Put the Horse Before The (Electric) Cart: Fuel and CO2 as a Transport Problem

Lee Schipper, Ph.D.
Senior Project Engineer
Precourt Institute for Energy Efficiency
Stanford
Global Metropolitan Studies,
Univ. of California, Berkeley CA 94707 USA

Wireless?
Login: westcoast
Password: WESTCOAST1
Precourt Energy Efficiency Center
Your Host at 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)
Stephen Schneider, 1945-2010
Without Him This Conference Would Not be at Stanford
Traditional Approach
Latin America?
Knee-Jakarta Reaction to Mal-Asia?
Asia: lumbering into modernity
Congestion or Access?
Indian Inclinations?
Which Comes first, the Motorised Minority or the Majority?

Cheap Two Wheelers, but No Sidewalks

The Peoples’ Car: Which People?
Whoops: the Transport System is Unsustainable
You Can’t Fix Carbon without Fixing Transport.

Courtesy Transfuture.net
Transport Most Rapidly Rising CO2 Emission Source

CO2 Not the Worst Externality Transport Faces
Why is Energy and Transport a Hot Button Issue?

- Enhancing energy security against oil imports
- Restraining climate change from CO2 emissions
- Dwindling taxes: finding a new, major source of revenue for transportation
- Reducing externalities associated with using transport fuels – air pollution, climate, etc
- Equity issues – who pays for more expensive fuel?
- Is efficiency or fuel economy the only policy goal, or does total oil and CO2 Emissions matter?
- Can California or the West Coast lead with own GHG reduction goals?
Pillars of Sustainable Transport: Serve, not Sever, Development

• Economic Sustainability
  – Affordable to users and authorities
  – Attractive as a business
  – Each mode bears social costs

• Social Sustainability
  – Promotes access for all, not just a few
  – Removes Barriers
  – Avoids irreversible binds

• Environmental Sustainability
  – Leaves no burdens for future generations
  – Minimizes accidents, damage to human health (air pollution, etc)
  – Reduces greenhouse gas emissions

– Governance - The Roof Over these Pillars
– Make and Keep the Rules, Protect the Weak
“ASIF” Decomposition
Measuring and Understanding Impacts

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

Impacts from Transport

- Fuel Use
- CO2, Air pollution
- Congestion
- Accidents

Total Transport Activity

Veh-km and pass-km by mode

Occupancy/Load Factor

Modal Energy Intensity

Technological energy efficiency

Vehicle characteristics

Vehicle fuel intensity

Emissions per unit of energy or volume or km

Real drive cycles and routing

Lesson: Attack All Components of Transport
The ASIF Transport Centered Approach: Avoid and Shift, Improve/Mitigate

Avoid CO2-Intensive Development: Singapore Land Use Planning, Congestion Pricing

Shift and Strengthen: Mexico City Metrobus

Improve and Mitigate: Efficient Vehicles

Improve and Mitigate: TRUE Low Carbon Fuels
IMPROVEMENTS IN ON ROAD (FLEET) FUEL ECONOMY - HOW TO ACCELERATE?
Fuel Consumption - Curb Weight For MY2005 Vehicles
Source: Prof. John Heywood, MIT

The graph illustrates the relationship between curb weight (kg) and fuel consumption (L/100km) for MY2005 vehicles. The data points show a clear trend indicating that fuel consumption increases significantly with an increase in curb weight. The graph is sourced from Prof. John Heywood at MIT.
New Standards Hopeful, but Real Targets Must be MUCH Lower

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)

- Fleet on road 2007
- New Vehicles Sold 2007 on road
- Proposed/ Strengthened New, on Road
- Needed, new 'on road' by 2030[FIA]
Carbon Cobenefits – Low Priced
Bus Rapid Transit (BRT) – Mexico’s Metrobus

260,000 people/day over 20km for US $60mn
Lower emissions, CO2, reduced car traffic
Carbon Cobenefits: Changes in Emissions for High Speed Rail in the US - Fill the Trains!

Note Changes << Total Emissions from Travel for 2050

- Recall EIA case has higher CO2 emissions for cars, greater total travel so greater HSR switch.
- Total emissions in EIA case 2050 are 2100 MTCO2, for GLOBAL case 510 MTCO2
“ASIF” Decomposition For Freight: Road Map For Saving Fuel Use and CO2

Emissions from Freight Vehicles

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

Fuel Consumption, Air pollution, health impacts Global CO2

Vehicle characteristics:
Size, capacity, power, fuel

Technological energy efficiency

Vehicle fuel intensity

Modal Energy Intensity

Real drive cycles and routing: For trucking includes “hotelling”

Total Freight Activity

Veh-km and tonne-km by mode

Emissions per unit of energy or volume or km

Fuel Type and emission controls

Fuel Use

Lesson: Attack All Components of Fuel Use and CO2 - Focus on What Moves, How and How Far
Don’t Forget that Freight is Great
A Huge Amount Comes Through the West Coast
Sustainable Transport: How Do Alternatives Look?

Environmental sustainability – health of citizens and ecosystems
  • Zero local emissions
  • Uncertain GHG Impacts: Could be all from coal!
  • Hope that vehicles are efficient

Economic sustainability (efficiency and robustness)
  • No one knows impacts on consumers, transport operators

Social sustainability (equity)
  • Should not harm any group or divide communities
  • Danger that the usual bag of stimuli helps only the wealthy

Governance sustainability: requirements
  • Question for conference: What’s needed?

How Does Each Alternative Scale?
How do Externalities Scale?
How are Plants or Electrons Counted?
Frame the Goals of Transport Fuels: Outcomes

• **Improved Urban Air Quality – Original Goal for EtOh, MtOh**
  – Alcohol blends can help oxygenate, bio-diesel helps
  – CNG has some benefits over gasoline or diesel
  – Electric Drive – Elsewhere Emission Vehicles

• **Lower Oil Imports And Improve Fuel Security**
  – First value “1 less barrel of oil imported” and tax oil
  – Lower vehicle use, higher efficiency also improves security
  – Mandated or subsidized bio-fuels cut off other options

• **Reduce GHG Emissions**
  – Detailed calculations required, but some clear losers
  – Other “solutions” have varying degrees of closet carbon
  – Is CO2 relief reliable without a carbon tax?

---

Can Goals Be Balanced Without Clear Prices on Externalities
The CO2 and Oil Impact of EEV’s
Not a Simple Matter of Calculation Even for Bio Fuels
Does a “Low Carbon Fuels Standard” work w/o CO2 Taxes

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 100?
Fuel cycle, land use implications

*”Elsewhere Emissions Vehicles”
Electric Drive: Framing the Policy Problem

• The Technical Issues – Will Policies Help or Hinder?
  – Range, battery costs, lifetimes, and disposal/recycling
  – Life cycle emissions issues
  – Identifying key environmental and social bottlenecks before lock-in

• Economic and Behavioral Issues
  – Can we have lower emissions and oil use at lower cost?
  – Can we price carbon, oil, and electric power demand at the margin?
  – Do we understand how real people will drive electric vehicles?

• Key Policy Issues
  – Top down (pricing), bottom up (incentives), or somewhere in between
  – Tax ‘bads’ or pick winners and subsidize ‘goods’?
  – Has any society really managed this kind of transition?

Even with Road/Fuel Tax, Electric Drive is Cheap; Does that Make Transport Problems Better?
Individual Vehicle and Fuel Examples
Salvation or Bigger Nightmares?

• Corn Ethanol in the US ($1/gallon oil displaced)
  – Driven by farm state interests and mandates now unstoppable?
  – Clean burn and oil benefit, questionable CO2 benefit
  – Subsidy essentially an earmark

• Prius Envy-Rebound Effect
  – Great cars, but what about a less expensive small car?
  – Look at Brazilian CNG or Australian LPG – too cheap?
  – HOV passage and discounted bridge tolls giving away the

• Electric Vehicle Subsidies
  – Huge tax breaks – for what if society has to strengthen grid, generation?
  – Electrons make most sense with carbon, oil, time-of-day charges
  – Don’t forget equivalent fuel taxes must be imposed on electricity

*These Earmarks Imply VERY High Value to Saving Oil or CO2: Why Not Impose on All Users?*
## Transport Investment
Most Systems are Broke

### Fuel Tax Deficit – We Can’t Afford Free Lunches
- Fuel revenues only pay for ~40% of surface transport
- Breakdowns like I-35 Bridge Collapse
- Costs 10-25% of underground or rail per unit of capacity and distance

### Capacity Imbalance
- Roads, airports face congestion crunches
- Transit particularly affected – Empty fuel cell buses do little good
- Sprawl lies behind much of transit problems

### OPM (Other People’s Money)
- OPM encourages over investment in very expensive metro and bus
- OPM rarely can be used to improve service, balance system,
- What Mayor wants her name on a bus?

*Transport System Imbalance Leads To Swollen Energy Bill*  
*Can’t Fix Energy Without Fixing Transport*
This is a Sustainable Transport Problem not Just a Fuels Problem

• Rapidly Rising CO2 Emissions a Symptom of Bad Transport
  – Rising car/two wheeler use driven by poor alternatives
  – Congestion raises emissions from everyone, drives more to cars/2W
  – Too much policy “carbo-centric” rather than development focused

• Focus on Transport and Development Policy with CO2 Twist
  – Avoid-Shift-Mitigate strategy with financing
  – Keep the car from taking over, while its not too late
  – Avoid carbo-centric “projects” and funding that ignore all else

• The Real Challenge: Balance
  – Fuel prices must reflect costs and environmental damage
  – Vehicle use must reflect congestion and safety costs
  – Urban development must avoid car-centrism

Policy and Direction, not just Other People’s Money (OPM) the Key Missing Ingredients in Transport Policy Today
US Transport, Energy, Climate and Resources Policy: An Environmental Ponzi Scheme Called “Incentives”

- Existing Policies Timid & Aim for Modest or Zero Cost
  - “Prius Envy” and other free money
  - No variable charges for congestion, roads, insurance.
  - Subsidies for questionable energy sources (corn ethanol)

- A Better Way? Cut the Problem Down to Size
  - Need to find a way to create stronger price signals
  - Incentives where a clear case can be made – better targeting
  - Stronger regulatory approach with clear consumer product standards

- The Political Vicious Circle
  - The US hopes for technology to solve problems
  - The US unwilling to bear modest price increases in transport costs
  - Technology only solves problems if people want it & find it profitable

- The Present Outlook for Real Change in the US is Glum
  - Despite this Conference’s Best Intentions
Key Questions for This Conference

• What policy problems (e.g., climate, oil, load balancing) does electric drive in general and other ideas in the conference specifically address?
• What other policies (which may support other technologies) could address and solve the same problems, at higher or lower cost?
• How do we price electrons, electric capacity and charging needs, and battery acquisition?
• OPM (Other People’s Money): Who pays for “incentives” for new kinds of vehicles, transport systems (like HSR) and other goodies?
• What is our track record for avoiding “collective problems” other than those related to “clear and present dangers” if we have to pay up now?
• How do we solve much more profound transport problems that have greater external costs than fuels or CO2?
• Are your proposals “tea party proof”,