Tokyo 100-8310, Japan**

●President & CEO:	Masaki Sakuyama
● Established:	January 15, 1921
● Consolidated Net Sales:	¥4,238.7 billion (€ 35.32 billion)
● Paid-in Capital:	¥175.8 billion (€ 1.47 billion)
● Shares Issued:	2,147,201,551 shares
● Consolidated Total Assets:	¥4,180.0 billion (€ 34.83 billion)
● Consolidated Employees:	138,700

(As of March 31, 2017)
(Exchange rate: ¥120=€1)

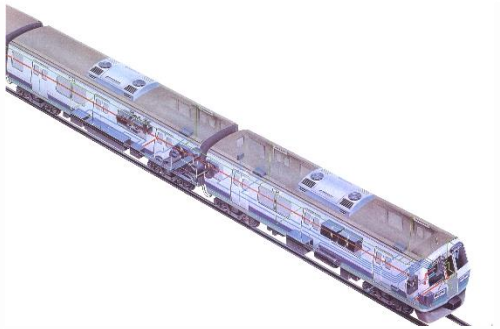
1. Corporate Overview

Business Fields

Energy & Electric Systems

Power Generation System

Railway Systems



Industrial & Automation Systems

Automation Equipment

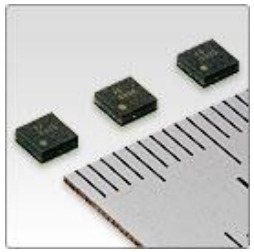
Industrial Products

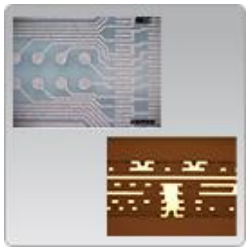
Information & Communication Systems

Communications Satellite

Electronic Devices

Power Devices





Home Appliances

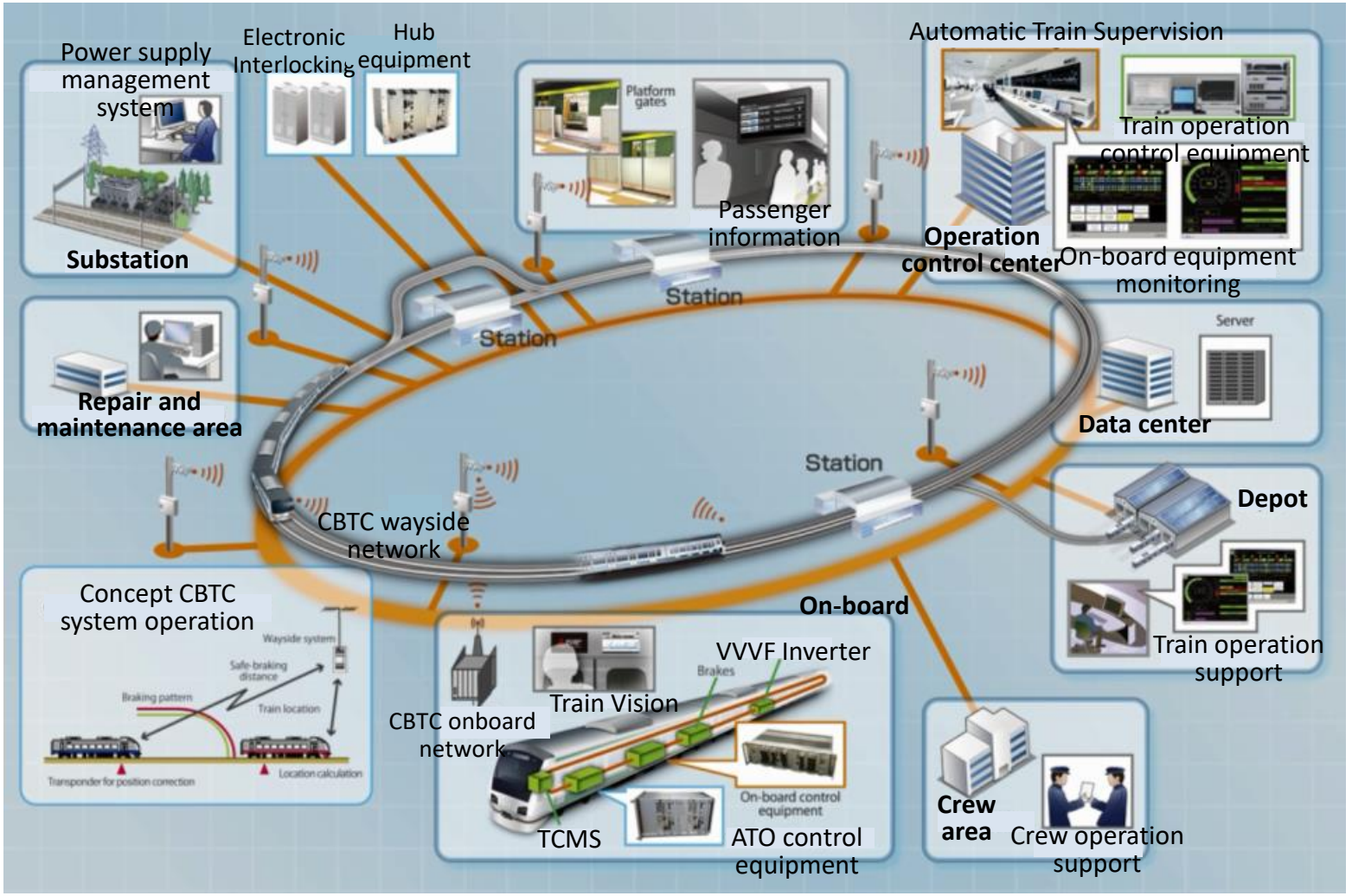
Digital AV

Room Air Conditioners

MELCO provides products from Space satellites, infrastructures, to living and personal items

1. Corporate Overview

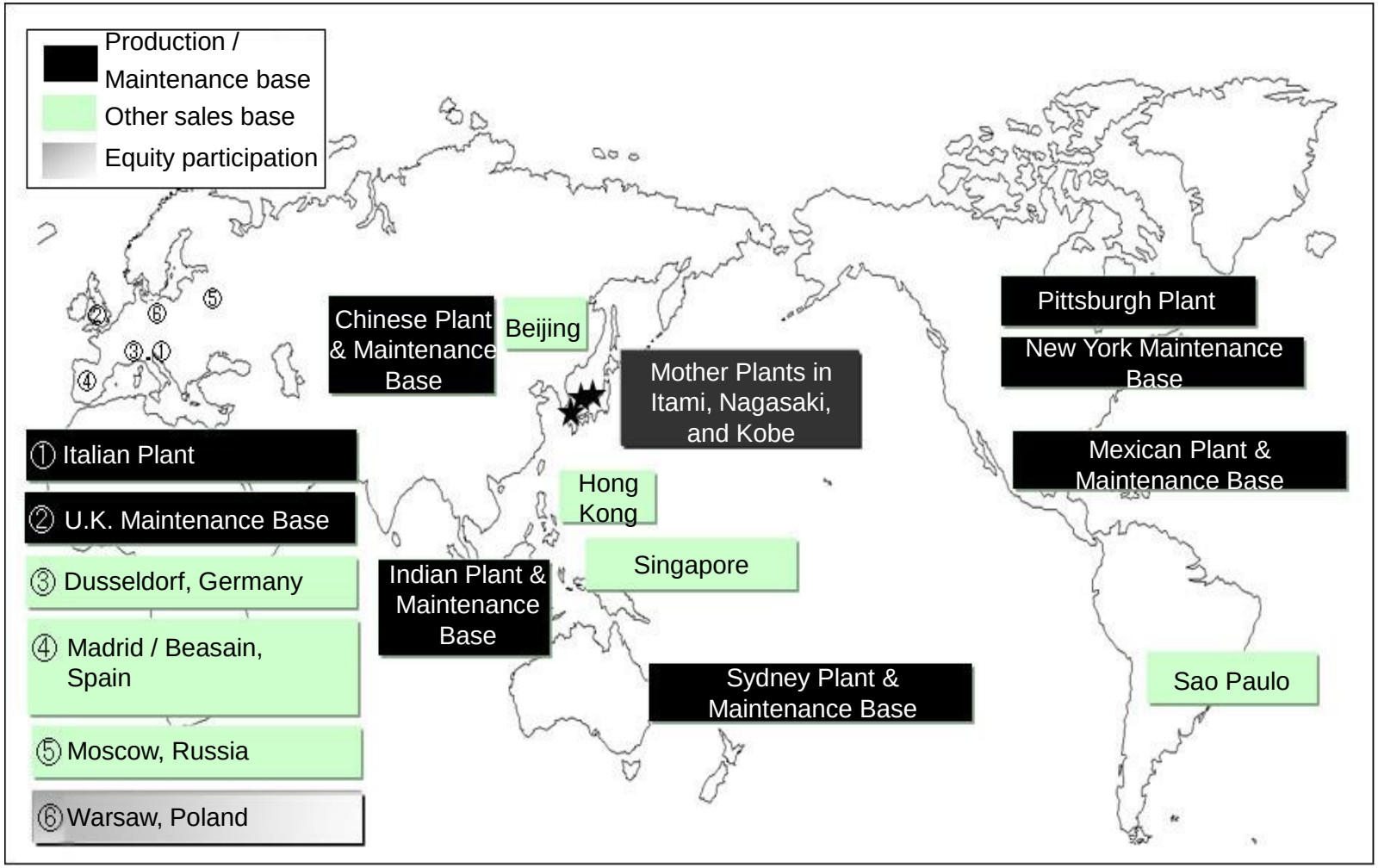
Products for Transportation Field



MELCO provides products in transportation fields from rolling stock to ground facilities

2. Expansion of Overseas business

2. Expansion of Overseas business



Mitsubishi Electric's overseas bases

MELCO started railway business in 1922 for domestic market, then for overseas market in 1960. Overseas sales and production bases have been expanded to Asia, America and Europe.

2. Expansion of Overseas business

Mitsubishi Electric products in Hong Kong

Mitsubishi Electric has contributed for urban transport in Hong Kong.
Our propulsion systems have been used for the rolling stock of MTR since 1980's.
The propulsion systems and other systems like APS and TCMS for more than 1,900 cars in Hong Kong has been and being supplied.

3. Energy Management Systems for Railway application

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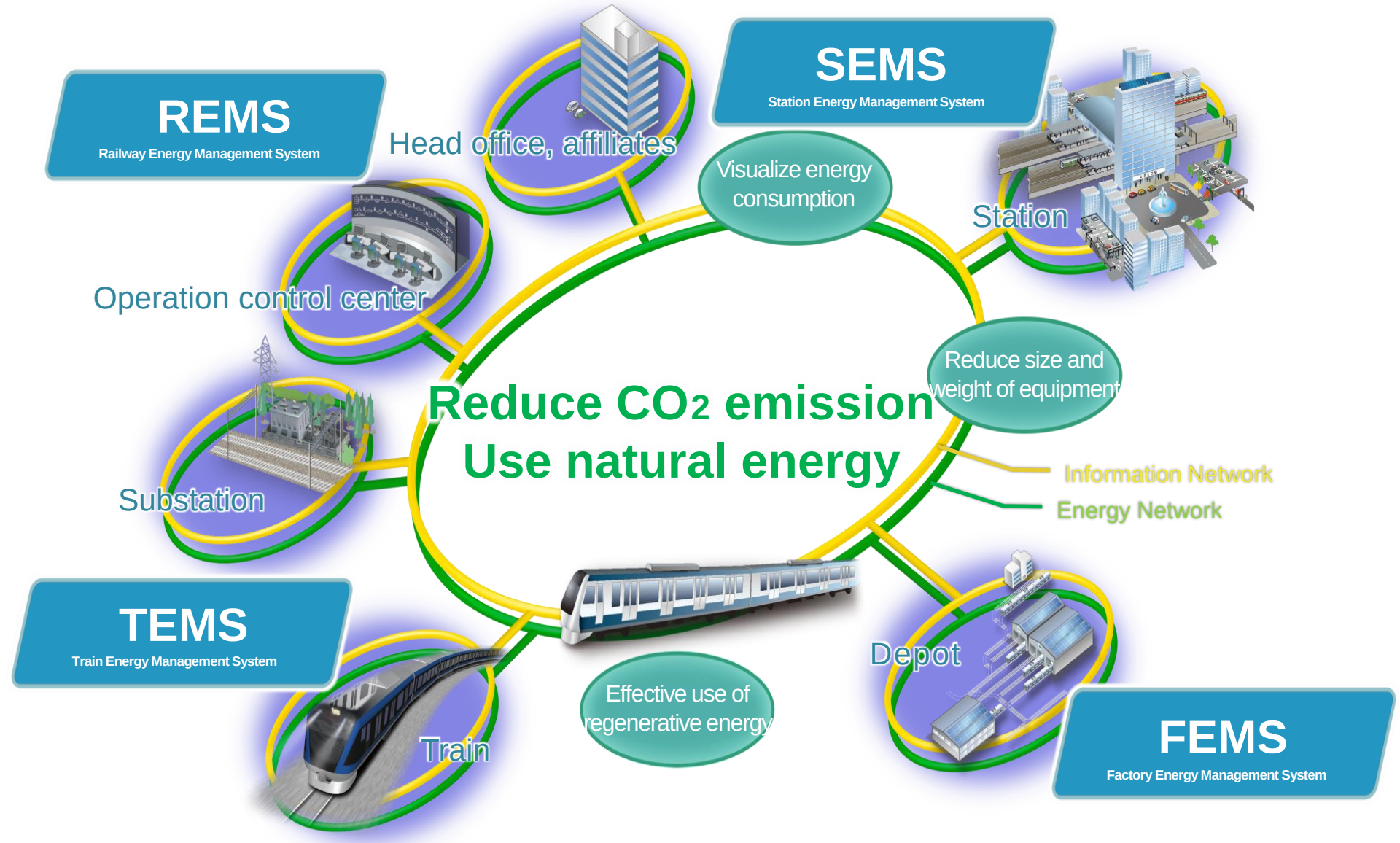


Energy Management System consists of four fields of railway applications

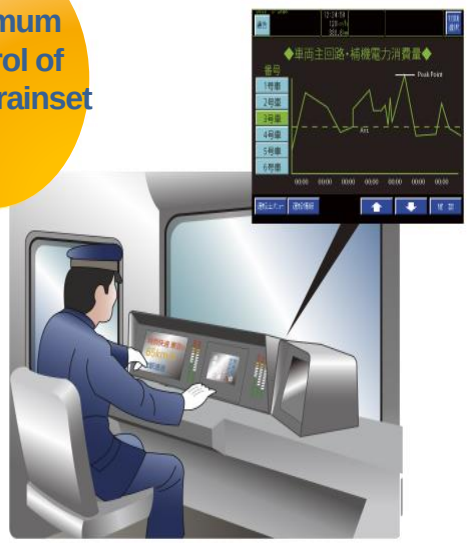
4. TEMS
(Train Energy Management System)

4. TEMS (Train Energy Management System)

TEMS

High-Efficiency on-board equipment and optimum control of entire trainset enhance total environmental performance of train systems.

Optimum control of entire trainset



Train Control and Monitoring System

Train

VVVF inverter

On-board devices

4. TEMS (Train Energy Management System)

TEMS | **SiC applied Inverter**

On-board devices

◆ The **world's first** **Silicon carbide (SiC) power modules inverter** installed in a commercial train.

*SiC is silicon carbide (a chemical compound of carbon and silicon)

All-SiC applied VVVF inverter for commuter train

The amount of regenerative electric energy is increased by reducing power loss

World's first *1
ALL-SiC Power Module
applied

Energy Consumption
40%
reduction
Total energy consumption of railcar systems, including traction motors, is reduced by 40% *2

Size and Weight
80%
reduction
Size and weight are reduced by about 80% *2

*1 – As of Dec 2013
*2 – Comparison of conventional traction inverter with GTO power Modules

MELCO is the world leading manufacture of SiC device, technology, and applications

4. TEMS (Train Energy Management System)

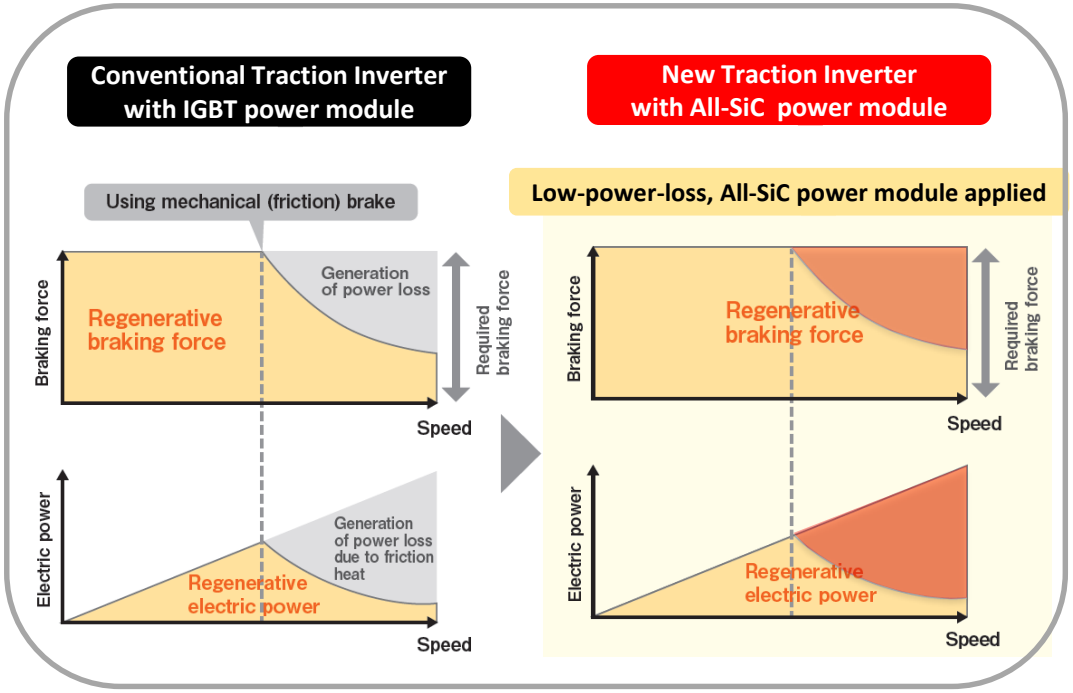
MELCO Semiconductor Technology

Power Device Development

■ Reduction of Power Loss

Effect on Propulsion Systems
- Reduction of Power Consumption
- Simplification of Cooling System
- Weight Reduction, Size Reduction

■ ***Advantage of new device SiC***
- **Low power loss**
- High frequency switching → Noise emission Reduction
- High operating temperature

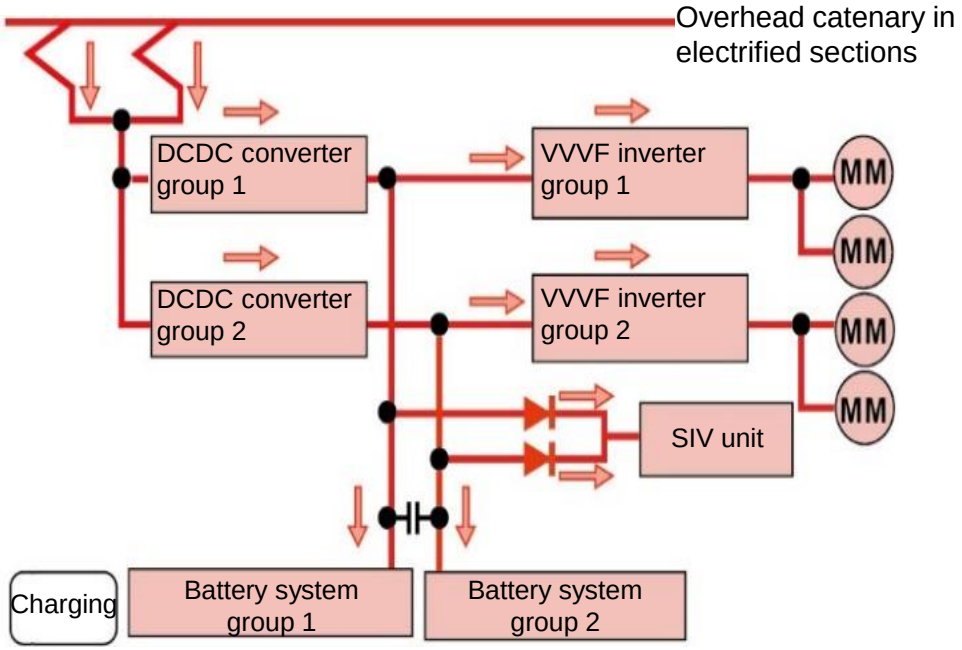


4. TEMS (Train Energy Management System)

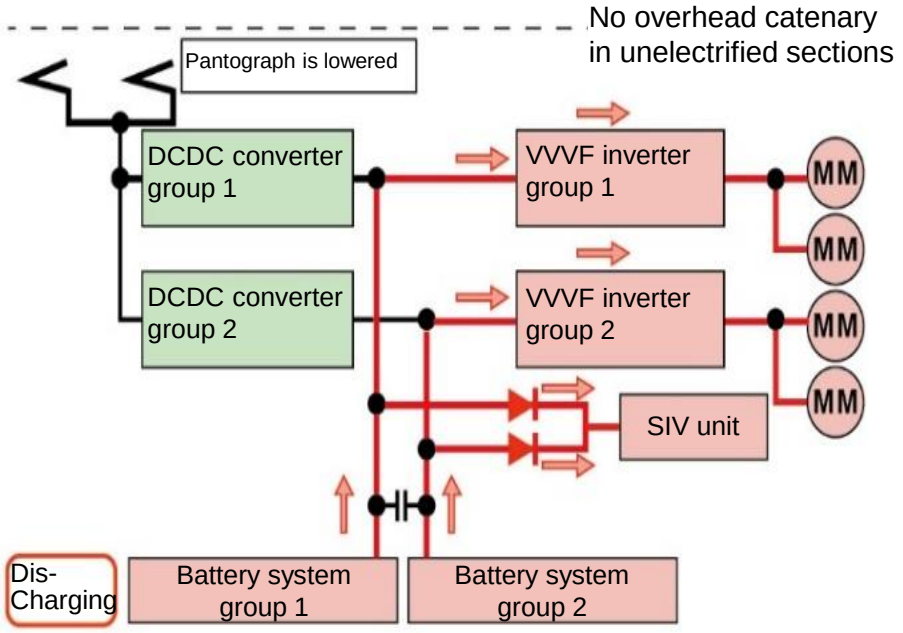
TEMS

Battery powered vehicle

On-board devices



(a) When traveling in an electrified section



(b) When traveling in an unelectrified section

Power converter for battery-powered EMU

4. TEMS (Train Energy Management System)

TEMS

Realization of Optimized Train System

TCMS(Train Control & Monitoring System) controls the equipment in order to optimize the power flow in a trainset.

Optimum control of entire train units

HVAC

Passenger Information System

Security System

Brake Control

Auxiliary Power Supply

Propulsion Inverter

Brain for Train

TCMS: Train Control and Monitoring System

- Support low energy operation
- Energy Saving Control
- Data base of consumption

5. REMS
(Railway Energy Management System)

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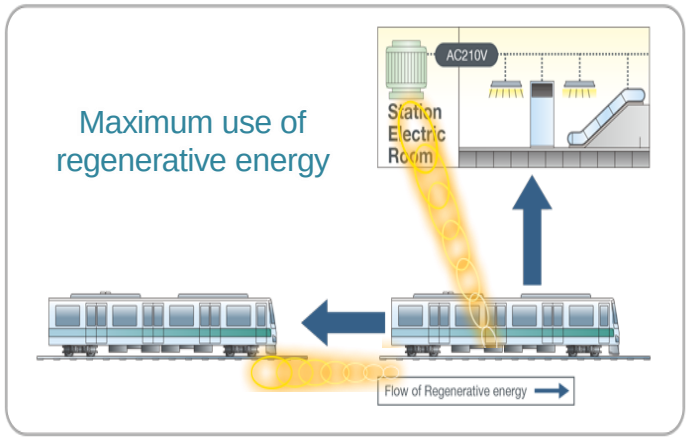
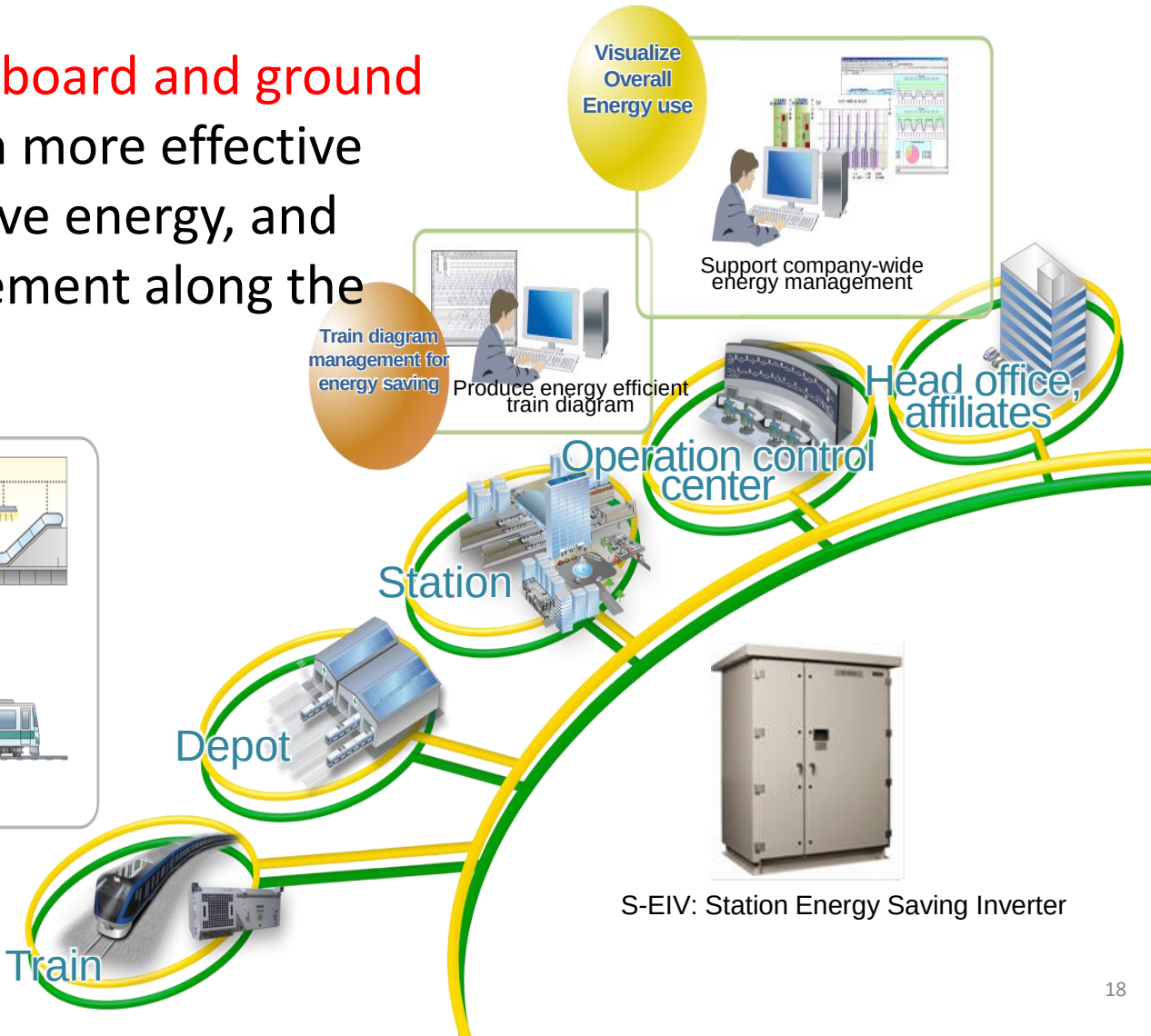
REMS

The coordination of on-board and ground facilities allows for even more effective utilization of regenerative energy, and ensures energy management along the entire line.



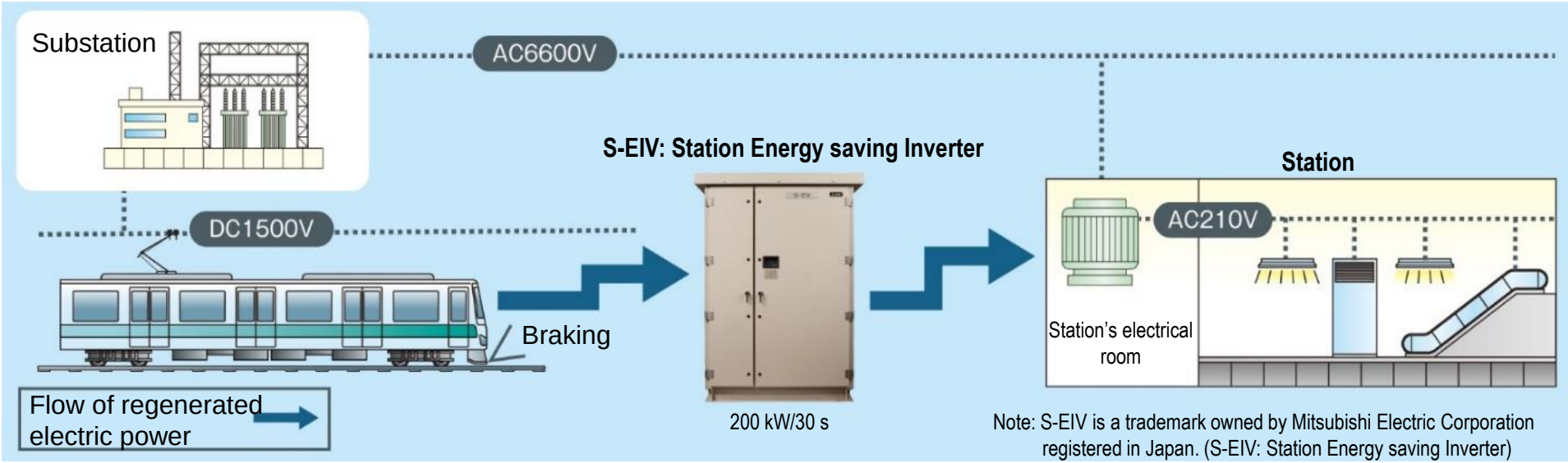


S-EIV: Station Energy Saving Inverter

5. REMS (Railway Energy Management System)

REMS S-EIV(Station Energy Saving Inverter)

■ Effective usage of regenerative energy from trains
S-EIV can supply a part of surplus regenerative energy to station facilities.



Note: S-EIV is a trademark owned by Mitsubishi Electric Corporation registered in Japan. (S-EIV: Station Energy saving Inverter)

■ Features:

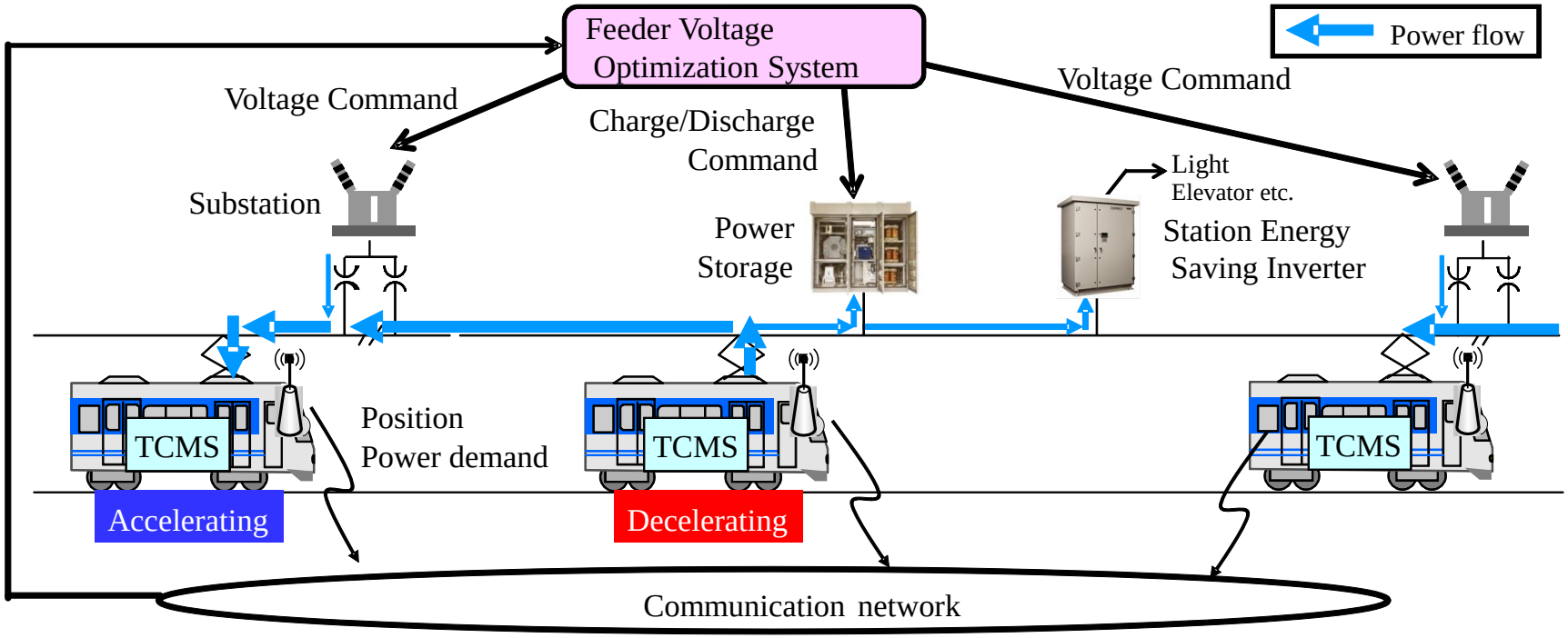
①Close distance between train in braking and regenerative facility
⇒ Minimize loss of the cable resistance

②Compact system without battery
⇒ Easy installation and low maintenance

5. REMS (Railway Energy Management System)

REMS Feeder Voltage Optimization System

We have been developing the new solution for railway energy saving, combined with substation on-ground and TCMS on-board.



TCMS: Train Control and Monitoring System

6. SEMS & FEMS
(Station EMS & Factory EMS)

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SEMS

- Use of energy-saving equipment in station facilities
- Optimize energy use throughout entire station
- Application of natural energy resources
- Visualize energy consumption

Visualize energy consumption in stations

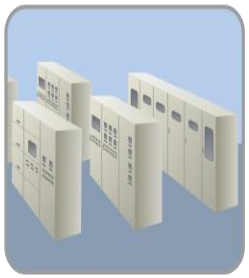
Station energy management room

Integrated station facilities management system

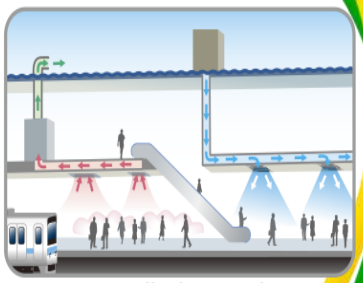
Electrical room, Machine room, Shops

Station

Solar power generators



Power receiving and distribution system



Ventilation and air-conditioning system

Elevators, Escalators

LED lighting

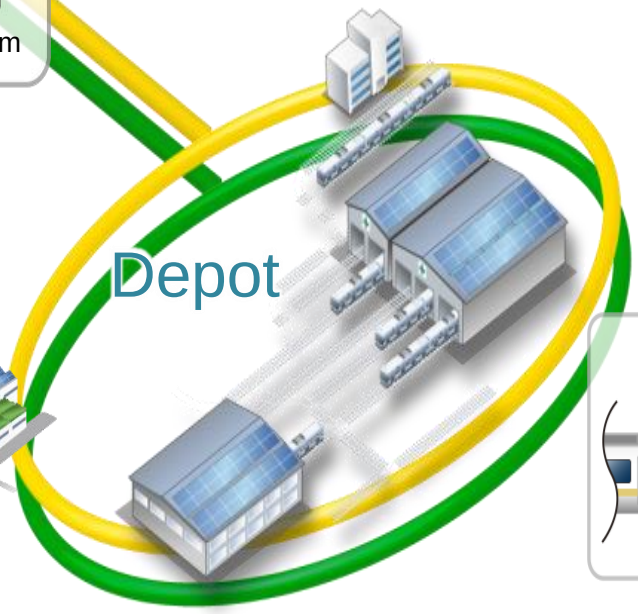
6. SEMS & FEMS(Station EMS & Factory EMS)

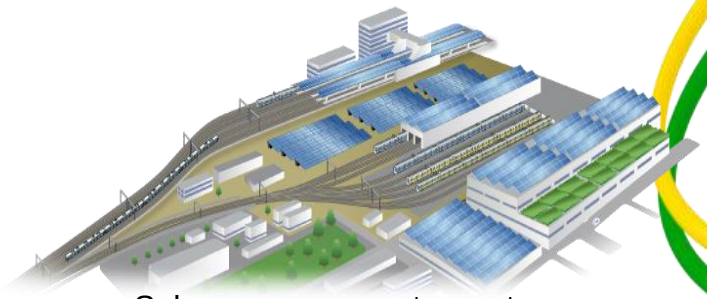
FEMS

Visualize energy consumption in depots

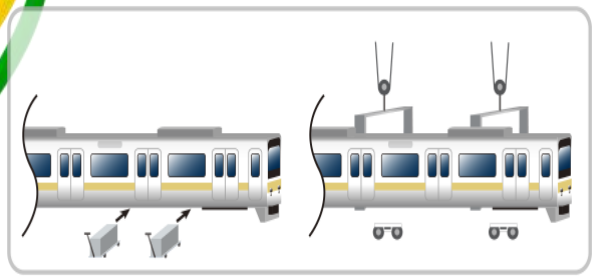
Integrated depot management system

- Individual onsite energy management and support of energy-efficient operation
- Effective use of space by installing large-scale solar power generators





Solar power generator system



Train refurbishment equipment

7. Conclusion

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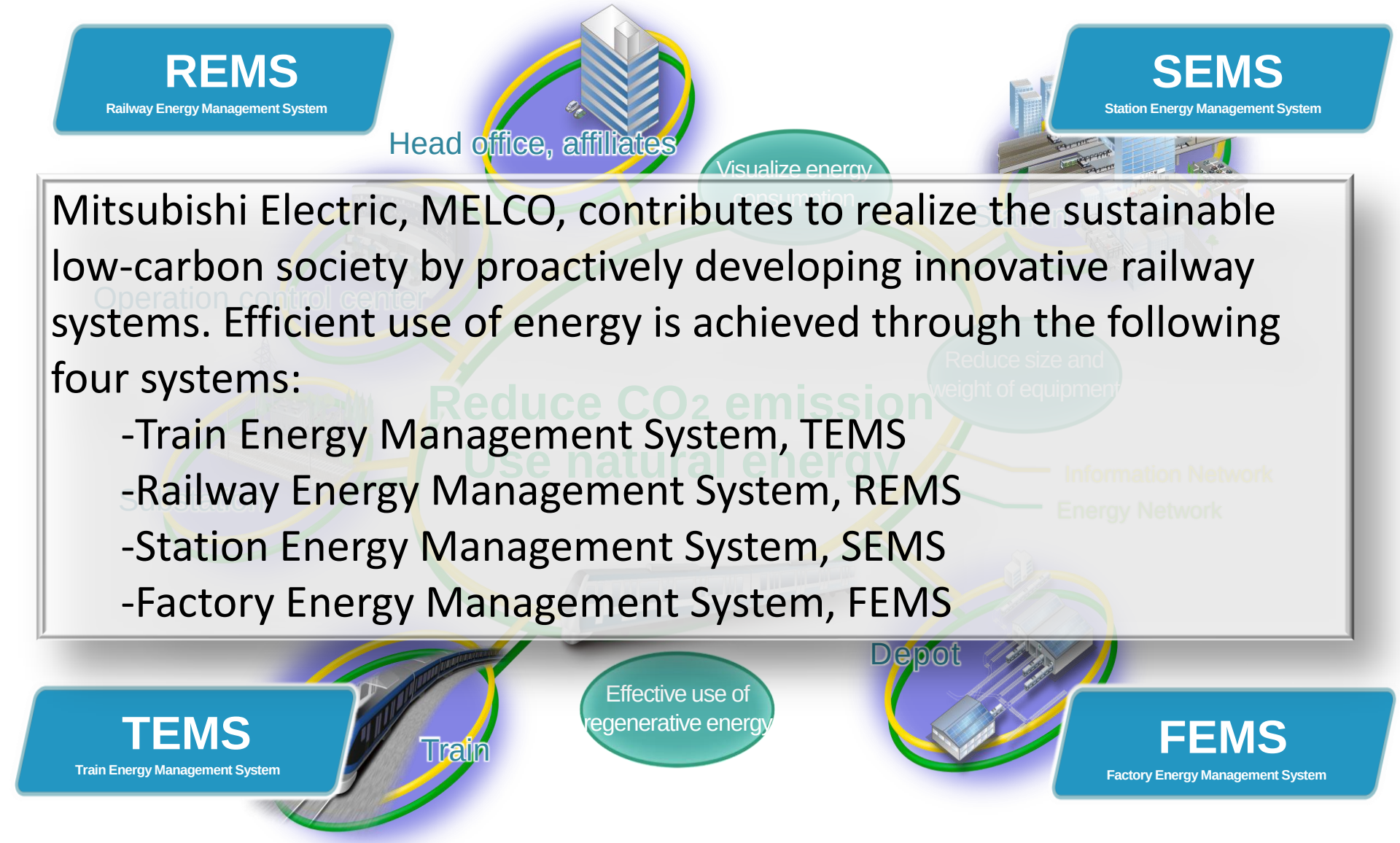
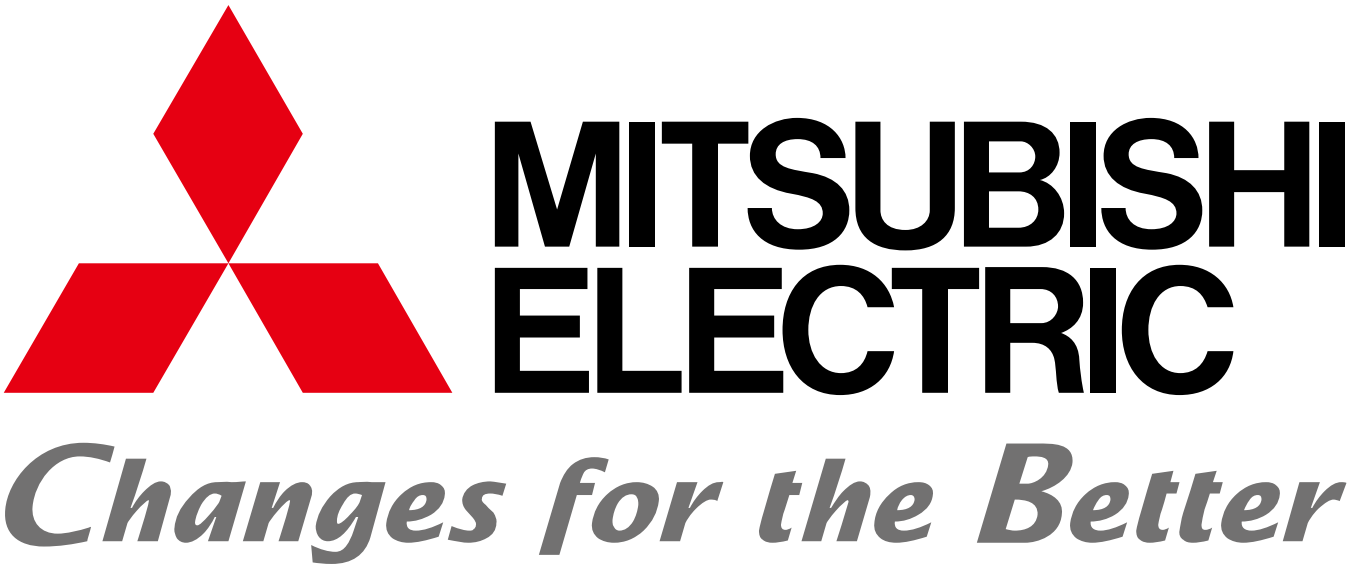


Mitsubishi Electric, MELCO, contributes to realize the sustainable low-carbon society by proactively developing innovative railway systems. Efficient use of energy is achieved through the following four systems:

- -Train Energy Management System, TEMS
- -Railway Energy Management System, REMS
- -Station Energy Management System, SEMS
- -Factory Energy Management System, FEMS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