Toward the Realization of Sustainable Mobility

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Toyota Motor Corporation

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What Mobility Has Given us

And What's Left

Achievements of Automobiles

Greater movement ability (persons, things)

Freedom and convenience: anytime, anywhere, to anyplace

Movable personal space

The development of mobility supports economic growth, as well as social and cultural expansion.

Challenges in Mobility

Environment & Energy

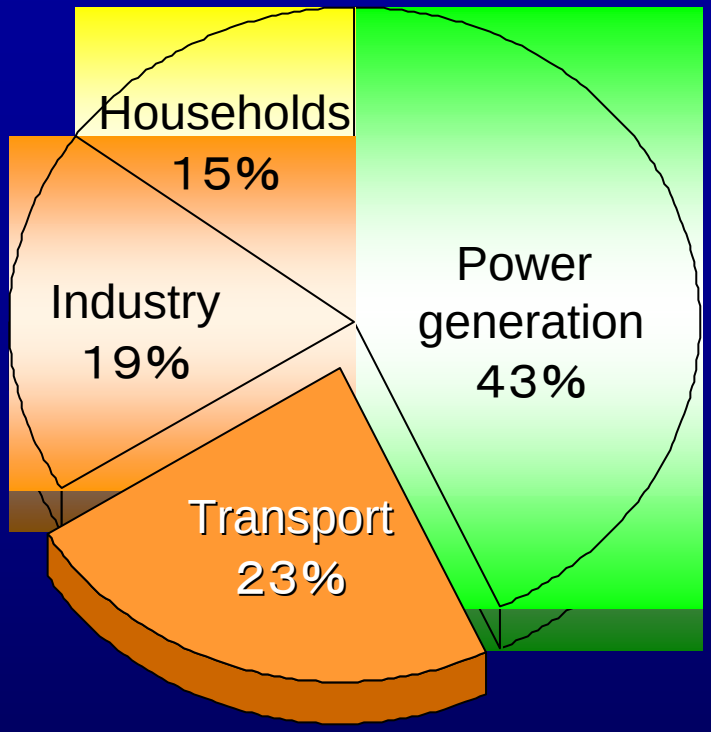
1. CO2 Emission
2. Oil depletion, need for alternative energy
3. Air pollution

Society

4. Traffic Accident
5. Traffic Congestion
6. Regional gap of mobility access

Environmental Energy Issue 1: CO2 Emission

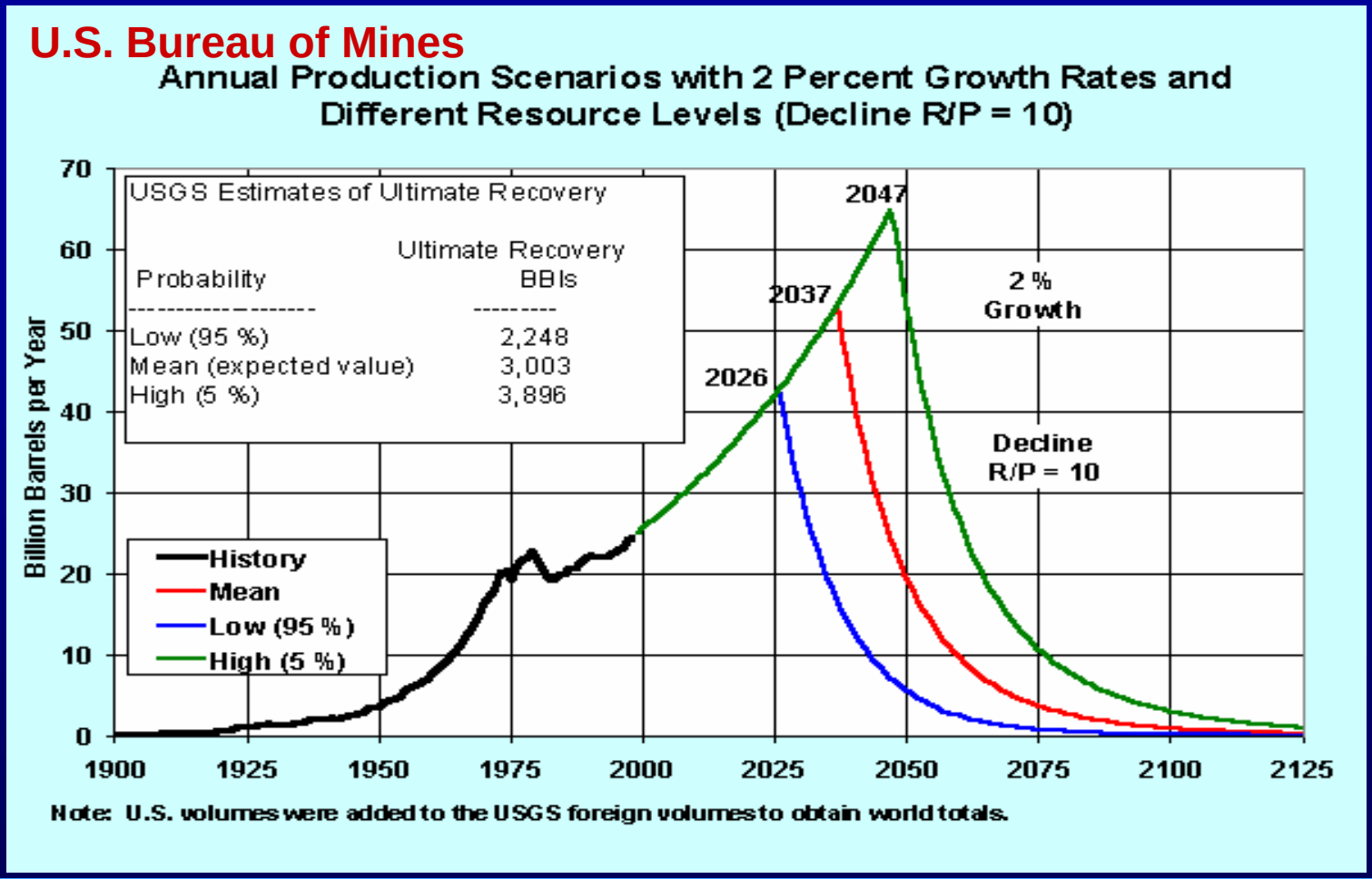
＜Global CO_2 Emission（by source, 2002）＞



Source：IEA/WEO 2004

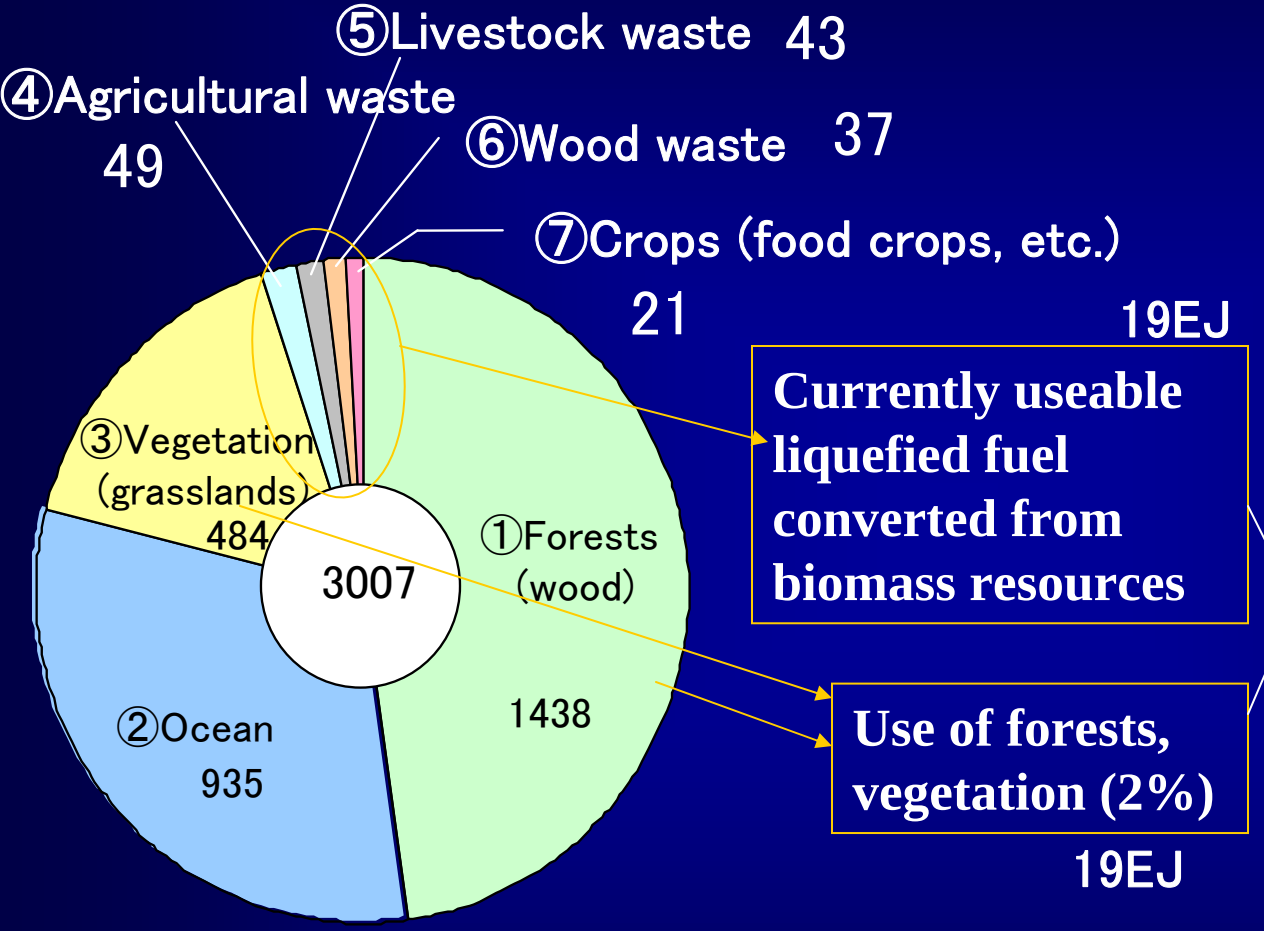
- Transport sector accounts for 23% of total emission
- Integrated approach is necessary in each sector

Environmental Energy Issue 2: Future of Petroleum



Extractable volume of crude oil may peak in 20 - 50 years.

Amount of Bio Resources



EJ=10^{18}J

19EJ

Currently useable liquefied fuel converted from biomass resources

Use of forests, vegetation (2%)

19EJ

38EJ ≪

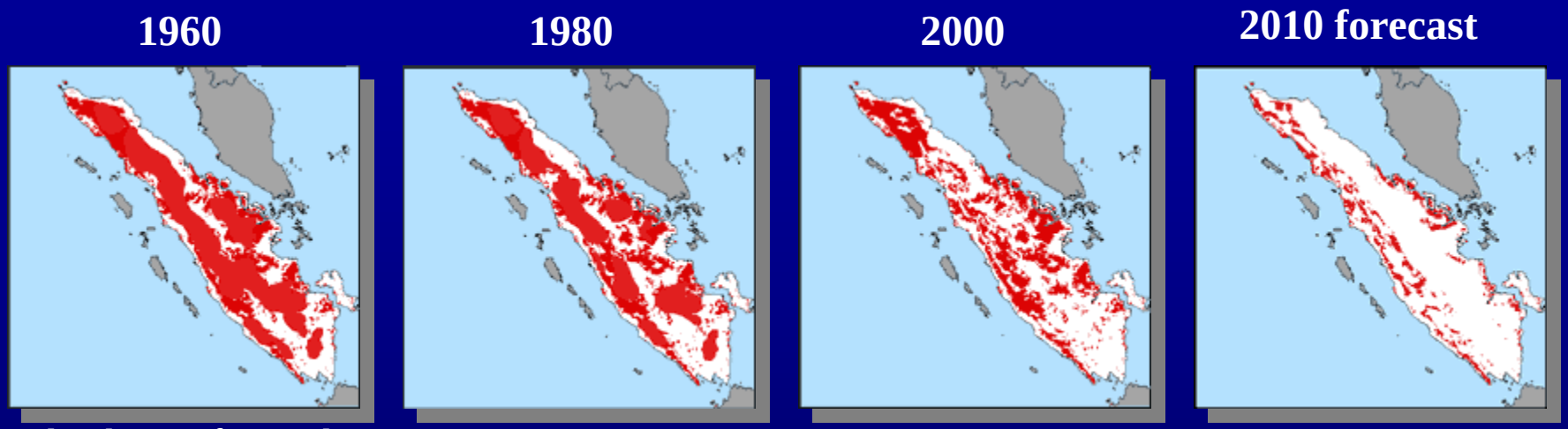
Energy consumed globally by automobiles (2002) 65EJ

2020

130～150EJ

Destruction of forest and impact on the ecosystem

Expansion of palm plantations on Sumatra

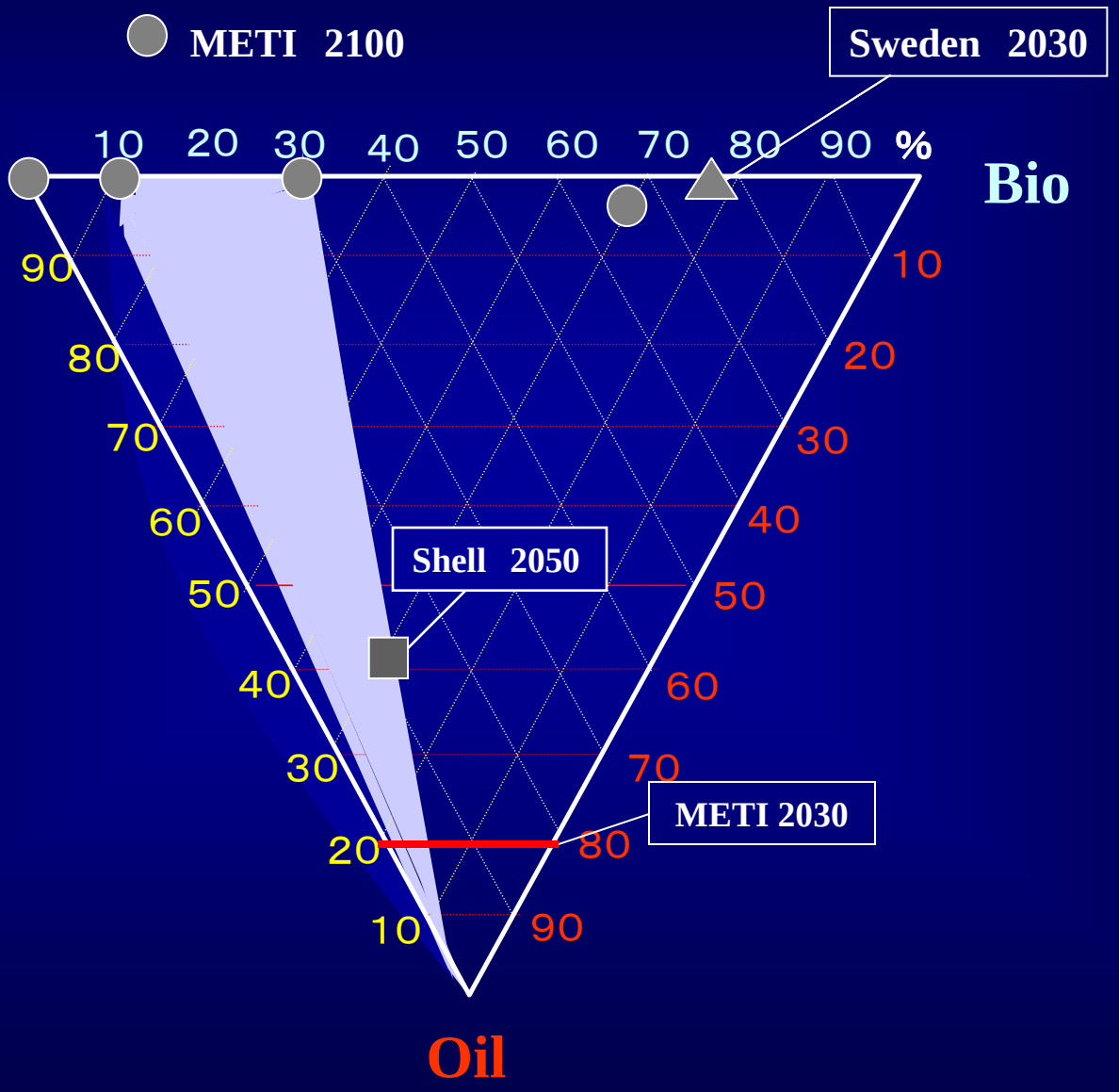


Red indicates forested areas

- Since 1980, deforestation in Indonesia and elsewhere is mainly as a result of plantations
- Due to forest development, various organisms native to the rainforest are facing extinction
- Plantation development is accompanied by illegal felling (increased illegal felling of inland forests)

If we seriously engage in bio-fuels as a business,
it will be vital to stop environmental destruction (regulations etc.)

Future Energy Sources for Automobiles



Source: Toyota Motor Corporation

Changes in Mobility

1. Shift to Hybrid (driven by electric power)

   Plug-in Hybrid

   Fuel Cell Hybrid

   Electric Vehicle

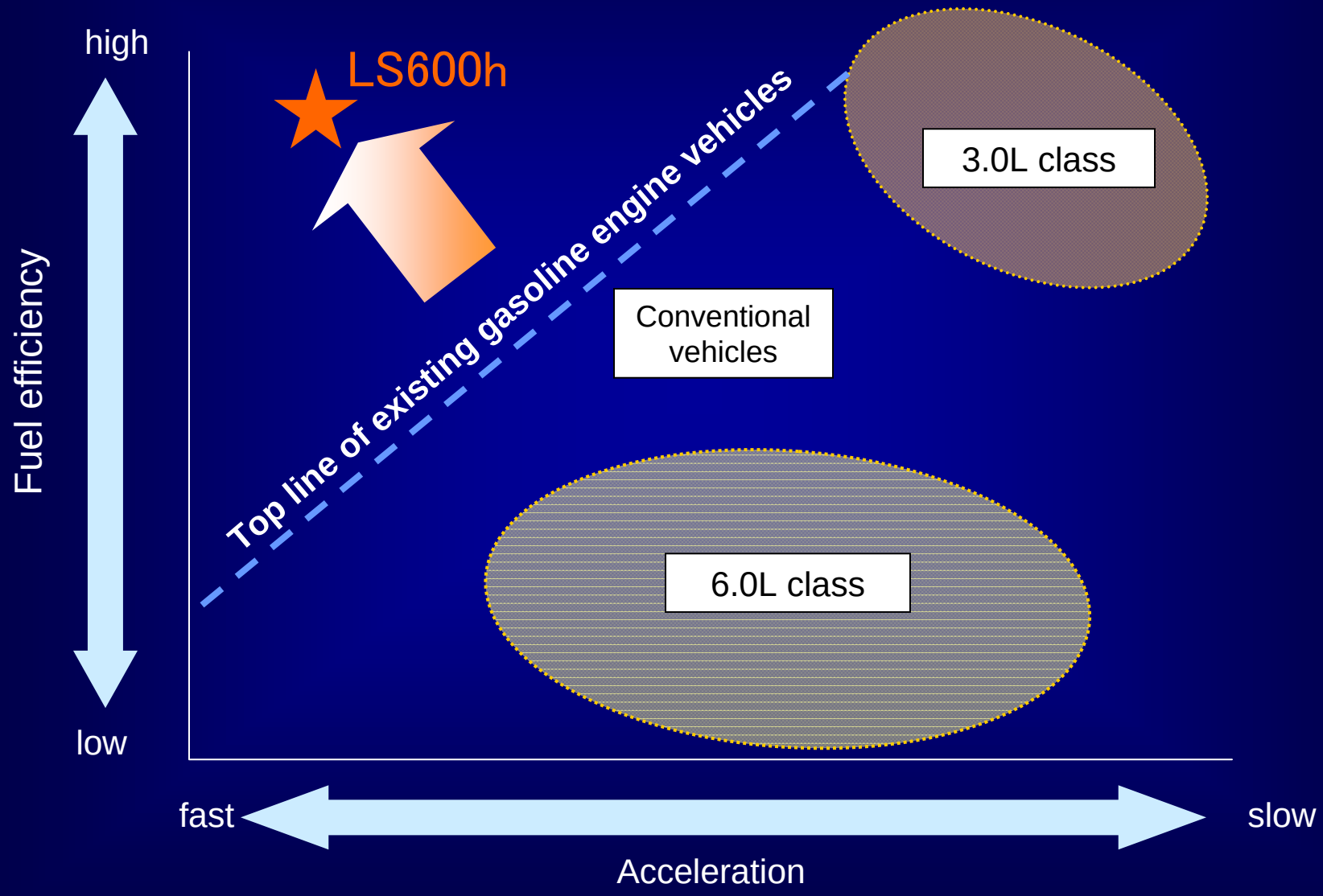
2. Shift to Ubiquitous World

3. Robotization

4. Shift to HMI (Human-Machine Interface)
   to connect human's hearts with machine

LS600h

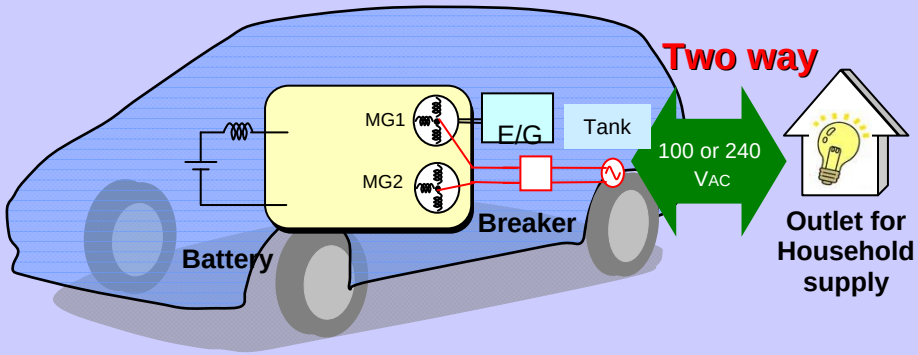
LS600h Fuel economy

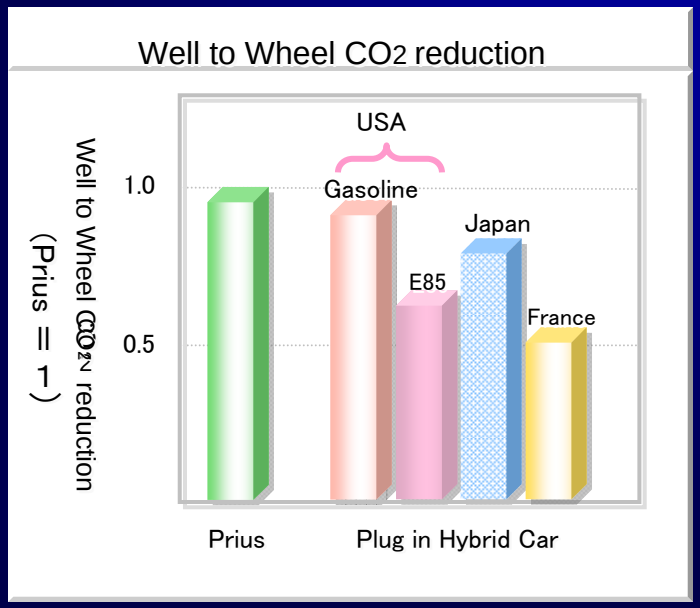


Note: Based on the internal measured figure of Toyota Motor Corporation

Plug In HV Systems (PHV)

Potential for diversification of energy sources (flex-fuels), fading out from fossil fuel dependence and reduction of CO_2



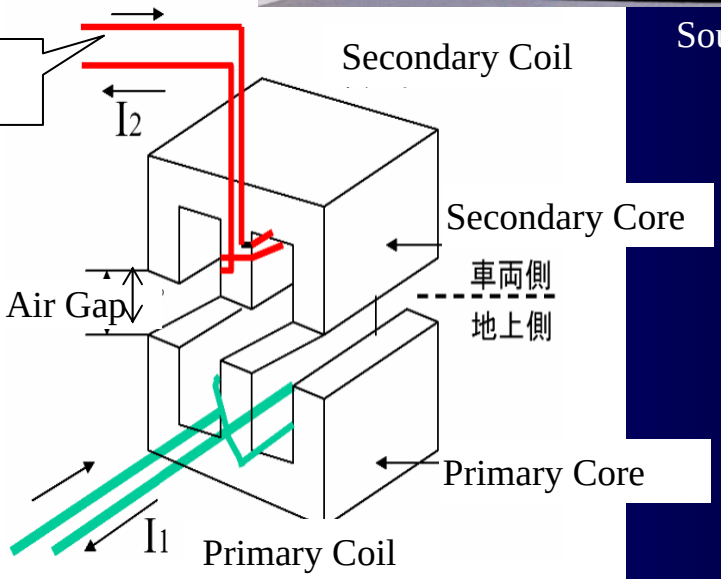


Inductive Charging System

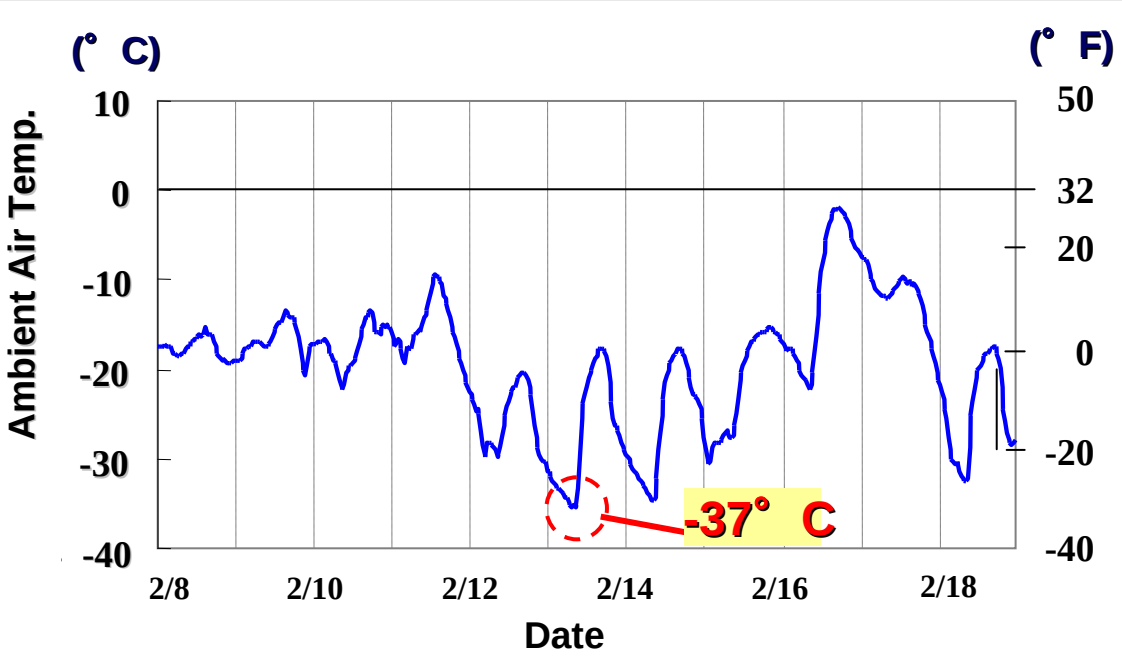
Source: Hino

◇Demonstration Project for Hybrid Truck & Bus
(Hino/Ministry of Transport)
(National Traffic Safety and Environmental Lab./Waseda Univ./NEDO etc.)

Controlling gap: 50mm



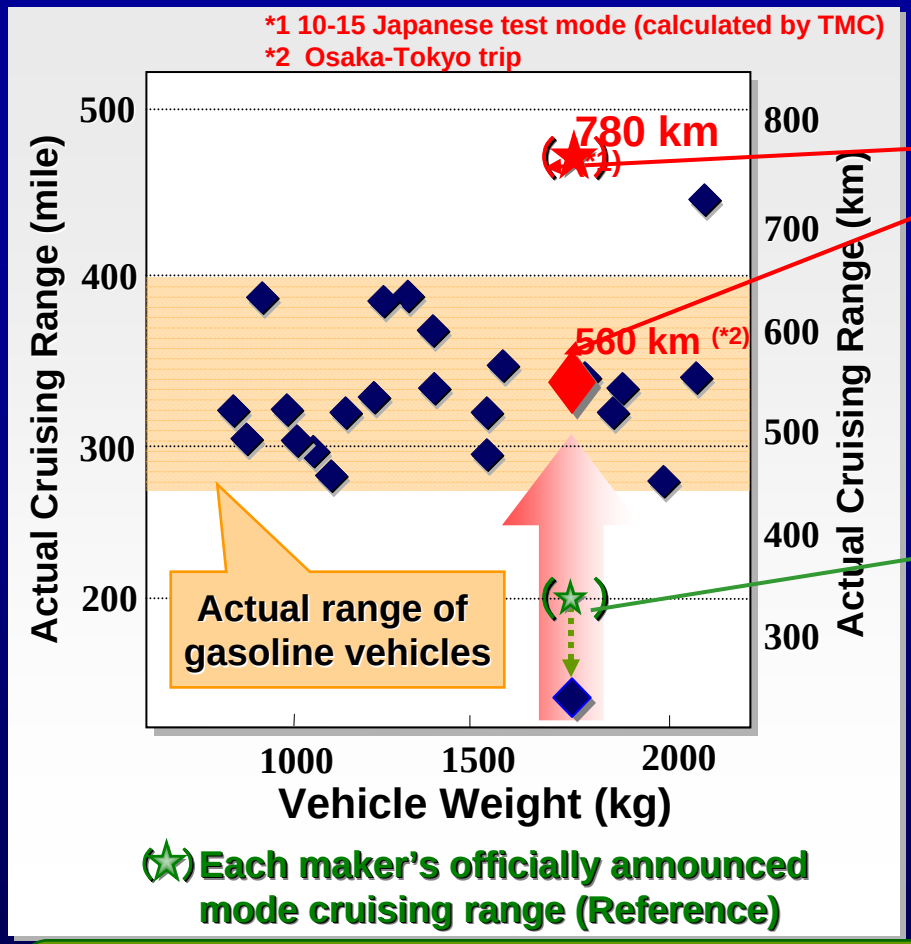
Freeze Start & Driving Performance Test of improved TOYOTA FCHV at Timmins, Canada



Ambient Air Temperature at Timmins

- TOYOTA performed freeze start and driving performance tests at Timmins, Canada. (Minimum temperature : -37° C)
- The driving performance immediately after start-up was the same level as conventional gasoline-powered vehicles.
- No major problem occurred in the FC unit.

Cruising Range of Each Car-maker's FCV



Improved TOYOTA FCHV

TOYOTA FCHV ('05)

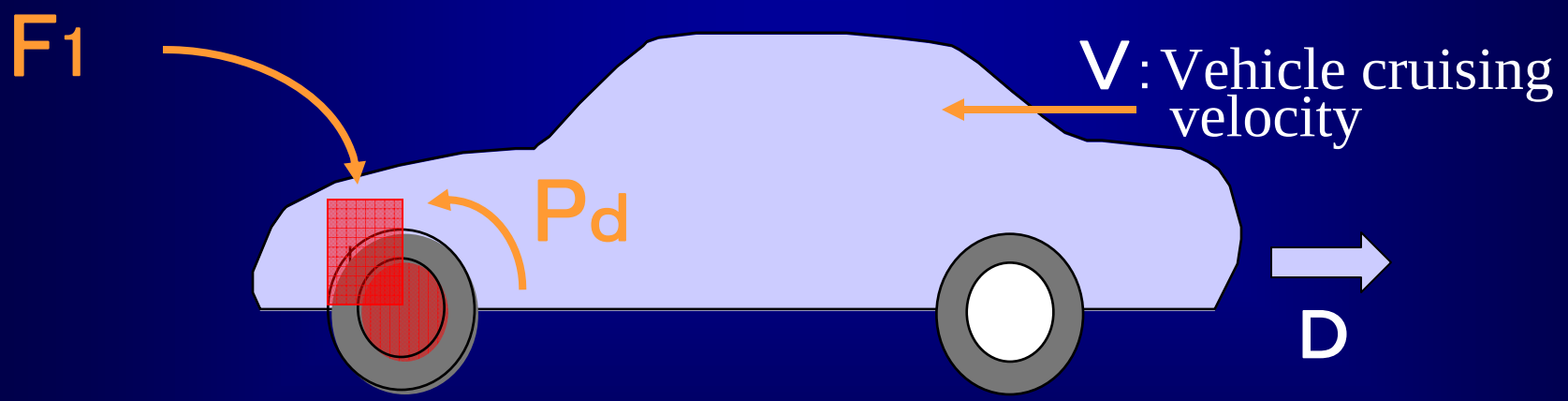
Actual cruising range of 500 km is required to be competitive with gasoline engine vehicles.
Improved TOYOTA FCHV, which is 25% more fuel efficient and can store app. 1.9 times the amount of hydrogen as the '05 model, successfully traveled between Osaka and Tokyo (560 km) without refueling.

Classic Theory of Automobile Efficiency

Power plant efficiency $\eta = \dfrac{P_d}{F_1}$ ……①

P_d : Driving power

F_1 : Input fuel energy flow



$P_d = D \cdot V$

$D = D$ (Driving resistance, acceleration force)

Mobility Performance Index

Mobility Performance Index $I_m = \dfrac{W_0 \cdot V}{F_0}$ ……②

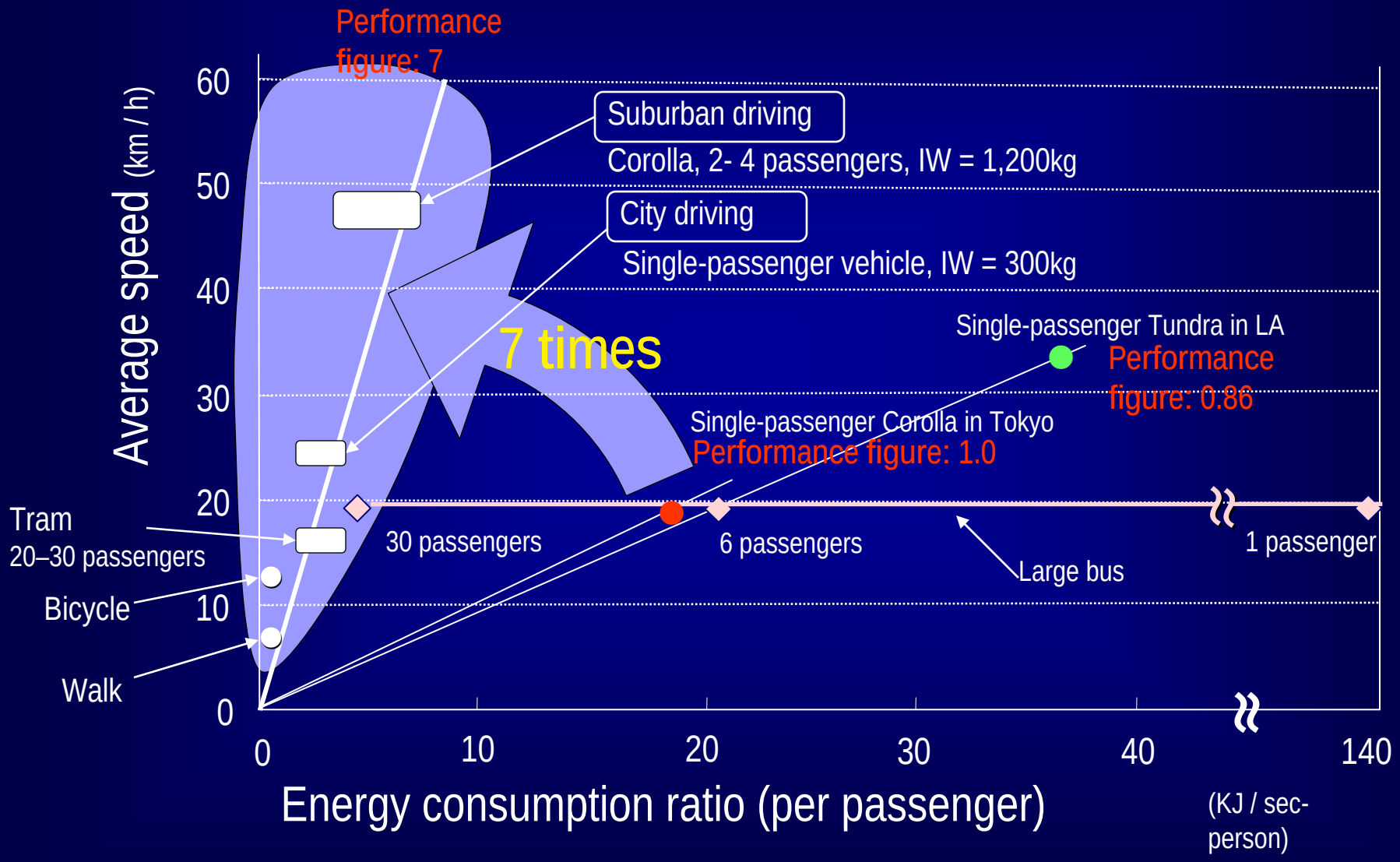
$W_0 \cdot V$: Mobility Effect

W_0 : Weight of object to be moved (Payload)

V : Vehicle cruising velocity

F_0 : Input primary energy flow
(Differentiated by time)

Mobility Performance: Improvement



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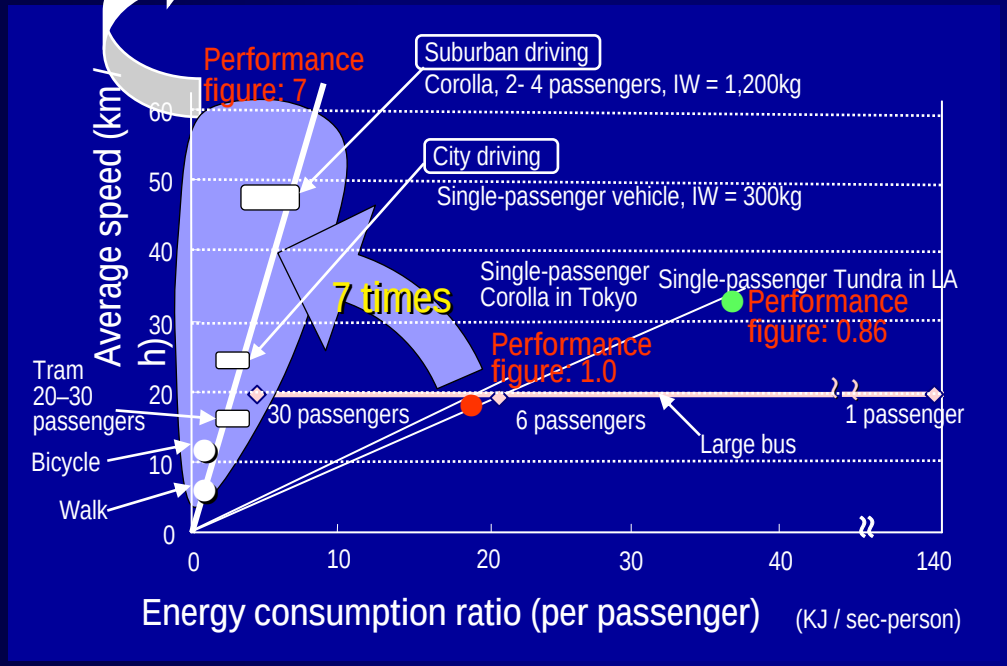
Mobility Performance: Realization

Optimal combination of diverse transport modes



Smooth traffic flow

Reduction of energy consumption

Ubiquitous Technology

- Automated parking

Combining urban transit innovation with urban development

- Upgrading the urban and road infrastructure
- Introduction of ITS
- Transportation demand management (TDM)

Innovation of Mobile Units and Energy Conversion

- Reducing size and weight, automated driving, and automated platoon operation
- Plug-in hybrid vehicles, electric vehicles, fuel-cell vehicles

Proposal

Cutting congestion and CO_2 emission by half
Reducing traffic fatality to zero

Goals :

Rebirth of urban traffic systems

without congestion, CO_2 emission and accidents

New generation logistic systems

for timely delivery at competitive cost

Actions :

Concurrent efforts from diverse perspectives

1) Effective deployment of transportation infrastructure
2) Active application of advanced IT and ITS technologies
3) Market penetration of new generation vehicles
4) Awareness and participation by citizens and industries
5) Strategic policy decision and its implementation

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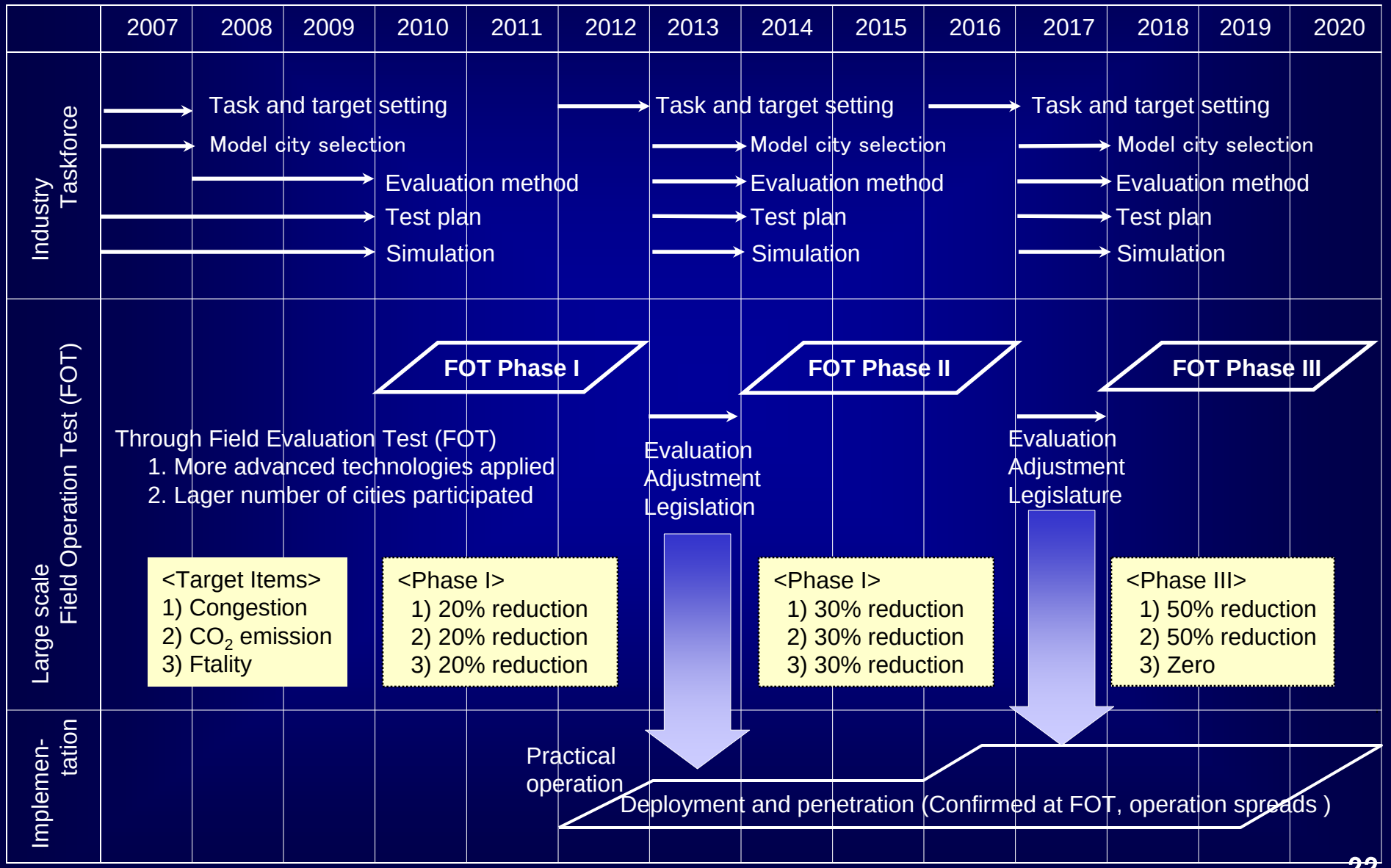
Transportation and Logistics Renaissance

Road Map



Project of Accelerating Reduction to the Society

Realizing Safe & Smooth Road Transport utilizing Information Technology

Plan: "The Project of Accelerating Reduction to the Society" aims to visualize for the citizen the outcome of large demonstration projects at a model city/line in a selected district, and to accelerate the application of successful practice on other areas. The special committee for new transportation & logistics in ITS Japan is taking initiatives in collaboration with industry, committed for realization with government.

Council on Competitiveness-Nippon
- –Make direction
- –Promote a plan

Proposal

Advice

Transport & Logistics Renaissance Project
- –Make a proposal
- –Launch the organization
- –Support promotion
- –Follow up outcome

General Science & Technology Conference
Project of accelerating reduction to the society

Road Transport System (ITS) Task Force

Policy-making, budget allocation, project promotion

Leader: Councilor Mr. Okumura

Member: Cabinet secretary, Police Agency
Ministry of Internal Affairs and Communication
Ministry of Economy, Trade, and Industry
Ministry of Land, Infrastructure, Transport and Tourism

Specialist: Intellectuals, ITS Japan

Academia

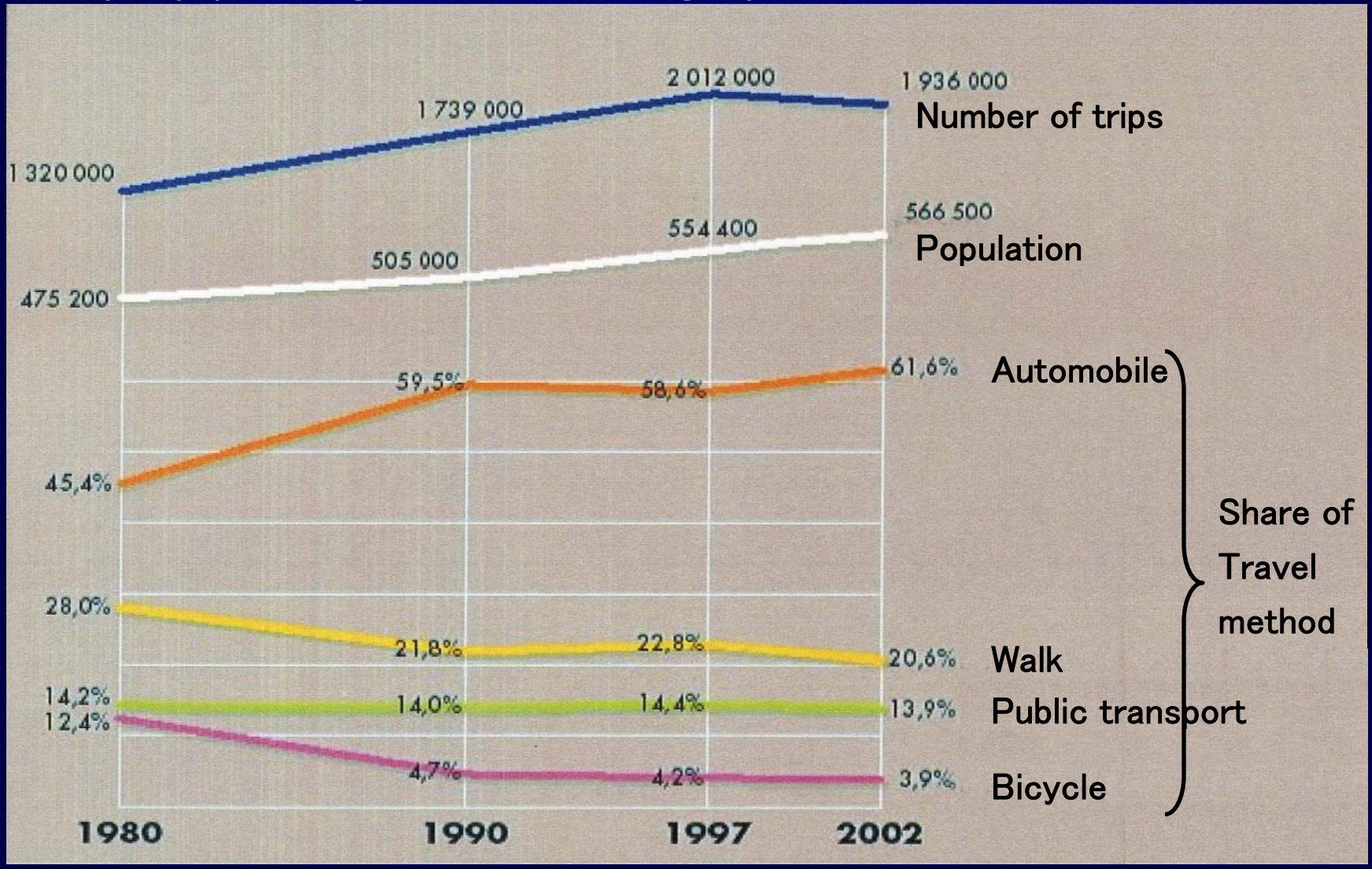
ITS Japan The special committee for new transport & logistics

Project proposal & promotion

Town revival WG	Advanced logistics WG
Auto manufacturers	Auto manufacturers
Electronic manufacturers	Electronic manufacturers
City developer	Transport company
Model city/local district	Highway company
etc.	Railway company etc.

Example）Nantes, France: Mobility Demand and Change of Travel Method

Traffic became smooth due to park & ride,
despite population growth and increasing dependence on automobile.




ACCÈS CŒUR D'AGGLOMÉRATION
RENNES ST. MALO
Porte de Rennes
AUTOROUTE (Périphérique nord)
BREST VANNES ST. NAZAIRE LA BAULE
Porte d'Orvault
ANGERS LE MANS PARIS
Porte de Gesvres
Orvault Grand Val
Le Cardo
René Cassin
Porte de La Chapelle
Morlière-Paquelais
Recteur Schmitt
La Beaujoire
Porte de La Beaujoire
Gare de Couëron
Porte de Sautron
Morlière
Petit Port Facultés
Porte de Chézine
Sillon de Bretagne
Port Boyer
Haluchère
Porte de Carquefou
BREST VANNES ST. NAZAIRE LA BAULE
Porte d'Armor
Plaisance
BOULEVARDS
Porte de Ste-Luce
François Mitterrand
Porte d'Atlantis
Frachon
ANGERS LE MANS PARIS
Gare de Basse-Indre
Porte de St-Herblain
Centre-ville Voir au verso
Porte d'Anjou
Porte de l'Estuaire
Place Foch
Gare
Commerce
LOIRE
Gare de Chantenay
PÉRIPHÉRIQUE OUEST
PÉRIPHÉRIQUE EST
Trentemoult-Roquios
Gare des Pas Enchantés
Trentemoult
Grénéraie
Chapeau Verni
Pirmil
Porte du Vignoble
Porte de Goulaine
POITIERS CHOLET
Neustrie
Pont-Rousseau
Bourdonnières
Porte de St. Sébastien
PORNIC NOIRMOUTIER
Porte de Bouguenais
8 Mai
Grande Ouche
Trocardière
Gare de Frêne Rond
Porte de Vertou
Gare de Vertou Nord
Porte de Grand-Lieu
Porte de Vertou
Gare de Vertou Sud
Gare de Bouaye
PÉRIPHÉRIQUE SUD
SÈVRE NANTAISE
Porte de Retz
Porte de Rezé
Porte des Sorinières
LA ROCHE / YON LA ROCHELLE NIORT BORDEAUX
LIGNE 1 FRANCOIS-MITTERRAND / COMMERCE / LA BEAUJOIRE
Du lundi au vendredi : 4h / 0h30 – Samedi : 4h / 2h30 – Dimanche 5h30 / 0h30
LIGNE 2 ORVAULT GRAND VAL / COMMERCE / NEUSTRIE
Du lundi au vendredi : 4h40 / 0h30 – Samedi : 4h20 / 2h30 – Dimanche 4h20 / 0h30
LIGNE 3 SILLON DE BRETAGNE / HÔTEL-DIEU
Du lundi au vendredi : 5h / 0h30 – Samedi : 5h / 2h30 – Dimanche 6h15 / 0h30
LIGNE 4 BUSWAY PLACE FOCH / PORTE DE VERTOU
Tous les jours de 5h à 0h30 – Le samedi jusqu'à 2h (Porte de Vertou) et 2h30 (Place Foch)

Integrated Safety Concept

Parking

Preventive safety

Pre-crash safety

Crash safety

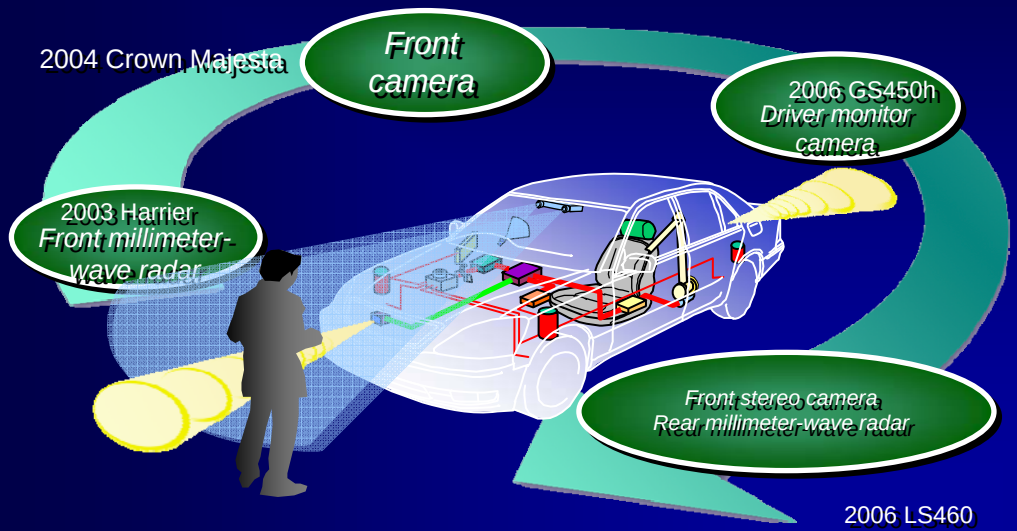
Rescue

“Coordination of safety systems”

“All driving stages”

Integrated Safety Concept

Automotive Evolution



Pedestrian also detected

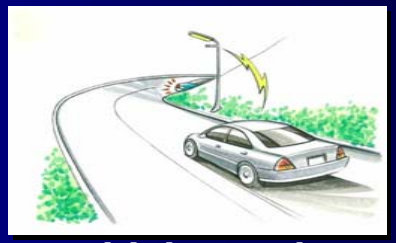
Pre-crash Safety System

Lane keeping Assist

Radar cruise control

VSC (Vehicle Stability Control)

Infrastructure-Coordinated Systems



Vehicle-road communication

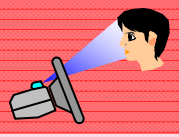
Vehicle-vehicle communication

Communication with pedestrians

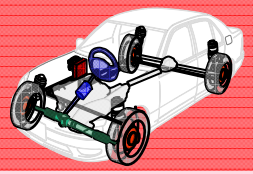
Automotive to “Robomotive”

Recognition

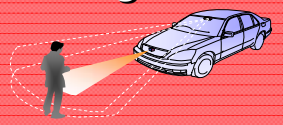
- Driver status (face direction, etc.)



- Vehicle behavior, etc.

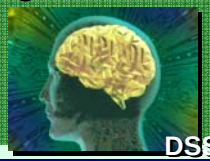


- External environment recognition



Decision

- DSS computer
  (Danger prediction: Optimal control according to extent of danger)



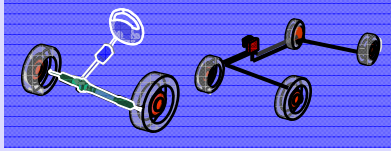
DSS: Driver Support System

- Integrated control system

Action

- HMI

- Vehicle control



- External communications

Robotization

- i-unit

- Toyota Partner Robot

Achieving Sustainable Mobility

Creating affluence for people, societies, and the world

- Expanding the scope of activities -

Heart and feelings technology

Communities

History, culture

Health

Diversifying values

Appeal, vitality

Aging society

People and lifestyles

Jidoka technology

Ubiquitous technology

Anytime, anywhere, to anyplace

Security, safety, comfort, freedom

Harmonizing

Coordination

- Connecting -

IT・ITS

RT

Technology for smoothing traffic flow

Urban spaces, infrastructure

Automated driving technology

Fusion

High speed, large volume, high efficiency

Automated platoon driving

Weight reduction technology

Plug-in HV

FCHV

EV

Diversification of mobility

Robots

Thank You for Your Attention.

i Q_CONCEPT

i - REAL