

Road trains using a standard truck and electrically propelled trailers

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Background and Objectives

- Economic corridor
- Planning factories
- Need for fast and flexible inter-country transportation
- Truck transportation is useful but expensive

➡ Truck transportation improvement is necessary

➡ Road trains using hybrid trailer technology developed by JARI

- Realize mass transportation
- Fuel cost reduction
- Personnel cost reduction

Has to be developed together with logistics infrastructure implementation.



Truck transportation on a European Highway (E30: 5,800 km / Russia --- Ireland)



Photo: Hannover, Germany Oct.14, 2014

Road Trains in the World

Road trains are used in Argentina, Australia, Mexico, the USA, Canada, etc. for efficient transportation

Continental city to city transport (Adelaide --- Darwin : 3,027 km)



Road train in Brazil - Sugar cane transport (Farm --- Factory)



Road Trains in Japan (only on private roads)

Ube-Mine Private Expressway
28 km: Cement factory - port

Road trains cannot be used on public roads because of laws and regulations

↑ 道路法第四十七条、車両制限令第三条



Road train : Double



Road train : Triple



Semi-trailer



Full-trailer



Full-trailer: relaxation of length regulation (19 to 21 m /Nov. 2013)



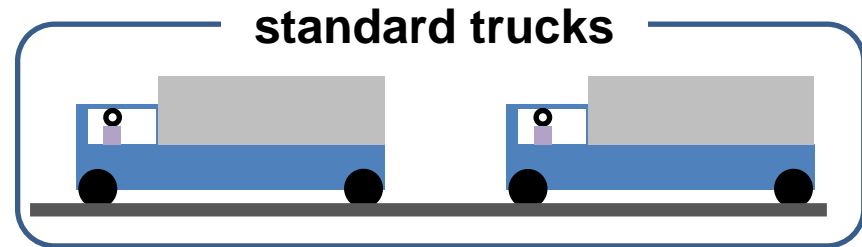
<http://halfzero.sakura.ne.jp/road/ubemine.htm>



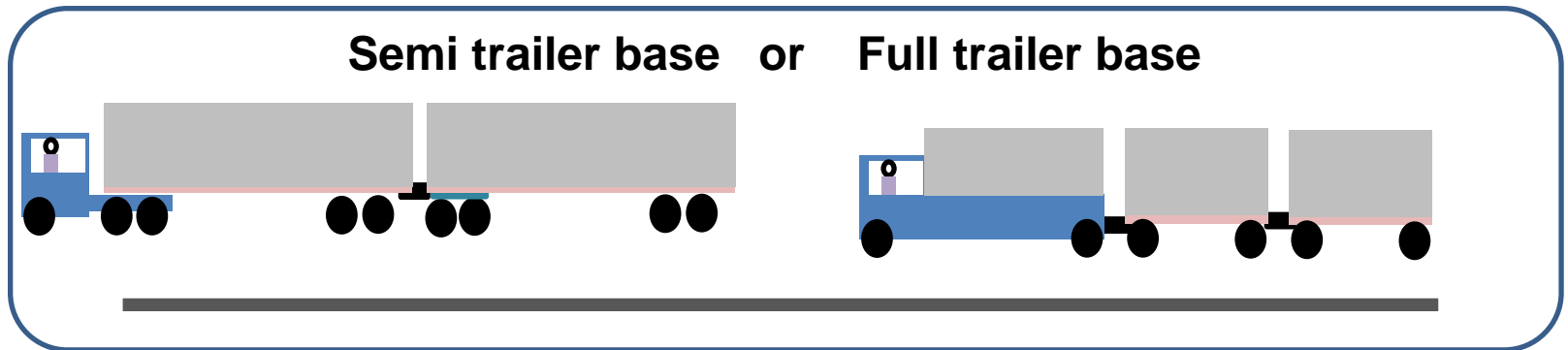
Asian Countries Truck Transportation Requirements



Industries require factory to factory transportation for inter-Asian countries, using corridors.



Road train: more efficient and flexible transportation



Disadvantages of Trailer Transportation



Do full trailers make traffic jams?

**Yes, sometimes they do.
Over taking is difficult.
Speed drops when going uphill.
etc.**



With a hybrid system the problem of speed dropping on slopes is smaller.

Advantages of Trailer Transportation



**Tri-deck motorcycle carrier
(effective transportation!)**



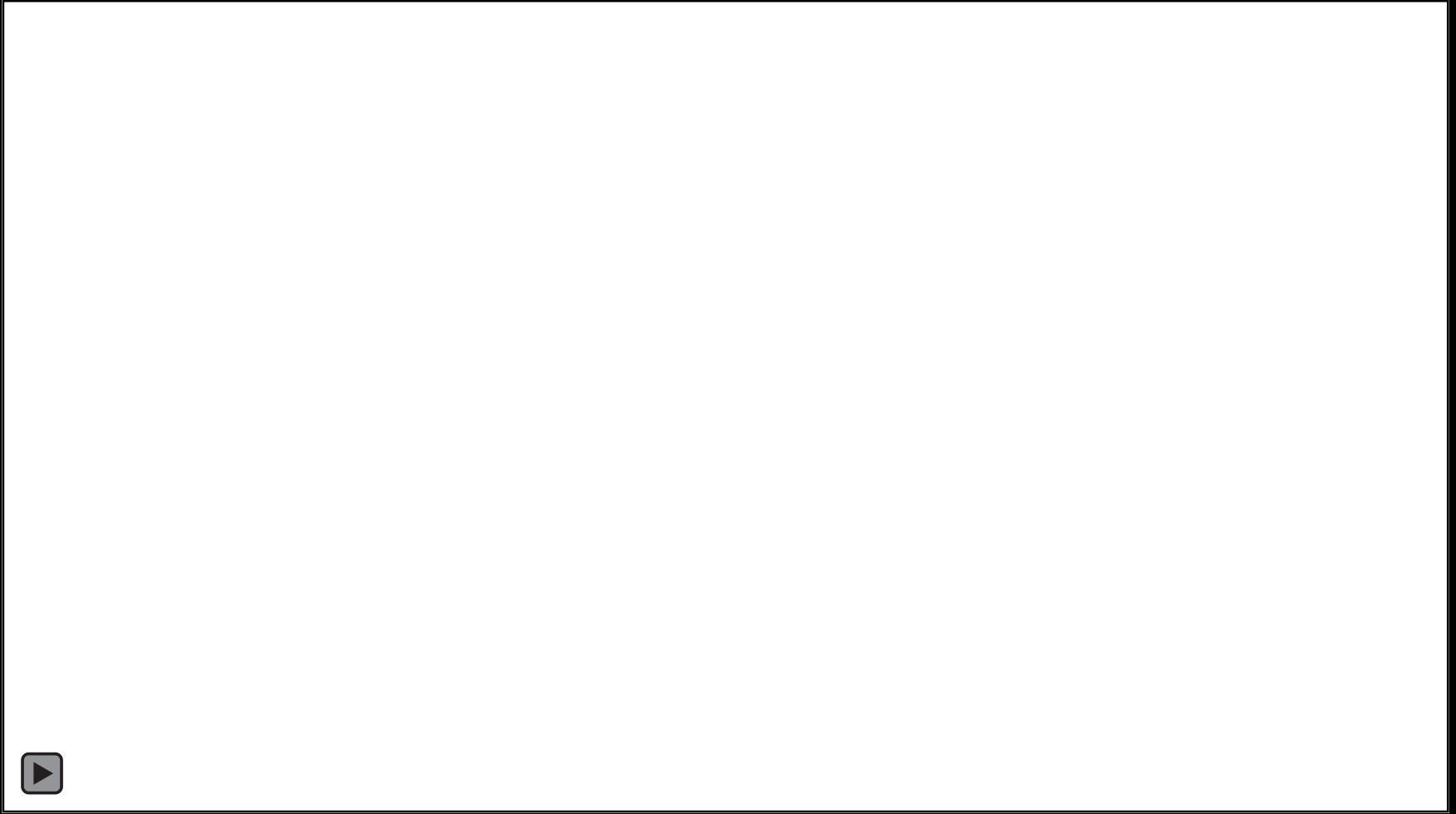
**Our hybrid system can use existing trucks plus a trailer
allowing for even more effective transportation.**

More Effective Trailer Transportation

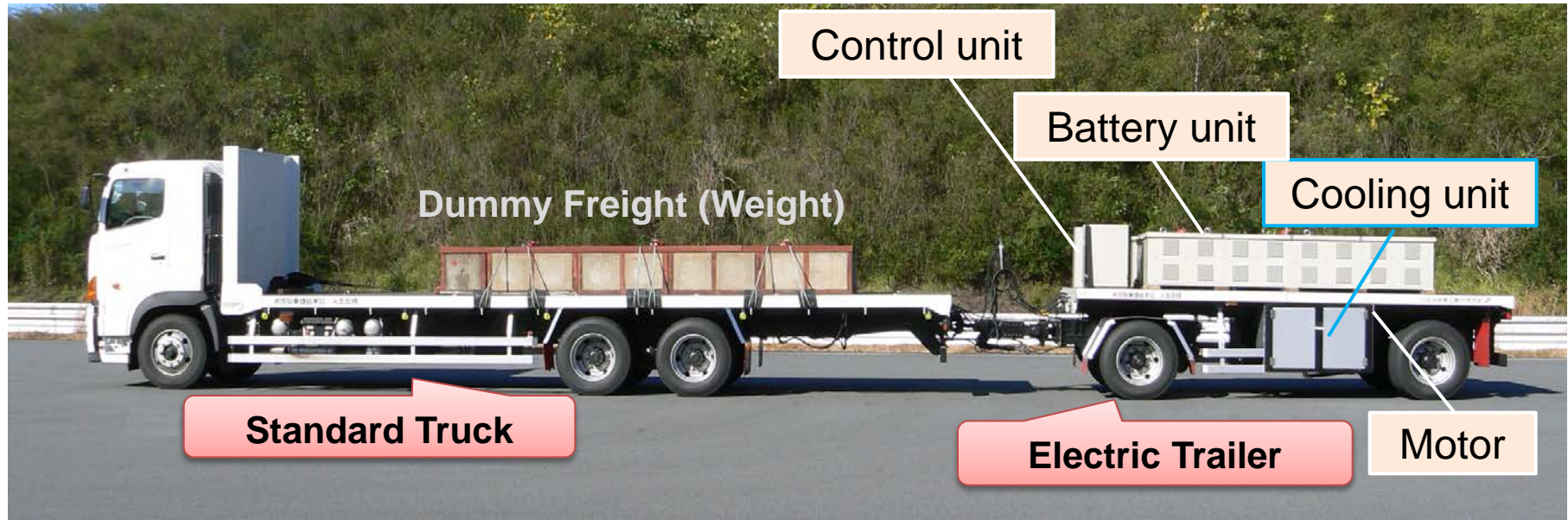


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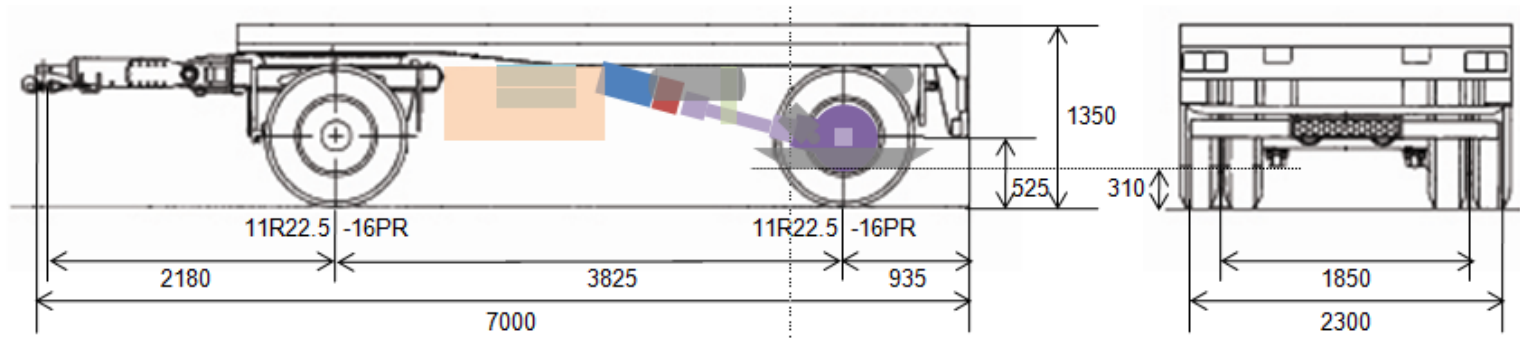




Concept Hybrid Full-trailer System



Rough layout of electric trailer for production



Merit of Hybrid Full Trailers

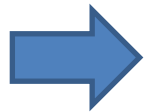
1. Improvement of transport efficiency

2. Fuel efficiency can be improved by:

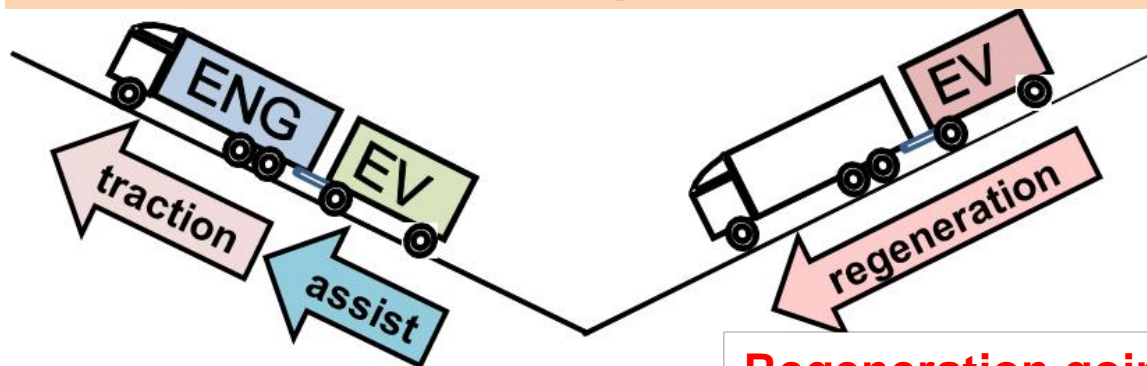
- Energy regeneration when braking and going downhill
- Decreasing of air drag force per unit carrying capacity
- Improvement of engine efficiency by increasing engine load on flat roads

3. Additional advantages

- Development is faster because a slightly modified standard truck can be used as a tractor head
- Eliminate the causes of traffic jams by improving drivability and reduce truck running frequency



Rationalization of transportation business

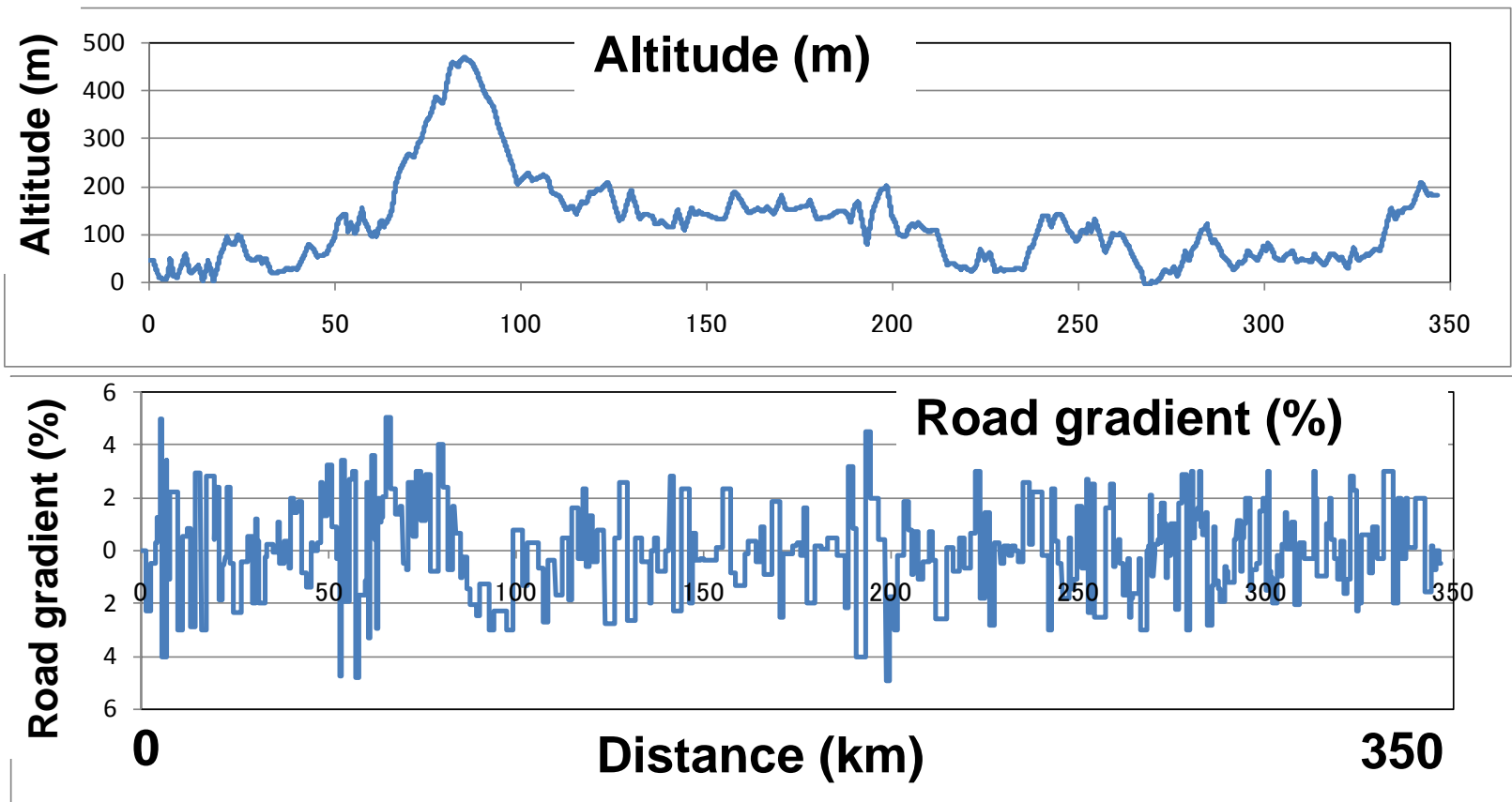


Each vehicle uses its own traction force
/ assist the traction force going uphill and acceleration

Regeneration going downhill and braking energy of the whole vehicle

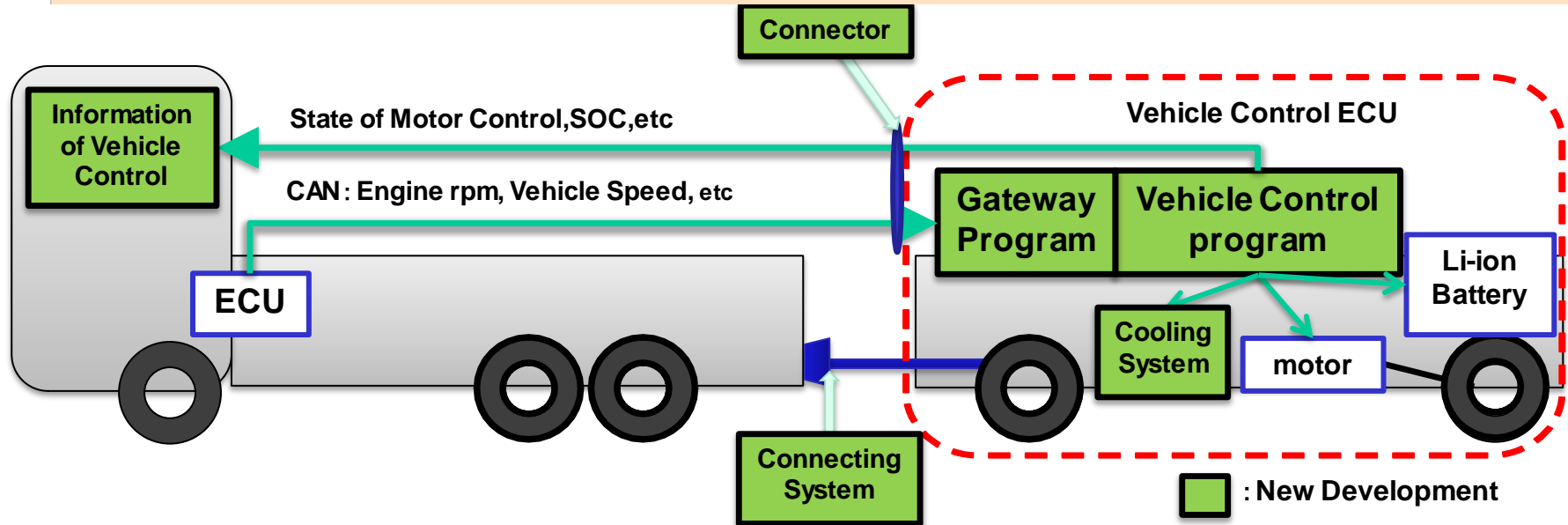
Road Conditions for Consideration of the Specifications

Calculate the motor power, battery power and battery state of charge under the actual altitude and road gradient conditions.



Specifications

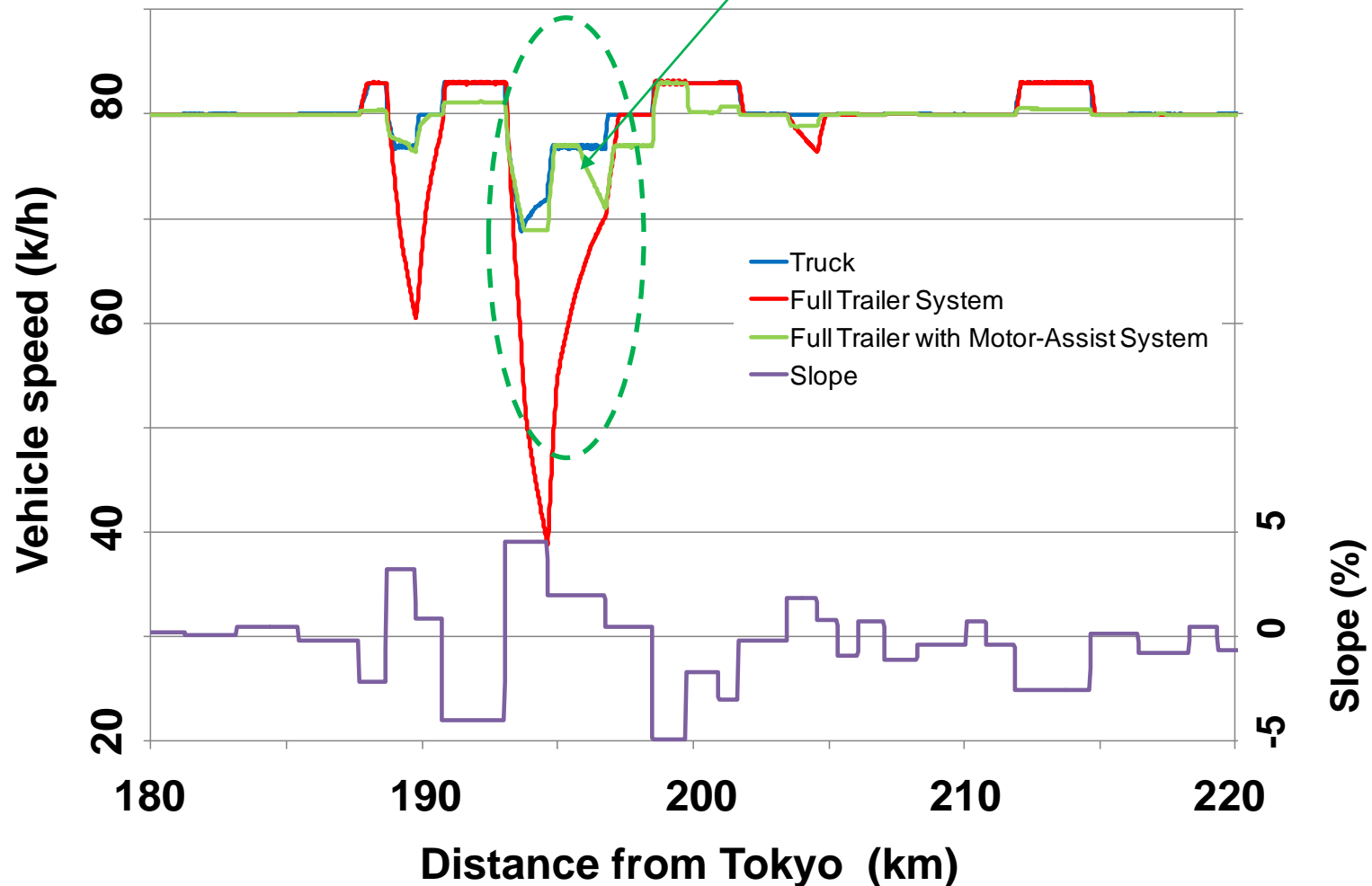
Motor power and battery capacity were decided through a matrix calculation. Fuel efficiency improvement and the battery state were considered.



	<i>Full Tractor</i>	<i>Full Trailer with Motor-Assist System</i>
<i>Overall Length [m]</i>	12	7
<i>Gross Vehicle Weight [t]</i>	25	19
<i>Drive Formula</i>	6x4	4x2
<i>Engine Power [kW]</i>	380	-
<i>Motor Power [kW]</i>	-	150
<i>Battery Rated Energy [kWh]</i>	—	36.3
<i>Connecting System</i>	<i>Drawbar type with hydraulic steering</i>	

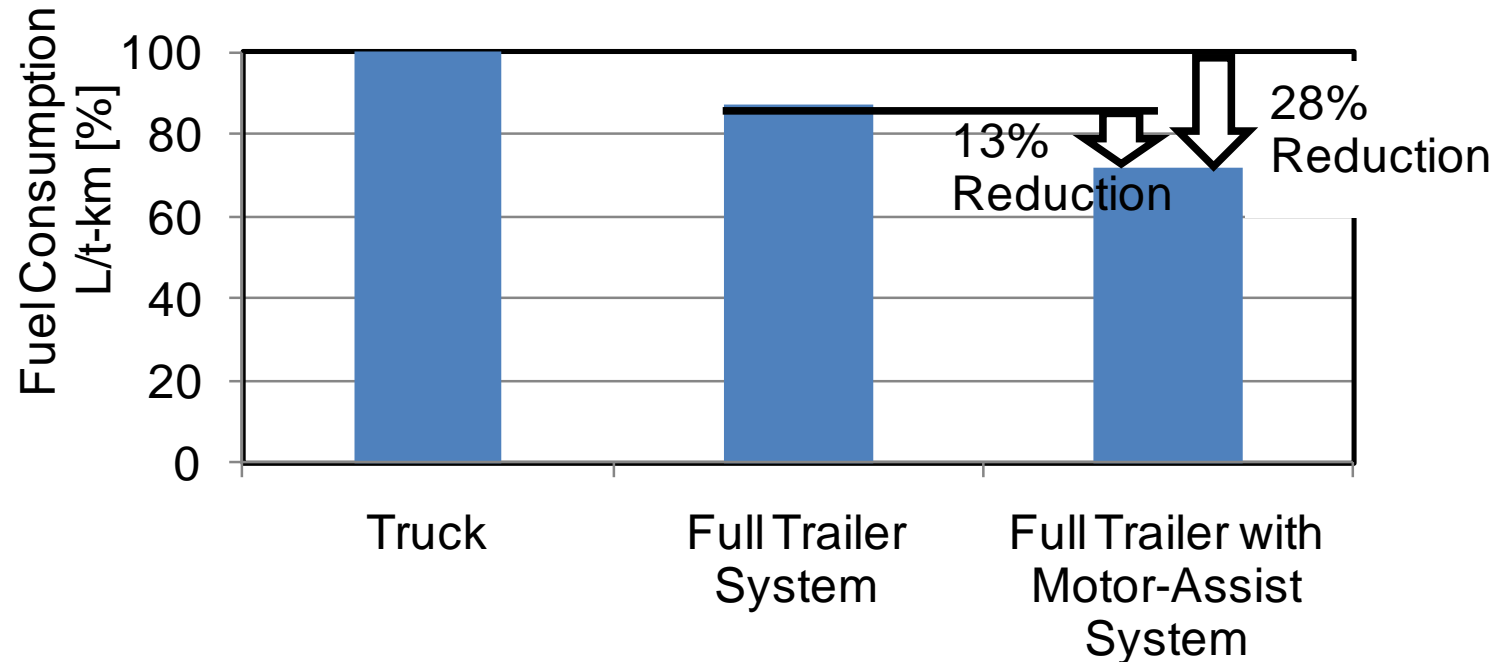
Driving Performance Improvement with the Motor-assist System

Vehicle speed of the Hybrid Full Trailer (Full Trailer with Motor-assist System) does not decrease even on steep slopes, about 5% gradient.



CO₂ Reduction from Fuel Consumption Improvement

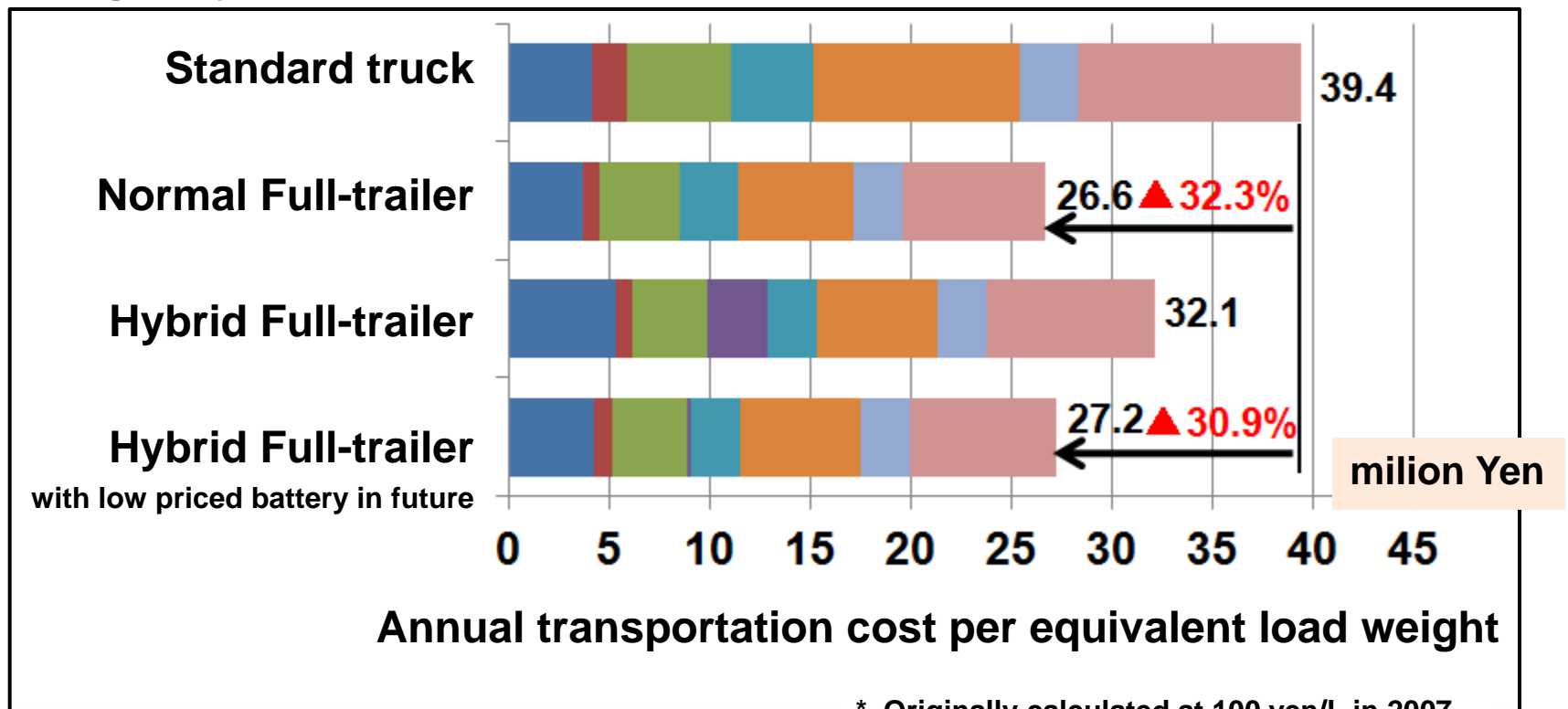
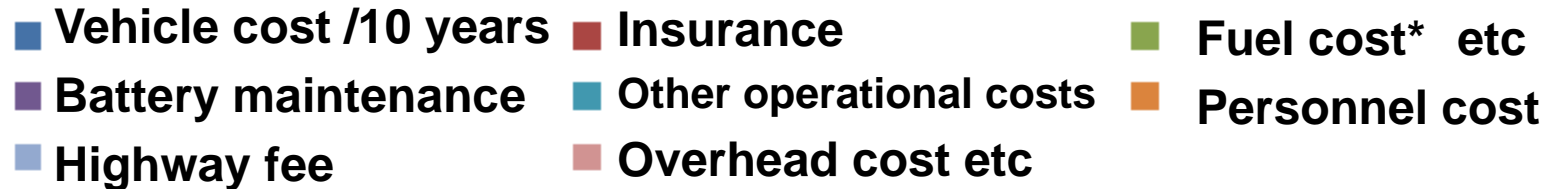
28% Less fuel consumption than standard truck
13% Less than full trailer



Further improvement can be obtained by control optimization.

Annual Transportation Cost Reduction

The cost will be practical if battery costs decrease in the future. It will be more cost effective than a normal full trailer, because of the recent situation of increasing diesel fuel price.



Future Possibilities

This control strategy of independently-regulated control for electric trailers can be used in other applications such as road trains, pickup truck trailers and camping trailers, etc.

However, we need to investigate safety issues such as over pushing from electric trailers.



Collaboration Possibilities

Let's start to investigate what merits this technology has when introduced in Asian countries along economic corridors.

If you agree and will join this project, we could start with a pre-study at JARI with the following items:

- 1) Road condition, altitude, road gradient, surface condition, etc.**
- 2) Logistics infrastructure conditions, such as third party logistics, etc.**
- 3) Hearing from transportation companies**
- 4) Technical investigation of suitable specifications and safety issues**

I hope we can create an international proposal of technical development and a demonstration project.

Contents and Summary

1. Background and Objectives

Good logistics infrastructure will be necessary for efficient industrialization along economic corridors

2. Concept of Road Train using Electric Trailers

Hybrid full trailer technology could be useful to improve logistics efficiency

3. Technical Explanation

JARI's hybrid full trailer technology could be useful to improve logistics efficiency along economic corridors in Asian countries

4. Future plans and Collaboration possibilities

Let's collaborate with a feasibility study to check if this system is effective or not.

Thank you for your attention.

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