Fuel Economy Trends in IEA Countries: Lessons and Lemons in the Race to Decarb

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Precourt Energy Efficiency Center (PEEC)  
Stanford University

- A research and analysis institute at Stanford
- Established in October 2006
- Initial funding: $30 million pledge by Jay Precourt
- Now PEEC Part of the Larger Precourt institute
- Mission – Keep our PEECers Up
  - To improve opportunities for and implementation of energy efficient technologies, systems, and practices, with an emphasis on economically attractive deployment
  - Focus on the demand side of energy markets
  - Energy efficiency: economically efficient reductions in energy use (or energy intensity)
Traditional Approach
Transport Approach: Stuckholm?
Religious Approach?
“ASIF” Approach

Impacts from Transport

\[ G = A \times S_i \times I_i \times F_{i,j} \]

Fuel Use
CO2, Air pollution
Congestion
Accidents

Vehicle fuel intensity
Emissions per unit of energy
or volume or km

Real drive cycles and routing

Total Transport Activity

Veh-km and pass-km by mode

Occupancy/Load Factor

Modal Energy Intensity

Technological energy efficiency

Vehicle characteristics

Broader Approach:
Fix All Components of Transport
Transport- CO2 Links:
Avoid and Shift, but also Improve/Mitigate

Avoid CO2-Intensive Development:
Stockholm Congestion Pricing

Shift and Strengthen:
Mexico City Metrobus

Improve and Mitigate:
Efficient Vehicles

Improve and Mitigate:
True Low Carbon Fuels
Improving Car Fuel Economy/CO₂

Getting The Right Balance

(original S Winkleman/CCAP)

Vehicle technology and fuels
Vehicle size/power
Vehicle Use, Traffic

Affected by F.E. Standards
Indirectly affected by F.E. Standards
Not Covered by Standards: 10-30% impact
“The Road From Kyoto”:
Transport/CO2 Policies in 6 IEA Countries

• Potential Large, Progress Slow, Risks High
  • Technology getting better there but economic signals still weak;
  • Political will missing in 2000, stronger now?
  • Absence of meaningful initial progress in the US notable

• Main Elements Still Important Today
  • Transport sector reform as umbrella for process
  • Mandatory standards on car fuel economy important
  • Fuel pricing also important (except US, which is in denial)

• Hard Lesson: Many Years to See Impacts
  • Countries moving slowly towards better transport policies
  • Present plateau in per capita car use important sign
  • Threats from distractions (bio-fuels, oil-price fluctuations, CO2 denials)

– Oil and CO2 more important now than before:
– Still, Frame as Sustainable Transportation
Vehicle ownership 1970-2007/08

Car and light truck ownership (vehicles per 1000 people)

Per capita GDP, 2000 US$ at PPP

- United States
- Canada
- Australia
- France
- United Kingdom
- Sweden
- Germany
- Japan
Car and light truck use 1970-2007/08

Per Capita Distance Driven in Cars and Light Trucks (vehicle km/yr)

Per capita GDP, 2000 US$ at PPP

- United States
- Canada
- Australia
- France
- United Kingdom
- Sweden
- Germany
- Japan
What Happened in Fuel and CO2?

- **Vehicle Energy Intensities (l/mil)**
  - Huge decline in N. America 1970s, stopped, restarted slowly >2000
  - Modest decline in EU after 1995, driven by Voluntary Agreement?
  - Increase in Japan until 1998, then decline with smaller cars

- **Travel Intensities (mJ/passenger-km)**
  - Huge decline in air travel (load factors, aircraft)
  - Mixed in rail and bus
  - Modest decline in car travel intensity (lower load factors)

- **Differences Among Countries’ Fuel Use**
  - US Cars dominate (followed by CDN, Aus, Jap) and lead savings
  - Differences in rail/bus small ex high US Values
  - Large countries have high domestic air travel energy (duh!)

*Sweden Highest Mobility/Capita in Europe
Highest Fuel Intensity of Car Travel, Too*
Where Is the Japan in On-Road Fuel Economy?

With the Top of the Pack but Falling Fast

Kaella: Tidigare beraekningar av Schipper et al 1994 (Nutek); VVerket, SIKA
Fuel Consumption - Curb Weight For MY2005 Vehicles

Source Prof. John Heywood, MIT

Fuel economy (mpg)

Fuel consumption (L/100km)

Curb weight (kg)
Car Fuel Use and Per Capita GDP 1970-2007/8
Is Growth Reversing after 50 years?

Source, L Schipper, based on official national data

1/3 Fuel Economy
2/3 Distance/per capita
Per capita Carbon (C) by mode
Japan and the US

![Graph showing per capita carbon emissions by mode for Japan and the US over different years.](chart.png)
Transport activity per capita
Japan and the US

PKM/Cap

JP 1973
US

JP 2000
US

JP 2008
US

Plane
Boat
Train
Bus
Car
Energy/passenger-km by mode
Japan and the US

- Car
- Bus
- Train
- Plane

MJ/PKM

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Car</th>
<th>Bus</th>
<th>Train</th>
<th>Plane</th>
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<tbody>
<tr>
<td>1973</td>
<td>JP</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>1973</td>
<td>US</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>JP</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>US</td>
<td>1.5</td>
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<td>2008</td>
<td>JP</td>
<td>3.0</td>
<td></td>
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<tr>
<td>2008</td>
<td>US</td>
<td>2.5</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
More on Differences in How We Travel
Is Japan that Different? Yes

• Car Dominates Travel and People’s Lives
  – Europe, while lower total mobility and car share, still car dominated
  – Japan patterns today looks like Europe 1960 – result of density
  – Japan non-megacity looks like Europe 1980s-90s

• Role of Urban Transit
  – Europe denser, larger share live and work within 500 m of transit
  – Europe, Japanese cities legacy of density, wars
  – Transit helped by higher densities, higher fuel prices, lower car ownership

• Intercity Transport
  – Japan, Europe denser and well served by rail (roads are tolled)
  – US spread out except NE, so air dominates (and has been cheaper)
  – Will HSR break US mold while Ryanair changes Europe?
COMPARISON OF JAPANESE AND US ENERGY USE FOR TRAVEL 2006

GJ/capita all travel modes

- Japan
- US

Per capita, others shares, others travel, others travel and shares, others intensities
COMPARISON OF JAPANESE AND US ENERGY USE FOR TRAVEL 2006

GJ/capita all travel modes

- Japan
- US

Per capita
Others Shares
Others travel
Others travel and shares
Others intensities
COMPARISON OF JAPANESE AND US ENERGY USE FOR TRAVEL 2006

GJ/capita all travel modes

- Per capita
- Others (shares)
- Others (travel)
- Others (travel and shares)
- Others (intenities)

- Japan
- US
COMPARISON OF JAPANESE AND US ENERGY USE FOR TRAVEL 2006

GJ/capita all travel modes

- Per capita
- Others Shares
- Others travel
- Others travel and shares
- Others intensities

Japan
US
COMPARISON OF JAPANESE AND US ENERGY USE FOR TRAVEL 2006

GJ/capita all travel modes

- Per capita
- others Shares
- others travel
- others travel and shares
- others intensities

Japan
US

CO2, gm/km

On Road Fuel Intensity, l/100 km

US (test x 1.24)  JAPAN (test x 1.33)  EU (test x 1.195)  Sweden (test x 1.1)

Fleet on road 1990

New Norm, on Road

2008 Stock, on Road

New Vehicles Sold 2008

Needed, new 'on road' by 2030 [FIA]
Diesels Greater than 55% of New Car Market in Europe: Yet Savings of CO2 from Diesel Small!

- Nine Countries Show Little Savings (Counting emissions, not gallons!)
  - On road diesel fleet emissions (gm/km) slightly (<5%) lower than gasoline
  - New vehicle test diesel emissions slightly (<5%) lower than gasoline
  - Diesel cars driven 50-100% more per year than gasoline cars
- Huh?
  - Cheaper diesel in Europe raises use, backfires on diesel policies
  - Diesels more powerful than gasoline equivalent, buyers choose bigger cars
  - Liter of diesel has 12% more energy, 18% more CO2 than gasoline
- But Diesel Drivers Are Different -- That’s the Point
  - Long distance drivers buy more expensive diesels with lower fuel costs
  - Increased switching to diesel stimulated by price – switchers drive more
  - Diesel SUVs increase attractiveness of SUVs

Avoid Subsidizing “Winners” or Loopholes like Cheap Diesel Flexfuel Vehicles, HOV Exemptions for Hybrids, Cheap LPG or CNG
Dieselization in Europe: Where are the Savings?
(Schipper and Fulton TRR 2009; Schipper Hedges 2010)

[Graph showing dieselization savings across different countries and contexts]
Electric Cars: EEV’s*?

Plug In Hybrid: When to gas, when to charge?

Swedish Car on Brazilian Ethanol: How do we scale up by a factor of 1000? Fuel cycle, land use implications

*”Elsewhere Emissions Vehicles”
Fuel Economy or Fool’s Economy?

So far EEVs Expensive Way to Save Oil or CO2

- **Costs and Economic Impacts of EEVs**
  - Cost of bio-fuels, electric drive compared to future fuel prices?
  - Role of subsidies and other hidden incentives (C-40 wants grid upgrade)
  - Do biofuels costs fall or rise at very large scale (>millions of bpd)?

- **Environmental Impacts: Who Knows?**
  - CO2 balance – direct, indirect from fossil inputs, land use, water etc
  - Need smart meters, peak load charging, way of paying road use taxes
  - Without a GHG tax, how are manufacturers, users supposed to act?

- **Real Issue: Picking Winners or Declaring Losers?**
  - Can a low-carbon fuels standard succeed without low-carbon fuels?
  - Most EV will be small: why not shrink oil fueled cars first?
  - How can objectives be defined without a pricing system in place?

Biofuels are expensive, but vehicles cost almost the same
E-Vehicles (batteries) have very high costs, but running costs low
Cash for Clunkers: A Lemon?
The Foolishness of our Car Scrappage Programs

• The Policy
  • Variable rebate for old cars of low MPG
  • Trade in for new cars
  • Overall Program less than a month, totally subscribed ($3bn)

• The Results - More Car Sales Or Just Accelerated Sales?
  • Average car junked < 15 MPG – Smart sellers dumped their worst car
  • Average new car bought 25.9 MPG, only 7% better than rest of year
  • New car doesn’t replaces previous first car, not the clunker

• Interpretation for US: Very Small Results, maybe Negative
  • Fuel savings small: clunkers would have died soon anyway
  • Marginal improvements relative to all other cars sold 2009
  • Energy/CO2 embodied in clunked cars only small
  
  Very Difficult to Show Any Positive Effects
  Why Do We Have Policies We Cannot Monitor?
  Free Money Rarely Affects Energy Use the Right Way
Household Vehicles in 2001, C4C and Recent Trends in New Vehicle Fuel Economy

<table>
<thead>
<tr>
<th>Category</th>
<th>Combined</th>
<th>Cars Only</th>
<th>SUV/Vans/Light Trucks Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Road MPG, Avg third Car (13 yrs old)</td>
<td>17.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Road MPG, Trade Ins</td>
<td>15.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Road MPG, C4C Vehicles Bought</td>
<td>25.2</td>
<td>26.0</td>
<td>22.5</td>
</tr>
<tr>
<td>MPG, All Vehicles Bought MY 2008</td>
<td>20.2</td>
<td>19.7</td>
<td>26.0</td>
</tr>
<tr>
<td>On Road MPG all Vehicles Bought First Half 2009</td>
<td>23.5</td>
<td>27.2</td>
<td>26.0</td>
</tr>
</tbody>
</table>
“Feebates” or “Green Owner Fee”
“Bonus/Malus” for France; Yearly Reg. Fee on Danish Cars

- Amount of Feebate
- could equal manufacture or consumer cost
- to achieve the given fuel economy improvement
Fuel Economy and Emissions
The Hard Policy Lessons

• Prices and Incomes Matter – in the Long Run
  – Car size, power and use related to incomes and fuel prices
  – Fuel economy and car characteristics related to fuel prices
  – Fuel choice related to fuel prices

• Fuel Economy Standards Help A Lot
  – Mandatory (US CAFÉ) worked, voluntary (Japan, EU) working now
  – Feebate/Bonus-Malus adds to impact
  – Avoid loopholes for “clean fuels” or “green cars”

• Transport Policy Matters Even More
  – Strong urban transport policies/congestion pricing reduce car use
  – Urban transport policies with teeth matter
  – Better traffic management/congestion pricing reduces idling fuel loss

As Much as High Fuel Prices Hurt Some
They Caused Unimagined Changes
Freight, Energy and Emissions
A Different Story

• Mode Shares Determined by Geography, Products
  – US has high domestic freight, non-truck share; Japan opposite
  – Rail regaining share in the US; Japan? Key to future is intermodal logistics
  – Light trucks important in US and Japan – traffic, CO2, but little t-km

• Energy Intensities – Generally Falling but Look Carefully
  – Rail and shipping lowest, because mostly bulk materials
  – Trucking depends on loading, truck capacity utilization, traffic conditions
  – Capacity utilization more important than vehicle efficiency

• Issues – Will Freight Volume Keep Rising?
  – Greater freight volumes: Increased distance vs increased lifting of goods
  – Neglect of railroads – can they be turned around?
  – How much freight is to/from ports involved in foreign trade?

Freight Should Be Easier than Travel – No People
Fundamental Understanding of Trade, Development Needed
Domestic Freight and GDP
Tonne-km/capita vs. GDP/capita

GDP per capita [2000 USD at PPP]
Freight CO2 Emissions
CO2/capita vs. GDP/capita

Freight emissions per capita [Kg of Carbon]

GDP per capita [2000 USD at PPP]

- USA
- JPN
- FRA
- UK
- AUS
- DEU
- KOR
- SWE
- DEN
- ESP
Trucking Energy Intensity
MJ / Tonne-km

Graph showing the energy intensity of trucking across different countries from 1970 to 2006.
Japan: Policy Lessons
Sustainable Transport in a Crowded Place

• Efficient Cars but Inefficient Traffic?
  – Technological lead spoiled by losses in poor traffic
  – Hybrid and EV may be best choice for Japanese Traffic
  – Traffic management helps, or does it just encourage more cars?

• Ideal Geography and Demography for Shinkansen
  – Majority of cities on a densely populated corridor
  – Good land-use planning around stations for 50 years
  – Aging population happy to ride the “Green Car”

• Next Steps for Sustainable Transport?
  – Improved logistics to shift more freight to rail
  – Shift some fuel taxes to VKT taxes, variable cost insurance etc
  – Planning for a post-automobile culture

How Much of Japan’s Low Transport CO2 is From Energy/CO2 Policies, How Much from Transport Strategies
What’s Wrong in America?
Schipper’s Diagnosis for the US

• Market Farces, but no Market Forces
  ✓ Complete aversion to pricing, internalizing externalities
  ✓ Unwise to subsidise: “Prius Envy” and Corn Ethanol
  ✓ Misplaced hope on technology without real incentives

• Ideology – Fear of Looking American Consumer in the Eye
  ✓ Continued pressure against recognizing energy and climate problems
  ✓ Right wing aversion to any kind of intervention
  ✓ Liberals sure it can be all legislated

• Look Back Since the First Oil Crisis
  ✓ A few efficiency policies (CAFÉ, appliance efficiency) but no energy policy
  ✓ Not a lot else encouraging with measured, causal results
  ✓ A collapsing transport system (no money – fuel taxes -> 40% of costs)

It is Worrisome that in 2011 the US Approach is so Timid
Obama Has The Right Ideas – Congress Does Not

Schipper ITPS/UC Berkeley
Conclusions
Policy and Goals Cannot be Undercut

• Tough fuel economy standards now, with future tightening
  – Aim at 4-5 l/100km (20-25 km/l) for new cars by 2020
  – Add feebates ("bonus malus")
  – Phase out company car schemes— they add too many large cars to stock

• Taxation:
  – CO2 taxes throughout the economy
  – Shift some fuel taxation to vehicle use taxation, bolstered by realistic vehicle use fees to pay for transport,
  – "Variablize" fixed costs like insurance, parking, access (congestion) .¥

• “Incentives” (picking winners): Free Lunches mean Overeating
  – Diesel work shows that "incentivizing", combined with low fuel prices, can lead to rebounds or even backfire (UK Diesels < CO2/km than petrol)
  – Will a similar fate make biofuels or electric vehicles fools?
  – What other pathways lead to manufacture and consumer innovation?.

EU. Japan, US/Canada Each Need Their Own Approach
All Will Share the Same Elements
The Ultimate Clunker? – Absorbs its own CO2 but Does not Fix Transport Policy

- Millard Ball and Schipper 2010 ("Peak Travel") (*Transport Reviews*, November 2010)
- Lipcsy and Schipper , (Transport and CO2 in Japan) in production

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