低炭素社会の交通
Transportation in Low Carbon Society
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1. Facts and trends in Japanese transport (日本の現状)
3. 2050 Transport Visions: Combination (2050交通ビジョン:組合せ)
4. Conclusion (まとめ)
Trend of GDP and CO₂ emissions by sector in Japan

CO₂ emissions had almost the same trend as GDP before the 1st oil crisis. Industrial sector: stay leveling out. Energy Industry, Commercial & Residential sector: level out, then increase recently. Transport sector: continued to increase, then began to decrease.

運輸部門排出量は1997年ごろまで伸び続けた
Share CO₂ emissions of transport sector

運輸部門は日本の排出量の約2割を占める。その大半が自動車からの排出。
Trend of car possessions

Number of passenger car possessions

Year-to-year growth of car possessions

New cars sold

保有

増減

販売

乗用車の保有台数はピークを迎ええた
Size of passenger cars has been getting larger and causes larger CO₂ emissions

Number of car possessions (Million)

- Light passenger cars
- Small passenger cars
- Regular size passenger

Average Fuel economy (1987-2005)

- Average fuel economy had been getting worse in 90’s

Tax system change 稅制改正:
- 1989 普通車優遇 物品税廃止
- 自動車税低減
- 2000 低燃費車優遇 自動車税低減

税制の影響が明らか
Contents

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2. 2020 Transport Scenarios: Technologies（2020交通シナリオ:技術）

3. 2050 Transport Visions: Combination（2050交通ビジョン:組合せ）

4. Conclusion（まとめ）
Overview of the project across time horizon

(1) Assessment of effectiveness of new technologies and their policy measures taking lead time into account

(2) Proposal of long-term emission reduction scenarios by back-casting

Forecast of technological efficiency (vehicle, fuel conversion)

Cohort analysis by fuel, size, infra for fuel supply, etc.

Regulation & Incentive

Forecasting

Kyoto protocol
Base year 1990
22.8% increase at 2001

Further emission control

Increasing vehicle size
Increasing ownership

Green tax
Research period

Tax reform

2000
2020
2050

Mid term goal
Long term goal

Lead time needed for

EST Vision, Scenario

Demand side management

Technological reduction

Emission to be reduced

BAU

Socio-economic impacts

Environmentally Sustainable Transport

(1) Assessment of effectiveness of new technologies and their policy measures taking lead time into account

(2) Proposal of long-term emission reduction scenarios by back-casting
Survey and assessment of automotive technology

The Well to Wheel approach to assess total efficiency

Survey of technical information

Vehicle element technology and fuel supply routes were considered in the assessment of automotive technology.
Automotive technologies altering engine–drive vehicles

Combination of fuel supply and power-train

Engine drive
- Gasoline / Diesel vehicles
- Fossil fuel supply
  - (CNG vehicles)
- Engine power generation
  - Reforming
  - Fuel tank
- Fuel cell
  - Hydrogen tank or
  - CNG station
- Charging station
- Hydrogen station
- Long charging time

Motor drive
- Electric vehicles
- Motor
- Electric power
- Battery
  - Long charging time

Combination
- Parallel hybrid vehicles
- Series hybrid vehicles
- Plug-in hybrid vehicles

Plug-in hybrid vehicles
- Drive wheel
- Electric power

Automotive technologies altering engine–drive vehicles

Construction of energy stations are required
Paths from primary energy to automotive energy

- On-site water electrolysis
- Hydrogen (H2)
- Liquid fuel (traditional fuel, synfuel)
- Gas (consumer)
- Petroleum station
- CNG station
- Hydrogen station
- Charging station
- Construction of energy stations are required
- On-site reformer
- Water electrolysis
- CNG
- Electricity
- Power generation
- Renewable energy
- Biomass
- Fossil fuel
- Nuclear power

多様なパスがありうる
Well to wheel CO$_2$ emissions

- Although CO$_2$ emissions from FCEV are less than HV, FCEV has got problems to be solved such as FC durability, FCEV cost and the way to produce and supply hydrogen. Therefore, wide spread of HVs is thought to be one of the feasible and effective measures in 2020.
Scenario: Penetration of Hybrid Electric Vehicles (HEV)

HEV production capacity

The duplication of production capacity is required every year from 2005 to 2010.

HEV: ±0%

Baseline scenario

CO₂ emissions (Mt-CO₂)

HEV scenario

CO₂ emissions (Mt-CO₂)

(初期版) ハイブリッド車の大量普及で2020年+19%を±0%に
Revised Scenario: Penetration of Hybrid Electric Vehicles (HEV)

The 20% increase of production capacity for Japan is required every year from 2006 to 2020.

Toyota HEV world production

20(2005) → 100(-2015)

Baseline scenario

HeV scenario

HEV production capacity

ten-thousand vehicles/year

(改訂版) ハイブリッド車の大量普及で2020年+8%を-3%に
# Outline of 2020 scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Baseline</th>
<th>HEV</th>
<th>+Demand Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration of HEVs and BEVs</td>
<td>Pass. Car (PC) HEVs 20% Low duty vehicle (LDV) HEVs 10%</td>
<td>PC- HEVs 37%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LDV-HEVs 20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light PC-BEVs 37%</td>
<td></td>
</tr>
<tr>
<td>Fuel consumption of HEVs</td>
<td>40% reduction compared with the current fuel consumption of gasoline / diesel vehicles. LDV-HEV reduce 20% of fuel consumption of current LDV’s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement of fuel consumption (to 2002)</td>
<td>PCs, buses, LDVs reduce 10% of fuel.</td>
<td>PCs 20%, Buses 10%, Mini car 10%, Heavy duty vehicles 5%, LDVs 15%</td>
<td></td>
</tr>
<tr>
<td>Traffic volume (to 2002)</td>
<td>3% decrease of PCs</td>
<td>PCs -13%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7% decrease of freight vehicles (FVs)</td>
<td>FVs -16%</td>
<td></td>
</tr>
<tr>
<td>Air, rail, marine transport</td>
<td>5% reduction of fuel consumption of air, rail and marine transport. Air transportation increase by 20% compared with current volume.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂ emissions (compared to 1990)</td>
<td>+8%</td>
<td>-3%</td>
<td>-10%</td>
</tr>
</tbody>
</table>
Contents

1. Facts and trends in Japanese transport (日本の現状)


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4. Conclusion (まとめ)
Combination of countermeasures which reduce 20% each could cause over 70% reduction as total

Demand management  
*example by information-communication technology [transport-service per capita]*

Modal shift to reduce CO₂ EF per passenger-km or ton-km

Improve accessibility [passenger-km or ton-km per transport-service]

Improve load factor [vehicle-km per Pkm(Tkm)]

Improve load factor [vehicle-km per Pkm(Tkm)]

Improve fuel economy [Fuel consumption per vehicle-km]

Introduce low carbon energy [CO₂ emission factor per fuel consumption]
Estimated regional automotive CO$_2$ emissions

Each Area is categorized in:
1. Major cities
2. Cities with a pop of 0.5 million and above
3. Cities with a pop of 0.3 and above
4. Cities with a pop of 0.1 and above
5. Cities with a pop less than 0.1 million
6. Counties

都市部の一人当たり排出量は半分
Regional categories

Accumulated population [ten-thousand]

Transport CO₂ [t/capita/year]

Technological & behavioural countermeasures
Depopulation & shift from rural to urban

Index of the regional categories
- Rural
- Metro
- Provincial
- Urban

地域別の対策と人口減少パターン
CO₂ emissions of each vehicle category by trip length ranges

Ranges of trip length

(Estimated from Road Census 1999)
Effects of population density on life cycle CO$_2$ of various transit system

DIDではLRTが有効
TOD (Transit Oriented Development) in local city

- Lack of public transport for cities of less population than one millions.
- It has been difficult to manage LRT because “self-supporting accounting system” was required.
- Upgrading from traditional tram has started.

Toyama Light Rail (2006.4.26-)

地方中核都市等の都市計画と公共インフラ整備が重要
New concepts for personal mobility

Toyota i-REAL

the Segway Human Transporter

Kawamura cycle KE  Yamato transport/ Electric bicycle with a cart

電池搭載は小型近距離に適性

(catalog information)
Image of low carbon transport area

- Intensive land use
- Networking of proper modes on each areas
- Enhance public transport and walking

TransServ

\[ \frac{Pkm(Tkm)}{TransServ} \]

\[ \frac{\sum m}{\\text{mode}} \]

\[ \frac{Vkm}{Pkm(Tkm)} \]

Fuel

\[ \frac{Vkm}{Vkm} \]

Central area for pedestrians

Daily living area

Residential area along LRT lines

P&R

Shared taxi

Car-sharing

Bicycle

LRT

Ring road

Mini EV

Personal mobility

Agricultural community

Farm, green

Farm, green

Image of low carbon transport area
導入可能でCO₂排出が最小となる幹線輸送機関の分布

2050年は、2000年に対する人口減少率がDID地区と非DID人口地区で同じとした場合

路線維持不可能かつ既存路線がない所では自動車がCO₂排出が一番小さい。
このような地域が2050年には全国に広がる。

DID人口密度を維持・上昇させる土地利用施策や交通事業者への補助金投入（道路特定財源の見直し？）等の地域に応じた施策パッケージが必要

自動車依存脱却施策パッケージ
職住近接都市構築施策パッケージ
公共交通志向維持・強化施策パッケージ

地域に応じた施策パッケージでCO₂削減
## 2050 Vision: Passenger transport

<table>
<thead>
<tr>
<th>Compact neighborhood</th>
<th>Metro Urban</th>
<th>Metro Suburb</th>
<th>Provincial Urban</th>
<th>Provincial Rural</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>△ Rehabilitation</td>
<td>○ Rehabilitation</td>
<td>△ Rehabilitation</td>
<td>○ Compact Settlement</td>
<td>112→33Mt</td>
<td></td>
</tr>
<tr>
<td>△ Compact settlement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compact city</th>
<th>Δ City center renewal</th>
<th>△ Withdrawal</th>
<th>Δ City center renewal</th>
<th>×</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Enhance public transit</th>
<th>Δ Pricing</th>
<th>△ Park &amp; Ride etc.</th>
<th>○ LRT</th>
<th>Δ van pool, shared taxi</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Improve load efficiency</th>
<th>Δ Utilize small vehicles</th>
<th>△ Enhance sharing</th>
<th>×</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Improve fuel consumption</th>
<th>○ Urban mode</th>
<th>○ local mode</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Low carbon energy</th>
<th>△ less room for improve</th>
<th>○ biofuel, Low Carbon Electricity for EV and PHEV etc.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>pop(million)</th>
<th>46→40</th>
<th>15→12</th>
<th>27→20</th>
<th>35→23</th>
<th>124→94</th>
</tr>
</thead>
</table>

| t-CO₂/capita             | 0.66→0.27                | 0.94→0.35                | 1.03→0.38                | 1.11→0.51                | 0.90→0.35                |

2050年の70%削減に向けたビジョンの例
## 2050 Vision: Freight and inter-city passenger transport

<table>
<thead>
<tr>
<th>Supply Chain Management</th>
<th>Inter-local Freight: 300km⁻</th>
<th>Inter-city Freight: 30–300km</th>
<th>Inner-city Freight: −30km</th>
<th>(Inter-city Passenger: 30km⁻)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ SCM</td>
<td></td>
<td>△ SCM</td>
<td></td>
<td></td>
<td>106→32Mt</td>
</tr>
<tr>
<td>Compact city</td>
<td></td>
<td>○ Short route</td>
<td>△~× Enhance modal shift</td>
<td></td>
<td>To 1990</td>
</tr>
<tr>
<td>Enhance public transit</td>
<td>○ Marine transport, Rail</td>
<td>△ Rail</td>
<td>△ Hand cart</td>
<td>© Rail, Expressway bus</td>
<td>Excluding</td>
</tr>
<tr>
<td>Improve load efficiency</td>
<td>△ Low delivery frequency</td>
<td>△ Cooperative delivery</td>
<td>○ Cooperative delivery</td>
<td>○ Car pooling</td>
<td>(Inter-city Passenger: 30km⁻)</td>
</tr>
<tr>
<td>Improve fuel consumption</td>
<td>○ ITS, Fuel-efficient truck</td>
<td>© ITS, Fuel-efficient truck</td>
<td>○ ITS, Fuel-efficient truck</td>
<td>© ITS, Fuel-efficient car</td>
<td>Index:</td>
</tr>
<tr>
<td>Low carbon energy</td>
<td>△ biofuel</td>
<td></td>
<td></td>
<td>○ biofuel, PHEV etc.</td>
<td>◎: - 30%</td>
</tr>
</tbody>
</table>

| Mt-CO₂                  | 33→10                        | 49→15                        | 24→7                       | (35→10)                       |

2050年の70%削減に向けたビジョンの例
Uncertain issues for 2050 Vision

- Globalization / Regionalism
- Demography: aging society
- Immigration / Emigration
- Spatial distribution of population
- Leading industries
- Busier life driven by IT vs. slow life
- Demand for high speed travel
- Trip frequency and length for leisure
- Price of fossil fuels (especially oil)
- The way to produce and supply hydrogen
- Public perceptions for nuclear technology
- Price of FCEVs
- Preferences on vehicle-size
- Investment balance between road and public transport
Total expenses for gasoline per person was stable at 30-40 thousand yen from 1975 to 1999. Cheap price have cause large increase of car-usage in 90’s. Higher gasoline price may cause large decrease of gasoline consumption in next decade.

中長期的にはガソリン価格の変化に対する反応が大きく出る可能性がある
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4. Conclusion (まとめ)
### 2050Vision: Policy recommendations

<table>
<thead>
<tr>
<th>Policy Area</th>
<th>Metro Urban</th>
<th>Metro Suburb</th>
<th>Provincial Urban</th>
<th>Provincial Rural</th>
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<td>Compact city</td>
<td>△ City center renewal</td>
<td>△ Without renewal</td>
<td>△ City center renewal</td>
<td>×</td>
<td>To 1990</td>
</tr>
<tr>
<td>Enhance public transit</td>
<td>△ Pricing</td>
<td>△ Without pricing</td>
<td>△ Park &amp; ride etc.</td>
<td>○ LRT</td>
<td>△ City center renewal</td>
</tr>
<tr>
<td>Improve load efficiency</td>
<td>△ Utilize small vehicles</td>
<td>△ Enhance sharing</td>
<td>△ Public transit</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Improve fuel consumption</td>
<td>△ Urban mode</td>
<td>△ Local mode</td>
<td>○ Urban mode</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Low carbon energy</td>
<td>△ More room for improvement</td>
<td>△ Local mode for improvement</td>
<td>△ Biofuel, Low Carbon Electricity for EV</td>
<td>×</td>
<td></td>
</tr>
</tbody>
</table>

Index:
- ◎: - 30%
- ○: - 20%
- △: - 10%
- ×: no room

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Urban</th>
<th>Suburb</th>
<th>Urban</th>
<th>Rural</th>
<th>Total</th>
</tr>
</thead>
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<tr>
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</tr>
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2050年70%削減ビジョン達成に向けた政策の例
Conclusion

• Opportunities for low-carbon transport:
  – Penetrating HEV for 2020
  – Combination of various countermeasures for 2050
• Best practice examples
  – More hybrid on the market
  – Increasing support for public transit (e.g. LRT)
• Linkages with other policy goals
  – Sound public finance in depopulating society
  – Accessibility for transportation poor in rural areas
• Policy recommendations
  – Preferential tax treatments
  – Regional plan of land-use and transport

ハイブリッド自動車を生かしつつ公共交通と軽量なパーソナルモビリティの組合せへ
人口減少等への対応とあわせて、低炭素化に向けた計画と税制誘導による推進が重要