Transport and Energy Turmoil

Lessons from Recent Events
Prospects for the Medium Term

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For information about the presenter, visit www.richardgilbert.ca
For information about *Transport Revolutions*, and to pre-order, visit www.transportrevolutions.info
- Energy turmoil in 2008-2009
- Transport turmoil in 2008-2009
- The oil price surge caused the recession
- Vicious cycles, and breaking out of them
- Grid-connected traction is best
- Personal Rapid Transit (PRT) is grid connected
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Modern living depends profoundly on motorized movement of people and freight, 95% of which is fuelled by oil products.
Energy turmoil in 2008-2009

Oil prices had been rising since 2003, but the spike in 2008 was extraordinary, and the subsequent fall and recovery even more so.
Energy turmoil in 2008-2009

NYMEX natural gas prices (in red) also rose, fell steeply during 2008 and then somewhat recovered, all the while varying more.
Here is the price of coal, as shipped from Newcastle (Australia) to China. It had the same wild swing in price during 2008-2009.
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Vehicle sales in the US had been falling off, but the plunge in 2008-9 – by 25% for cars, 35% for SUVs etc. – was remarkable.
Transport turmoil in 2008-2009

Close-up of oil prices and US vehicle sales: as oil prices rose in 2007, sales of SUVs etc. fell and then sales of regular automobiles.

Sales of SUVs etc. fell with rise in oil price.
Sales of regular cars fell with the collapse in the economy.
The end of the Hummer is in sight. The Government of China blocked its sale to Sichuan Tengzhong Heavy Industrial Machines.
Vehicular movement began falling at the end of 2007, before sales slumped. It’s now about 5% below the previous trend.
The US – Canada too? – may have entered an era of fewer cars and less driving.

- Both General Motors and Toyota have said they are planning for a long-term shrinking of the U.S. automobile market by about 30%.

- During the period 1986-2006, the amount of driving in the Toronto region by 16-20 year-olds fell 31% per capita, even while driving by older age groups increased (very slightly).
Transport turmoil in 2008-2009

The vision of a car for every adult North American – built by a buoyant private sector – may be waning.
Land transport turmoil embraced the rest of the world too.

- China passed the U.S. to become the world’s second automobile manufacturer in 2008, and passed Japan to become the top producer in 2009.

- In 2009, China became the world’s largest market for domestic auto sales.

- World automobile production and sales fell for the second year in a row in 2009, perhaps the first time for several decades.
ICAO said aviation suffered its “worst ever performance” in 2009. Passenger traffic was down 3.1%. Cargo traffic was down 15.0%.
Transport turmoil in 2008-2009

Plane was already giving way to train, especially for business travellers where both are available (e.g., New York–Boston)
Over 80% of the world’s tonne-kilometres are performed at sea, most in bulk carriers like the Cos Bonny (in the Panama Canada).
The Baltic Dry Index reflects the cost of moving raw materials by sea. It fell more than 90% during the last six months of 2008.
Transport turmoil in 2008-2009

Finished and partially finished goods usually move in containers. This ship is less than half the size of the largest container carrier.
The Hamburg Index reflects the cost of moving containers by sea. It fell more than 80% between November 2007 and October 2009.
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The oil price surge caused the recession. This is not the orthodox view of the cause, but it is one that may be gaining support.

Wall Street is worrying about financing the PIGS (Portugal, Italy, Greece and Spain), and little wonder. Proposals to halt exploding public sector budget deficits in those countries already have the workers out in the streets in Athens and Madrid. ...

The fact of the matter is, wherever you go in the OECD, we’re all PIGS now. **That’s because we mistook an energy shock for a financial crisis and bailed out everyone under the sun.**

The oil price surge caused the recession. Petroleum liquids production is entering—may have entered—permanent decline (won’t know peak until well after it occurs).

Billions of barrels per year

- Natural gas liquids
- Deepwater
- Heavy oil
- Polar
- M.East
- Other
- Russia
- Europe
- US-48

Graph showing the production of different types of petroleum liquids from 1930 to 2050.
The oil price surge caused the recession.

What underlies the previous chart, and other challenges:

- 50-60% of global oil flows come from about 100 large oil fields, average age 50-60 years, most in decline

- super-giant oil fields were last found 50 years ago

- there are no third-party audits for >90% of the world’s ‘proven’ oil and gas reserves

- rusting infrastructure and an aging energy workforce are almost insurmountable obstacles to maintaining possible oil supply.

Matthew R. Simmons, Chairman Emeritus, Simmons & Company International (Energy Investment Bankers) at the AON Annual Energy Insurance Symposium, Houston, Texas, January 2010
The oil price surge caused the recession

“A spike in the price of oil has preceded almost every U.S. recession and market crash for nearly half a century.”
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We may be in a **vicious cycle**. Oil prices are boosted by scarcity, busted by recession, and so on.
Vicious cycles, and breaking out of them

This cycle may be reinforced by another cycle concerning oil price, oil investment and oil supply.
The two cycles create the conditions for high oil prices, and for low oil prices, impelled by geology and economics.
Vicious cycles, and breaking out of them

Humanity, though its dependence on transport and, in turn, on oil, appears to be between a rock and a hard place.

The **rock** is that even curbing the rate of depletion of oil production may require oil to be above $80/barrel.

The **hard place** is that a recession occurs whenever oil goes much above $80/barrel.
Vicious cycles, and breaking out of them

Breaking the cycle through less economic dependence on auto sales and less dependence of transport on fossil fuels.

- High oil price
  - Reduced oil supply
    - Less investment in oil
      - Increased oil demand
        - Increased economic activity
      - Low oil price
  - More investment in oil
    - Increased oil supply
      - Reduced oil demand
        - Reduced economic activity
Vicious cycles, and breaking out of them

Humanity may be between another rock and the same hard place – all amounting to a classic case of market failure.

This **rock** is that a shift to alternative transport fuels may require oil to be above $80/barrel.

The **hard place** is that a recession occurs whenever oil goes much above $80/barrel.
Vicious cycles, and breaking out of them. The possibility of such market failure impels consideration of rationing by a means other than price.
Vicious cycles, and breaking out of them

Gasoline was rationed during WWII, but not since. Oil geology and economics may impel rationing again.
Vicious cycles, and breaking out of them

Should North American governments embrace gas rationing as a way of bringing revolutionary but orderly change to transport industries?
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Constructing the ‘coal island’ at Red Trail Energy’s corn-ethanol plant, Richardson, North Dakota.
Grid-connected electric traction is best

Biofuels are problematic, now and in the foreseeable future.

- Estimates of how much the 2008 rise in food prices can be attributed to industrial biofuel production range from 20 to 75 per cent.

- Ethanol (now all from corn) comprises 4% of transport fuel in the U.S. – planned to rise to 13% by 2022.

- “Among currently and foreseeable commercial biofuels, only cellulosic ethanol has the potential to be produced and consumed on a sustainable basis ... but not for another decade or so.”

Grid-connected electric traction is best.

Electricity may be the best alternative to oil: clean, efficient, powerful, widespread, and potentially renewable.
Grid-connected electric traction is best.

The current focus is on partial electrification: gasoline-electric hybrids that produce modest gains in urban fuel economy.
There are many plans for plug-in hybrids and battery-electric vehicles, like the Volt; these need much better, cheaper batteries.
Grid-connected electric traction is best

Lithium is not good enough; what about barium titanate (EEStor), zinc air? — there is little evidence of feasibility

The specific energy of both gasoline and diesel fuel is about 12,500 Wh/kg, more than 60 TIMES the maximum value shown here. Thus, even if electric motors are five times as efficient, and batteries improve by a factor of three, there will still be more than a 4:1 difference in effective energy storage.
A fuel-cell solution is **impracticable** because of reliability, cost and, above all, high energy losses.

Grid-connected electric traction is best.

Total energy loss from turbine to motor $\approx 75\%$

(80% if hydrogen is liquefied for distribution)

Total energy loss from turbine to motor with direct connection via the grid $\approx 10\%$
Grid-connected electric traction is best. The only proven, efficient, cost-effective method of electric powering is grid connection.
Grid-connected electric traction is best. **Trolley buses** making use of existing roads (on bus lanes?) are a cost-effective way to electrify transit (a tenth the cost of LRT).
Grid-connected electric traction is best

Hong Kong shows that subways can be built and operated **without subsidy** (if densities are high enough).
Grid-connected electric traction is best.

Trucks can have grid-connected electric traction, such as this truck in a Canadian-owned mine in Nevada.
Energy turmoil in 2008-2009

Transport turmoil in 2008-2009

The oil price surge caused the recession

Vicious cycles, and breaking out of them

Grid-connected traction is best

Personal Rapid Transit (PRT) is grid connected
Personal Rapid Transit (PRT) is grid-connected. How might personal automobiles be grid-connected? This is one kind of suggestion.
The monorail may just be the road of tomorrow

Cincinnati investors Jay Andress and Andy Webster have developed the MonoMobile Liberator, an electric car that could use city streets or a monorail to get around town.

How it works:

1. Liberator owners would plug their cars in at night to charge up their batteries.

2. In the morning they would drive to the closest monorail on-ramp instead of an interstate onramp.
Personal Rapid Transit (PRT) is grid-connected. But PRT pods captive to guideways may be the best way to go.
Personal Rapid Transit (PRT) is grid-connected. This is an artist’s impression of what is being installed at Heathrow Airport, London UK.
Personal Rapid Transit (PRT) is grid-connected

Here’s a PRT station at Heathrow’s Terminal 5 car park.
Personal Rapid Transit (PRT) is grid-connected. 

The PRT system being developed for Masdar City, Abu Dhabi, is based on the one at Heathrow Airport.
Personal Rapid Transit (PRT) is grid-connected. As is the proposal for the airport at St. Louis, Missouri.
Personal Rapid Transit (PRT) is grid-connected. Similar too is the Vectus PRT system, undergoing trials at the test track in Uppsala, Sweden.
Personal Rapid Transit (PRT) is grid-connected.

Vectus is linked to Posco, Korea’s leading steelmaker.

Posco will help realize new rapid transit plan

September 26, 2009

A consortium started by Posco has signed a memorandum of understanding to produce eco-friendly “personal rapid transit” units for Suncheon, South Jeolla.

Vectus Ltd., the Korean-Swedish consortium, will make PRT units designed to carry four to five people each over the 5 kilometers from Suncheon Bay to the Suncheon International Gardening Festival site.
Personal Rapid Transit (PRT) is grid-connected. A system in which dedicated pods are hung from the rail could be better, such as this proposal for Seattle, Washington.
Personal Rapid Transit (PRT) is grid-connected

And this proposal for Götgatan, Stockholm, Sweden.
Personal Rapid Transit (PRT) is grid-connected. There are PRT proposals for San Jose airport, Santa Cruz, and Alameda, all in California.
Personal Rapid Transit (PRT) is grid-connected. Proposals for Edina (a suburb of Minneapolis), Ithaca, New York, and Perimeter Center, Atlanta.
Interest and development of PRT appears to be growing around the world. With the inevitable construction of at least two systems and the testing underway of several others … it can be argued that PRT is proving to be a feasible technology.

December 2008 report from the Virginia Department of Rail and Public Transportation to the Governor and General Assembly (State Legislature)
We might have had PRT instead of Google.

When I was here at Michigan ... I wanted to build a personal rapid transit system on campus to replace the buses. It was a futuristic way of solving our transportation problem. I still think a lot about transportation -- you never lose a dream, it just incubates as a hobby. ...

I think it is often easier to make progress on mega-ambitious dreams. I know that sounds completely nuts. But, since no one else is crazy enough to do it, you have little competition.

Commencement Address by Larry Page, co-founder of Google, at the University of Michigan, May 2, 2009
**Personal Rapid Transit (PRT) is grid-connected**

Should some of Toronto’s Transit City be PRT rather than LRT?

<table>
<thead>
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<th></th>
<th>Construction cost in $million/km</th>
<th>Time for a 6.4-km direct trip in minutes</th>
<th>Time for a 12.8-km trip, one transfer, one direction in minutes</th>
<th>Average capacity persons/hour/direction</th>
<th>Yearly millions of person-kilometres for each two-way km of service</th>
<th>Capital cost per person-kilometre in dollars</th>
<th>Operating cost per person-kilometre in dollars</th>
<th>Total cost per person-kilometre in dollars</th>
<th>Total cost compared with PRT</th>
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<td>Subway</td>
<td>300</td>
<td>15.0</td>
<td>35.0</td>
<td>14,400</td>
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<td>0.25</td>
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<td>43.0</td>
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<td>19.0</td>
<td>43.0</td>
<td>3,300</td>
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<td>0.10</td>
<td>0.42</td>
<td>0.52</td>
<td>1.56</td>
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<td>53.9</td>
<td>0.04</td>
<td>0.30</td>
<td>0.34</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Personal Rapid Transit (PRT) is grid-connected.

Objections to streetcars (and PRT) include visual pollution, addressed by the ground-level powering of the Tramway de Bordeaux.
Personal Rapid Transit (PRT) is grid-connected. The trams of my London childhood, withdrawn in 1952, had optional underground powering (and double-ended operation).
Personal Rapid Transit (PRT) is grid-connected...
And, of course, PRT can be very eco-friendly

Monorail using sails proposed by Henry R. Palmer in 1828


THANKS FOR YOUR INTEREST!
Unused slides
There is so much development going on right in this area. In 5 or 10 years we’ll have gridlock on (recently expanded) Highway 101/85 merge. We’ll need an alternative. The proposal to connect Google, NASA, and Caltrain makes sense as an alternative. PRT will be like a dam breaking. We’re all frustrated with current transit in the area.

Google employee
Here are oil and natural gas prices per unit of energy. Oil has mostly been more valuable, 2003-2006 being the main exception.
Other coal prices went up steeply in 2008. (Later data are not available.)
Energy turmoil in 2008-2009

Electricity could come from solar-PV, wind, geothermal, and marine, but above all from Concentrating Solar Power (CSP).
Energy turmoil in 2008-2009

This area of desert, 200 km in diameter, could if covered with CSP systems equal current U.S. electricity generation.