

Transport and Energy Turmoil

Lessons from Recent Events
Prospects for the Medium Term

Richard Gilbert

Robert Hunter Memorial Lecture,
University of Toronto

March 10, 2010

For information about the presenter,
visit www.richardgilbert.ca



Robert Hunter 1941–2005

activist and journalist

co-founder of Greenpeace

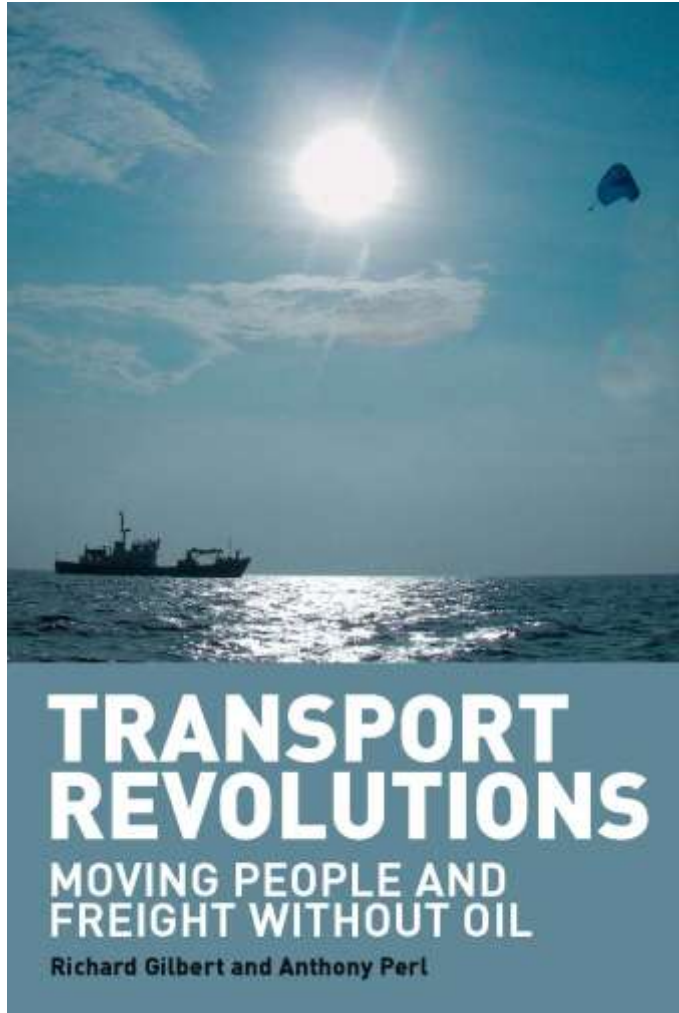
co-winner of the 1991 Governor

General's award for non-fiction

long-time reporter and

commentator for Citytv

FIRST EDITION PUBLISHED BY
EARTHSCAN (LONDON, UK)
IN JANUARY 2008



SECOND EDITION TO BE PUBLISHED BY
NEW SOCIETY PUBLISHERS (GABRIOLA
ISLAND, BC) IN APRIL 2010



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- 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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Energy turmoil in 2008-2009

Modern living depends profoundly on motorized movement of people and freight, 95% of which is fuelled by oil products.



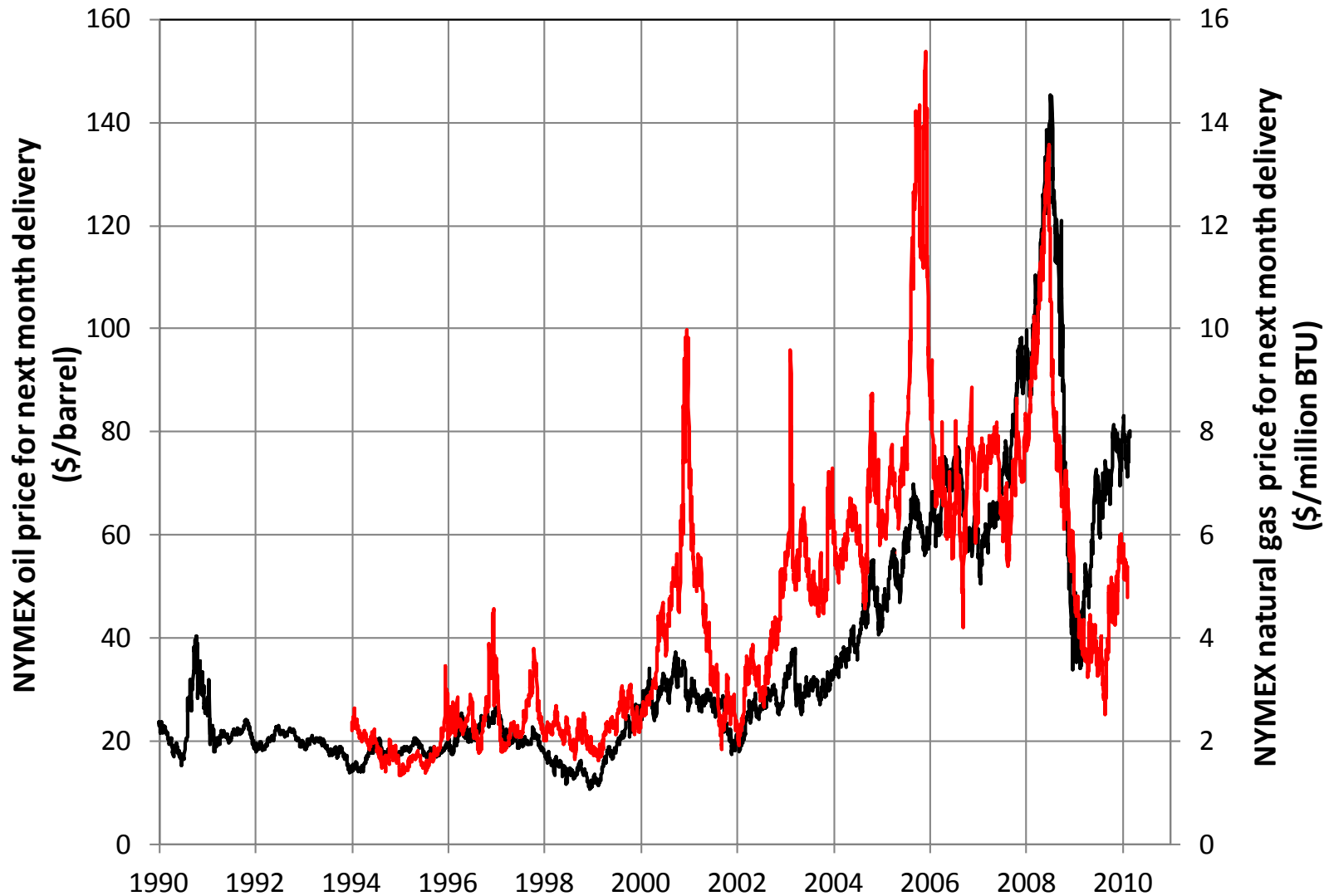
Energy turmoil in 2008-2009

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.



Energy turmoil in 2008-2009

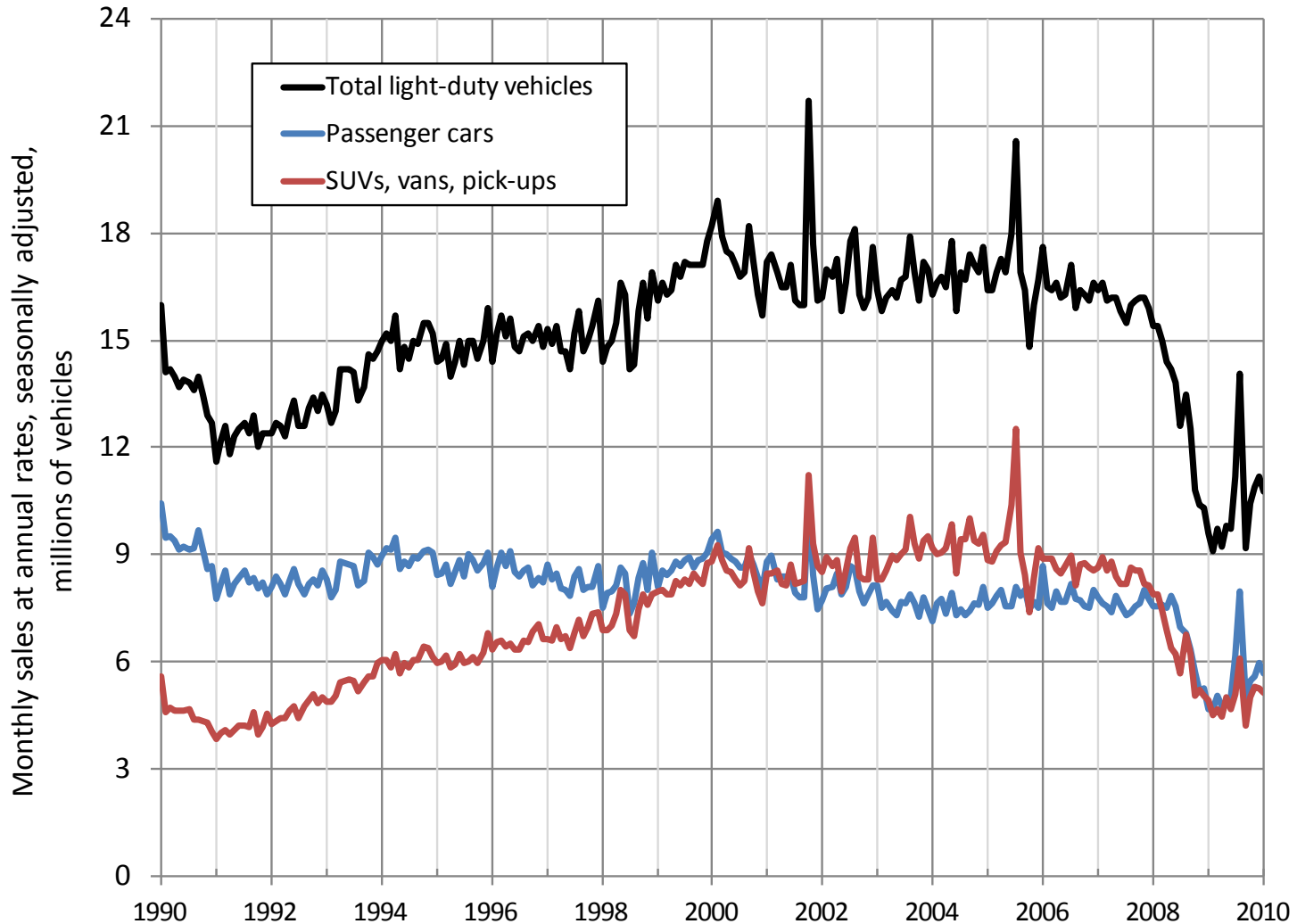
Here is the price of coal, as shipped from Newcastle (Australia) to China. It had the same wild swing in price during 2008-2009.



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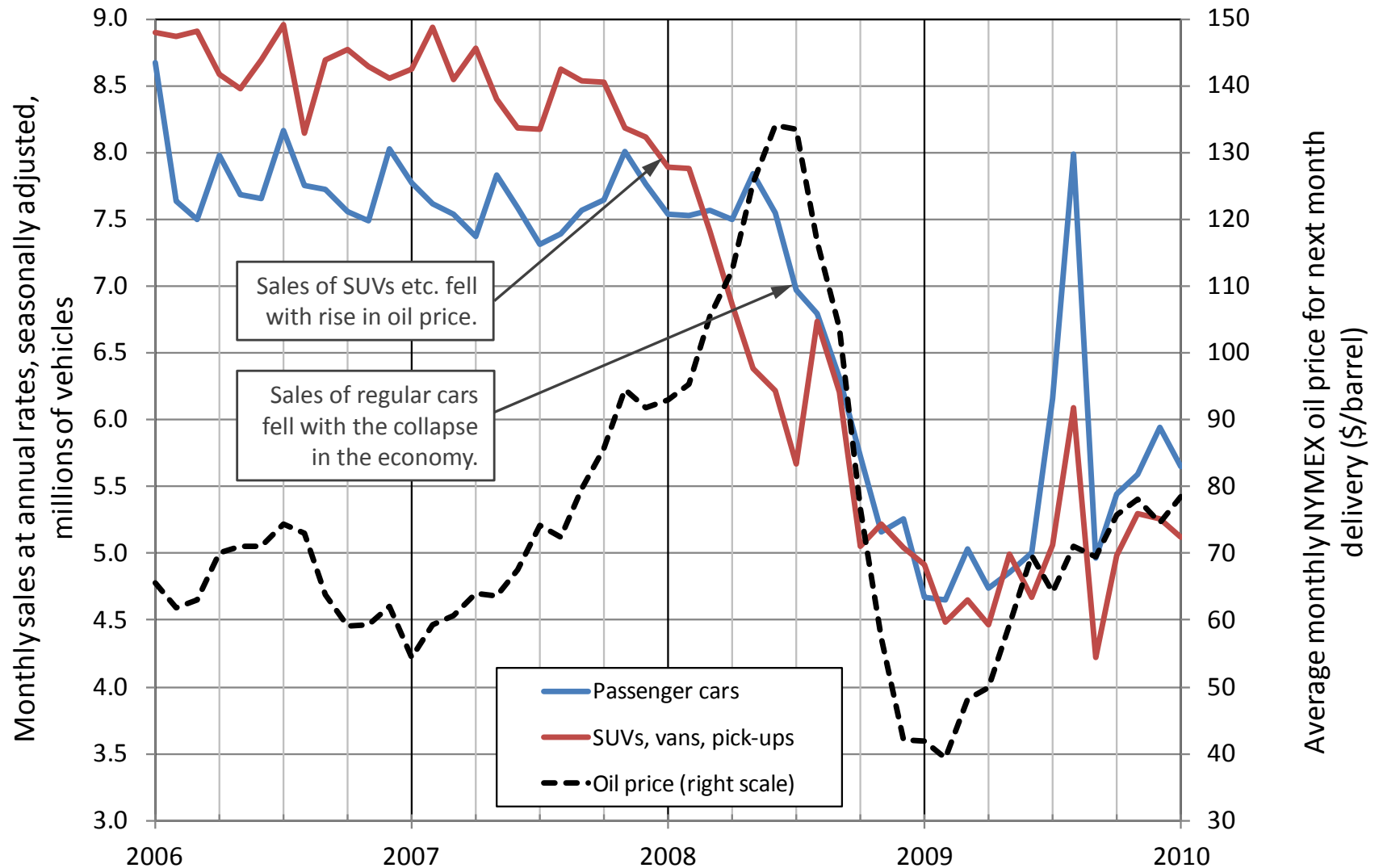
Transport turmoil in 2008-2009

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.



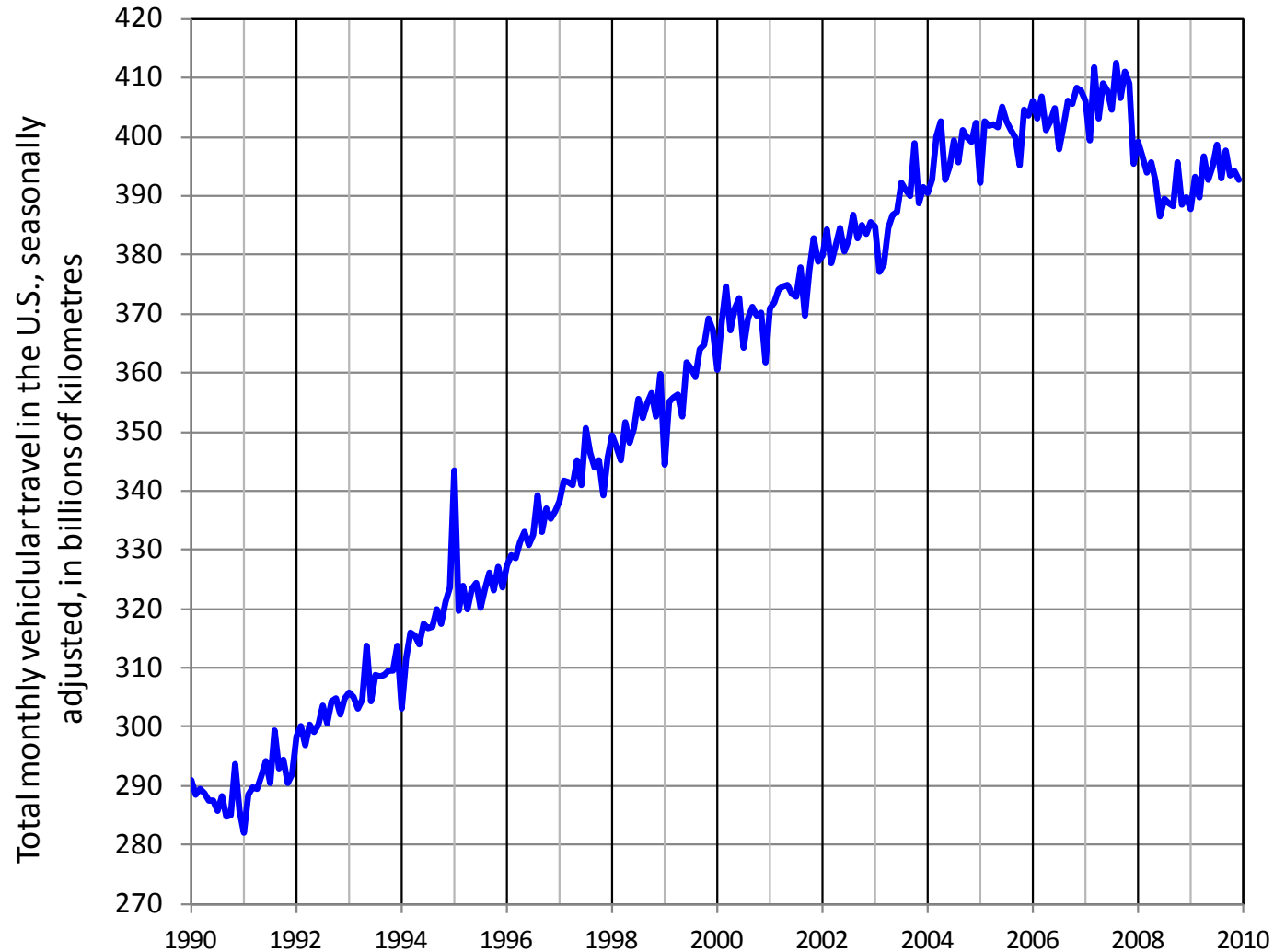
Transport turmoil in 2008-2009

The end of the Hummer is in sight. The Government of China blocked its sale to Sichuan Tengzhong Heavy Industrial Machines.



Transport turmoil in 2008-2009

Vehicular movement began falling at the end of 2007, before sales slumped. It's now about 5% below the previous trend



Transport turmoil in 2008-2009

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

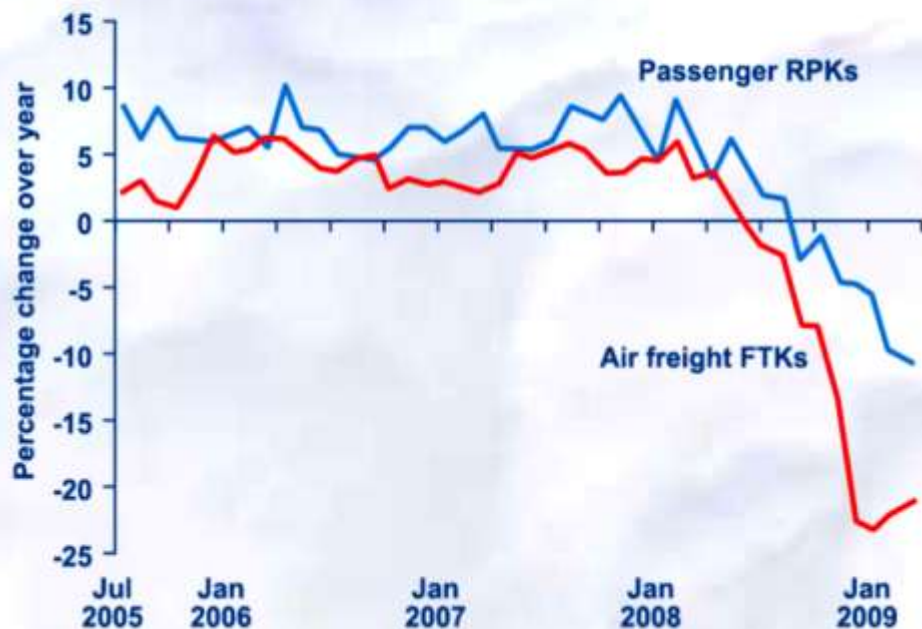
Land transport turmoil embraced
the rest of the world too.

- 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.

Transport turmoil in 2008-2009

ICAO said aviation suffered its “worst ever performance” in 2009. Passenger traffic was down 3.1%. Cargo traffic was down 15.0%.

International revenue passenger and freight tonnes - kilometers *Source: IATA*



Passenger traffic growth by ticket type *Source: IATA*



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)



Transport turmoil in 2008-2009

Over 80% of the world's tonne-kilometres are performed at sea, most in bulk carriers like the Cos Bonny (in the Panama Canal).



Transport turmoil in 2008-2009

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.



Transport turmoil in 2008-2009

The Hamburg Index reflects the cost of moving containers by sea. It fell more than 80% between November 2007 and October 2009.



- Energy turmoil in 2008-2009
- Transport turmoil in 2008-2009
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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.**

Jeffrey Rubin, former Chief Economist for CIBC World Markets, in his March 3, 2010, *Globe & Mail, Report on Business* blog.

The oil price surge caused the recession

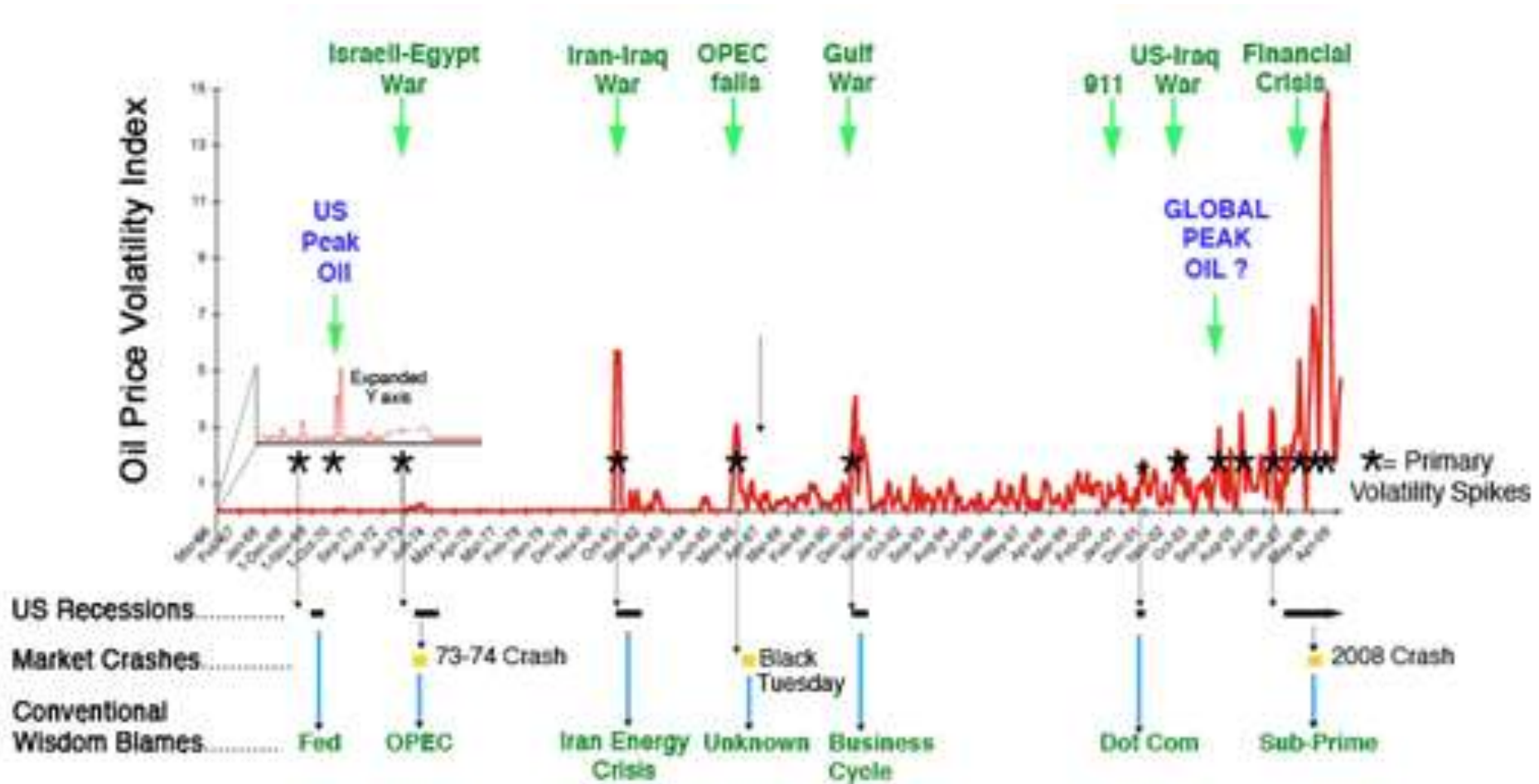
What underlies the previous chart, and other challenges

- 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

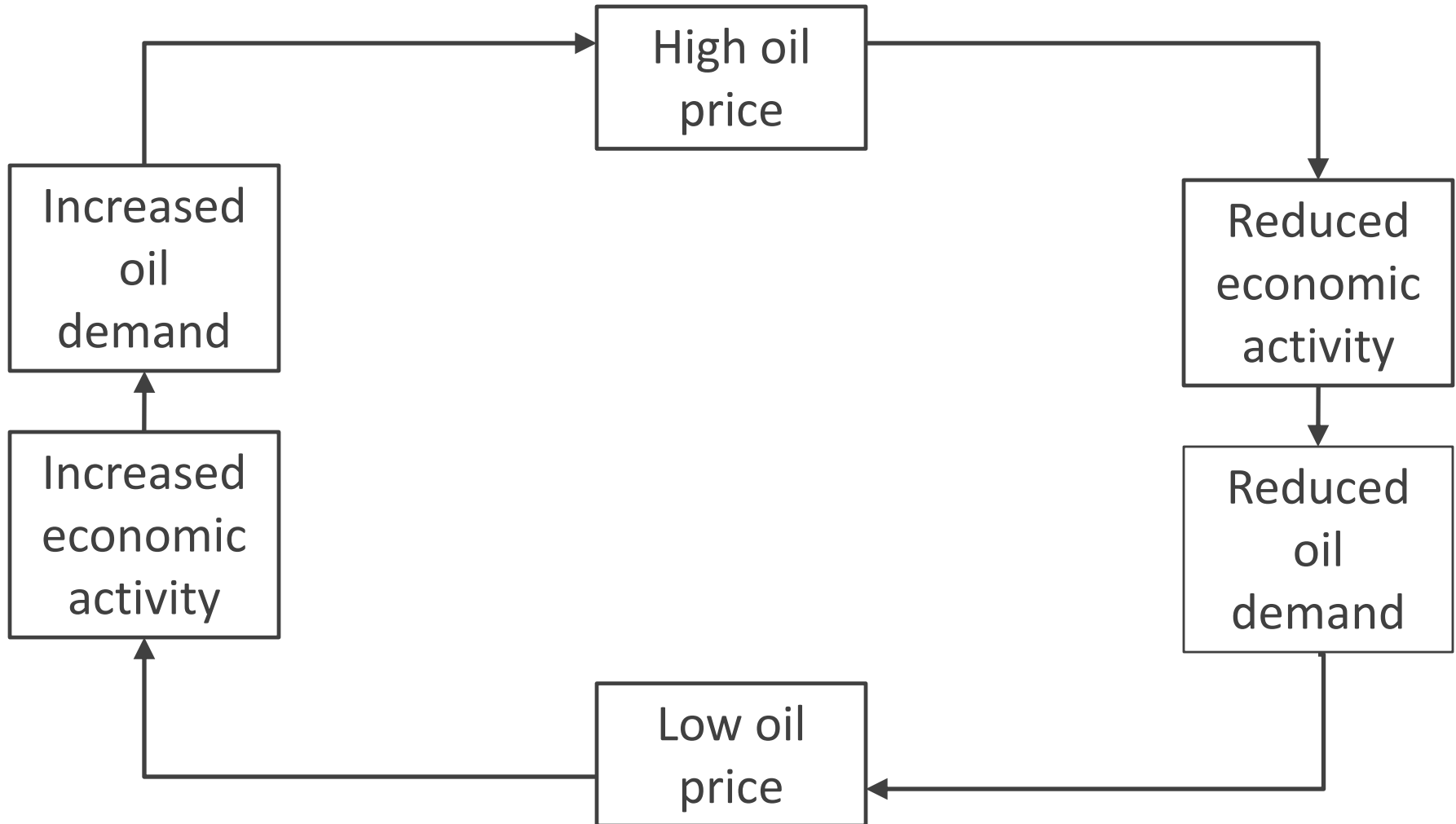
“A spike in the price of oil has preceded almost every U.S. recession and market crash for nearly half a century.”



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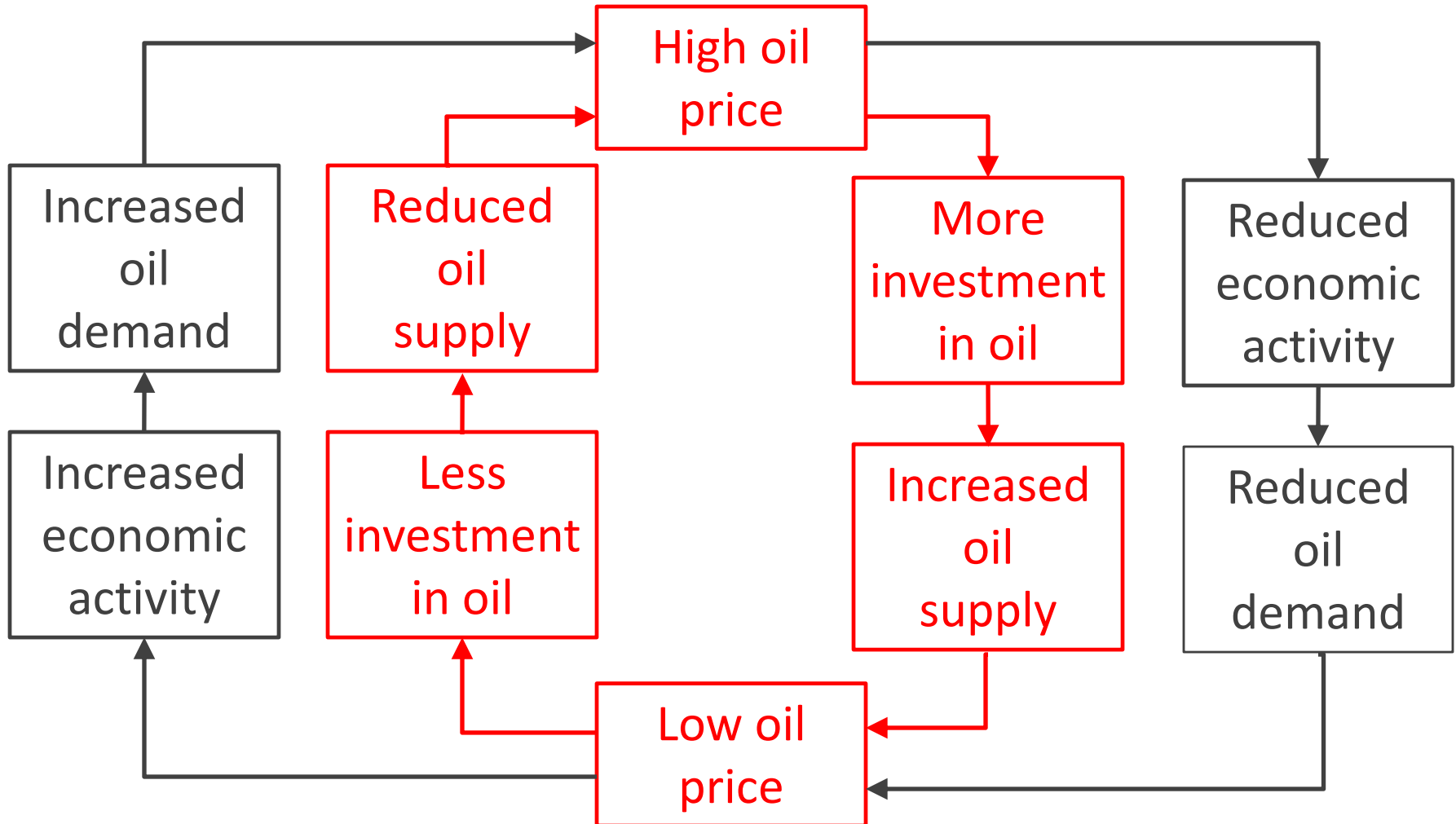
Vicious cycles, and breaking out of them

We may be in a **vicious cycle**. Oil prices are boosted by scarcity, busted by recession, and so on



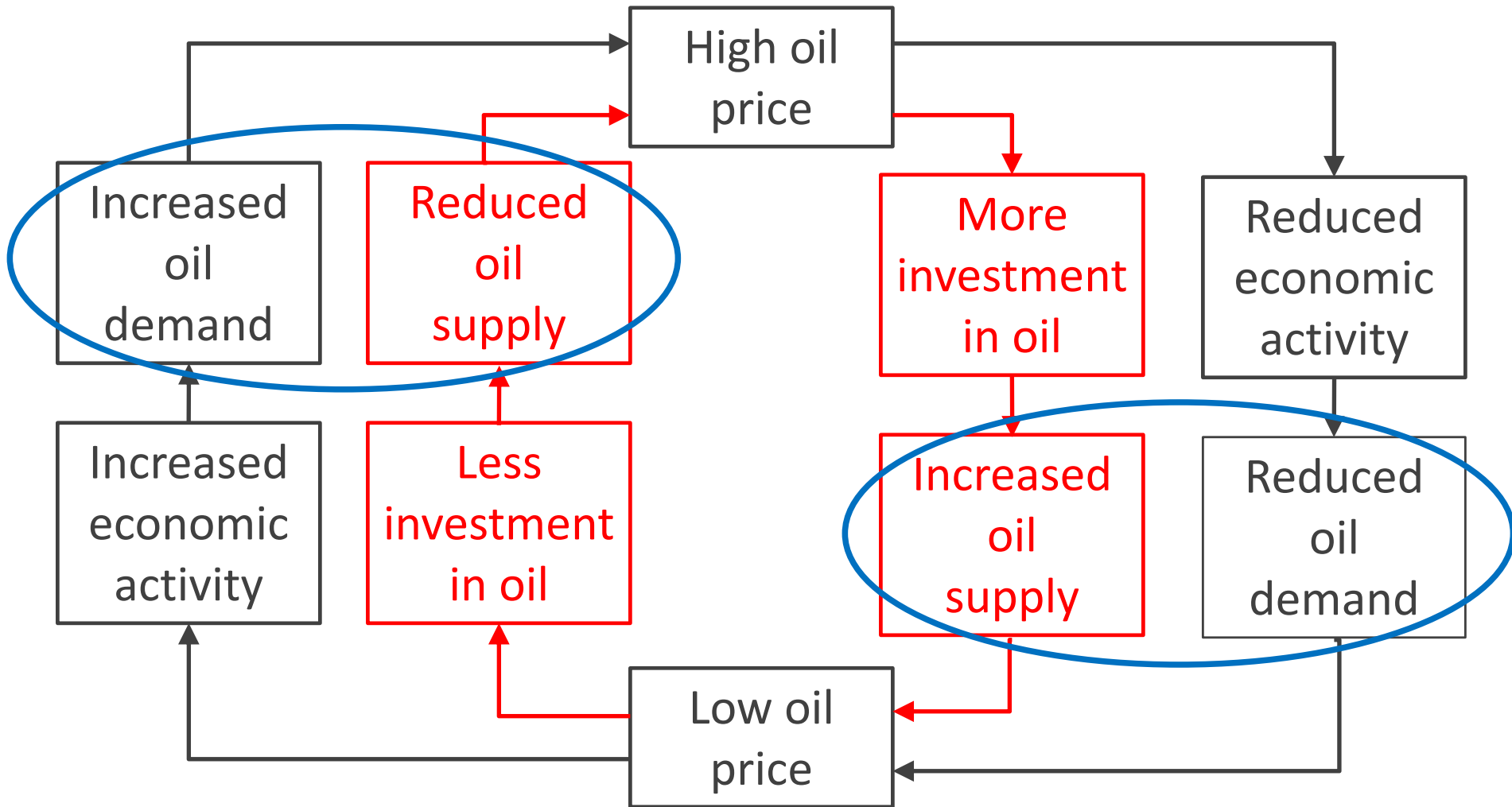
Vicious cycles, and breaking out of them

This cycle may be **reinforced by another cycle** concerning oil price, oil investment and oil supply.



Vicious cycles, and breaking out of them

The two cycles create the conditions for high oil prices, and for low oil prices, **impelled by geology and economics.**

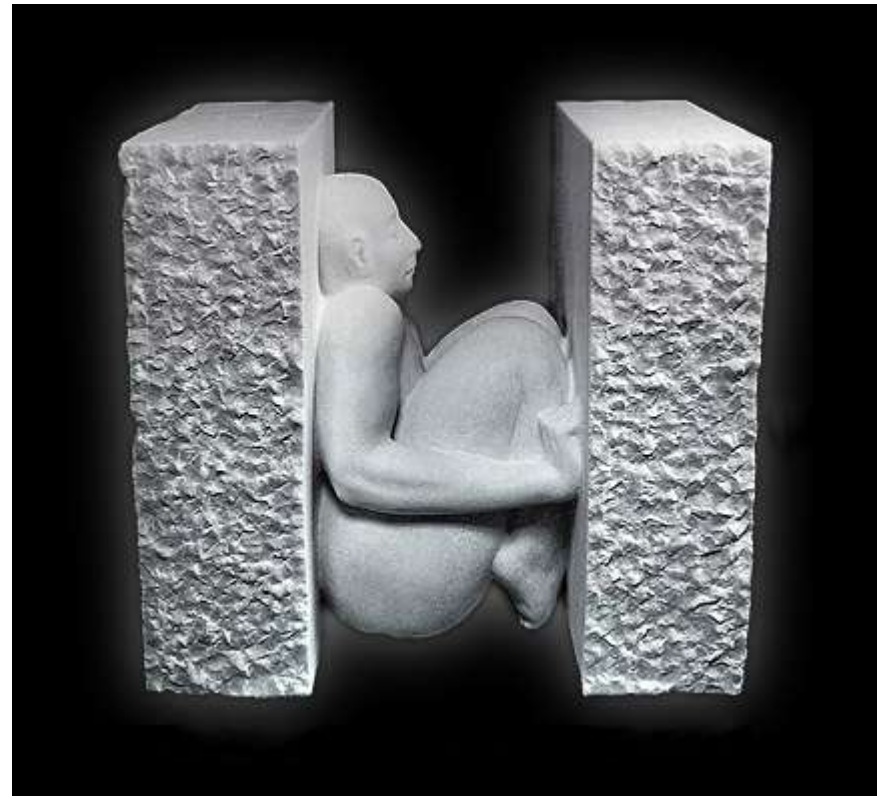


Vicious cycles, and breaking out of them

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

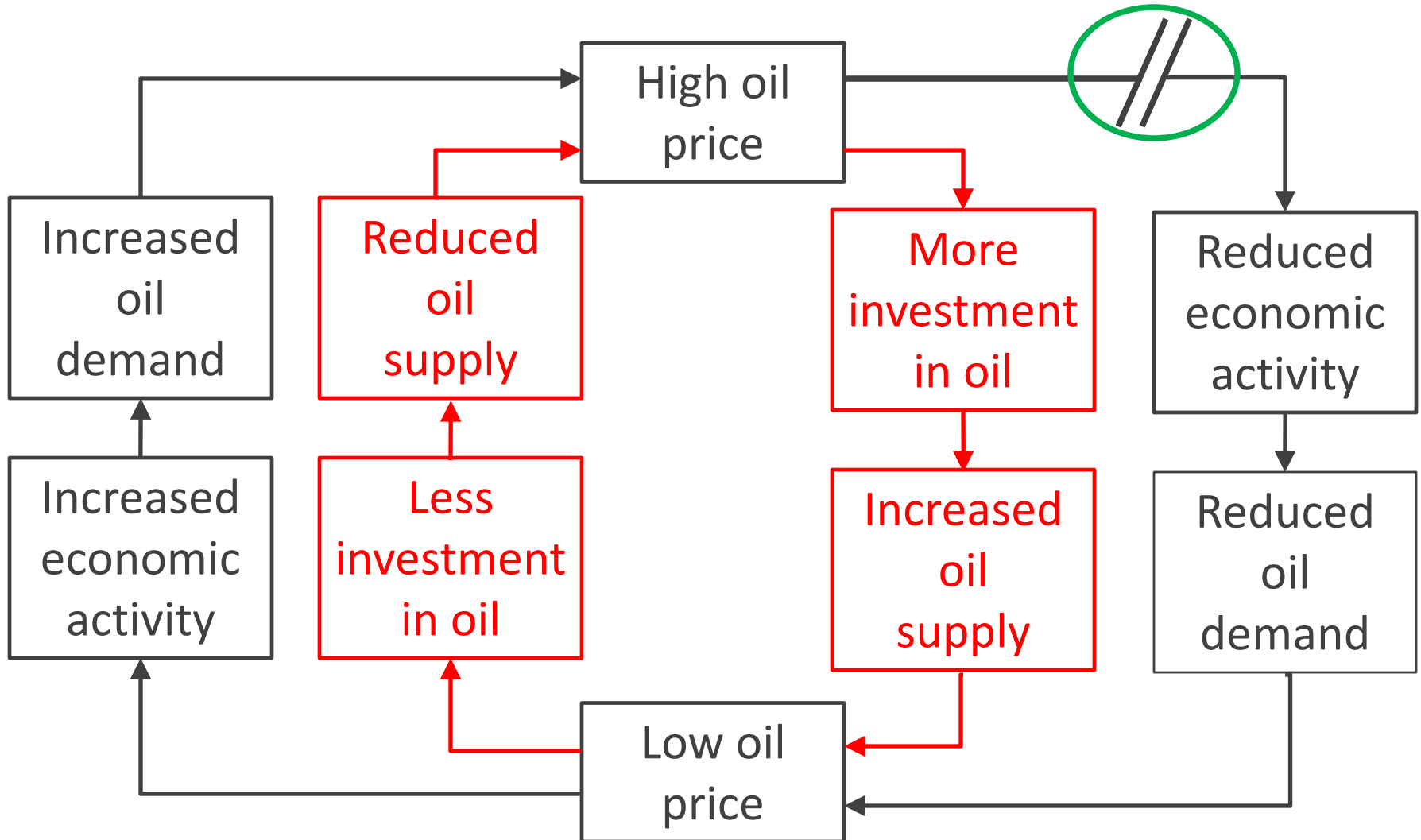
The **rock** is that even curbing the rate of depletion of oil production may require oil to be above \$80/barrel.

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.

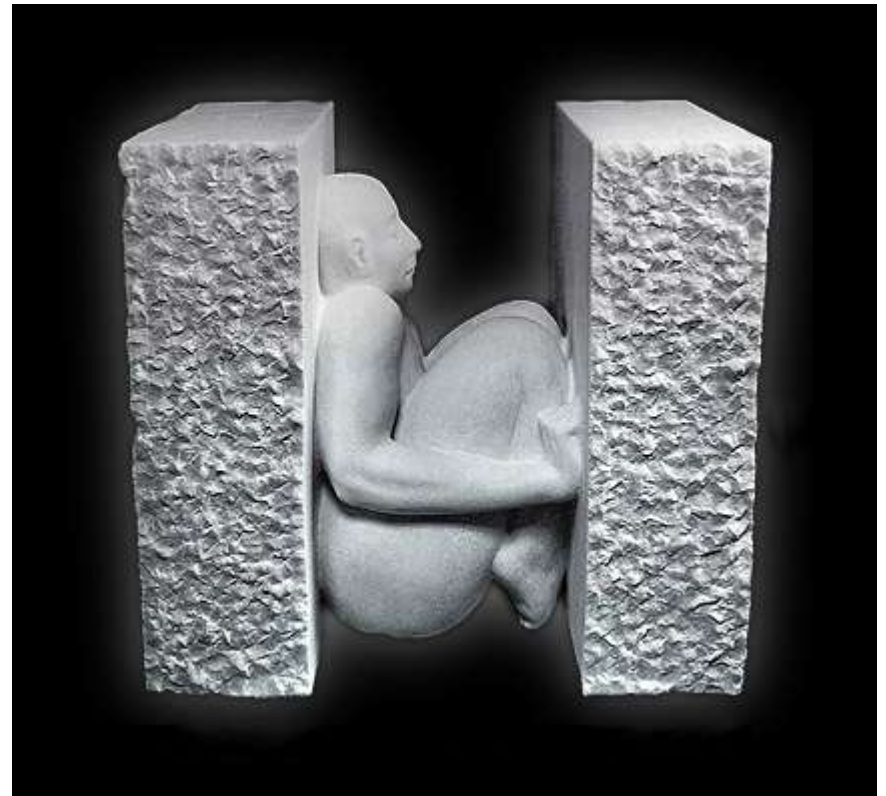


Vicious cycles, and breaking out of them

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.



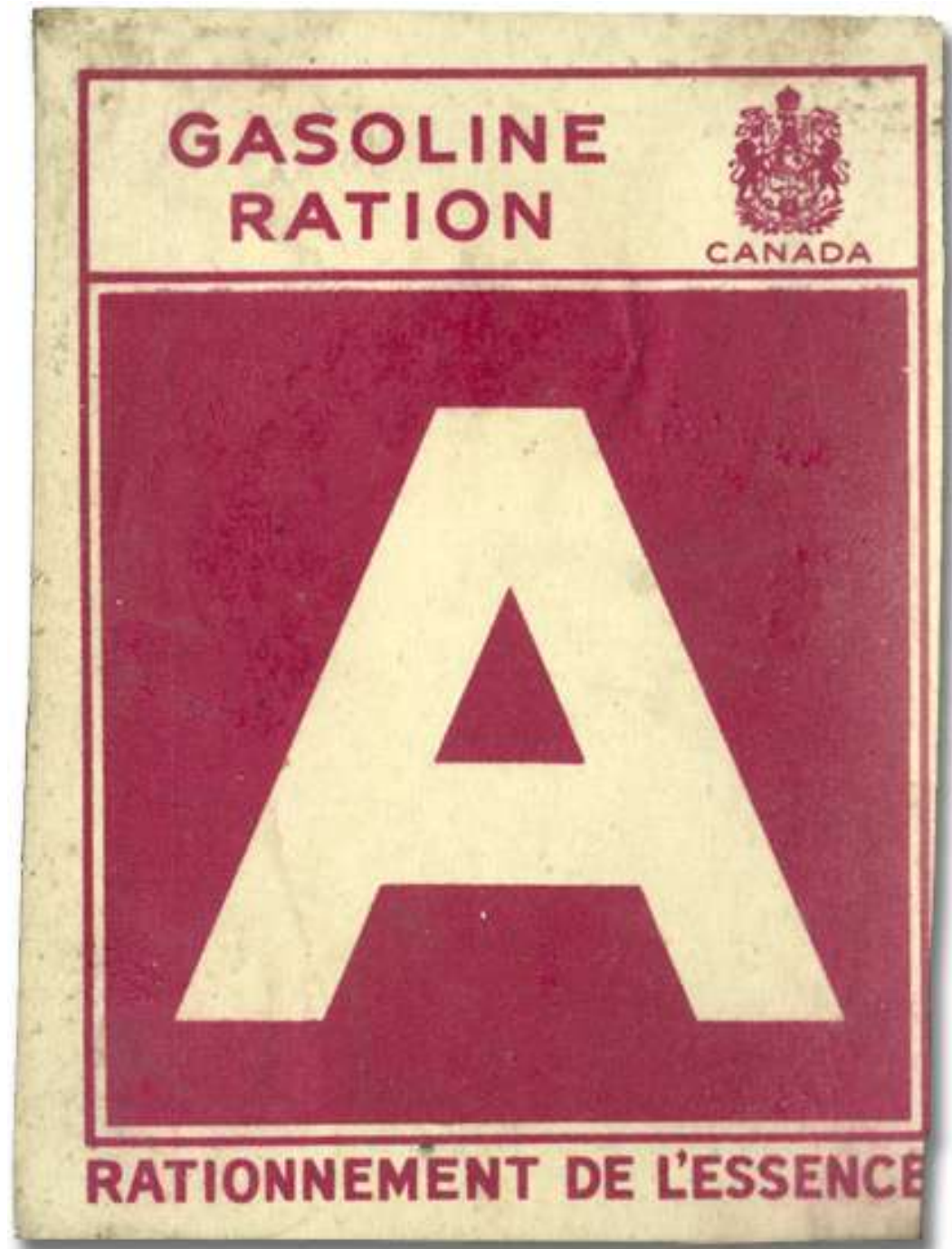
Vicious cycles,
and breaking
out of them

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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Grid-connected
electric traction
is best

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.**”

Quotation is from B.D. Solomon, Biofuels and sustainability, *Annals of the New York Academy of Sciences* 1185 (2010)

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.



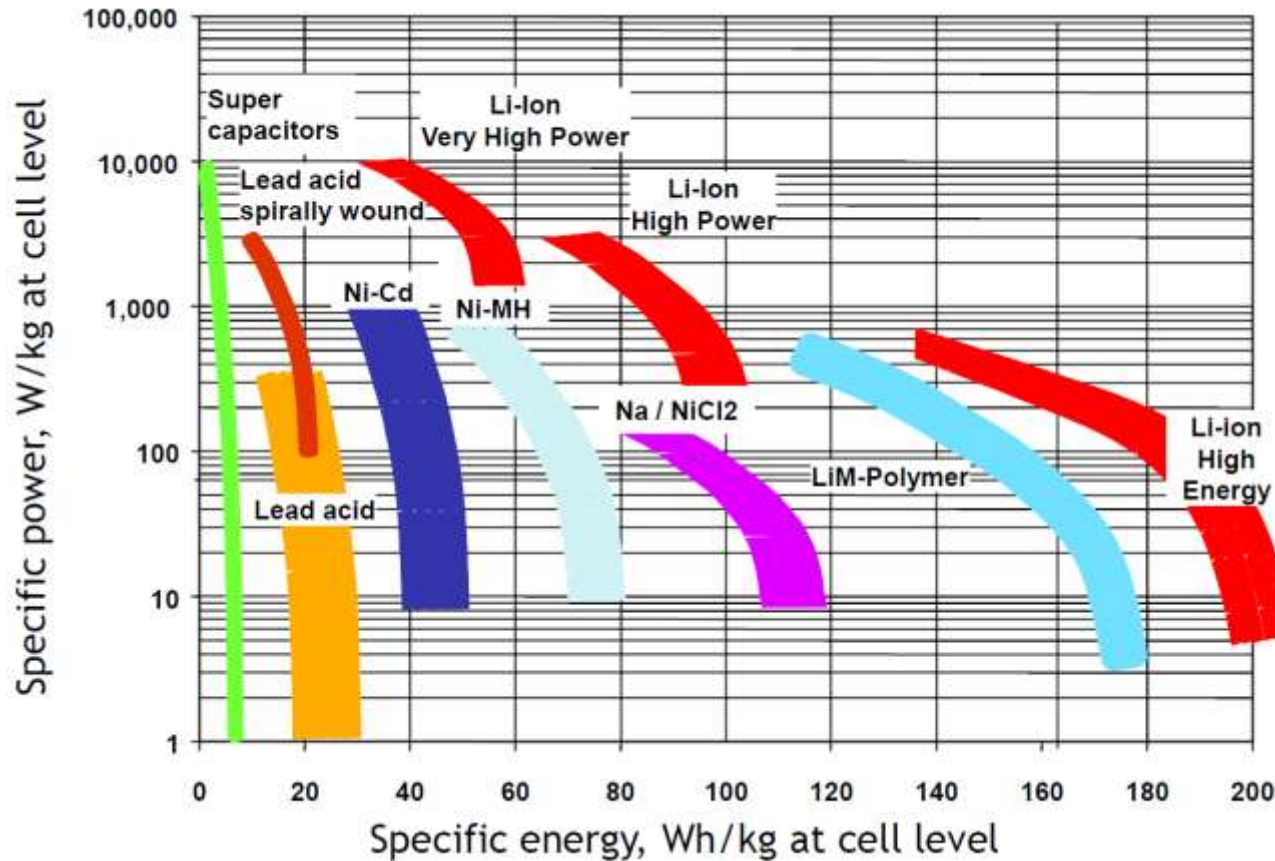
Grid-connected
electric traction
is best

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 (EESstor), 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.

Grid-connected electric traction is best

A fuel-cell solution is impracticable because of reliability, cost and, above all, high energy losses



50%
loss



50%
loss



HONDA FUEL-CELL CAR (FCX)

Total energy loss from turbine to motor \approx 75%
(80% if hydrogen is liquefied for distribution)



CALGARY LIGHT-RAIL TRAIN

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

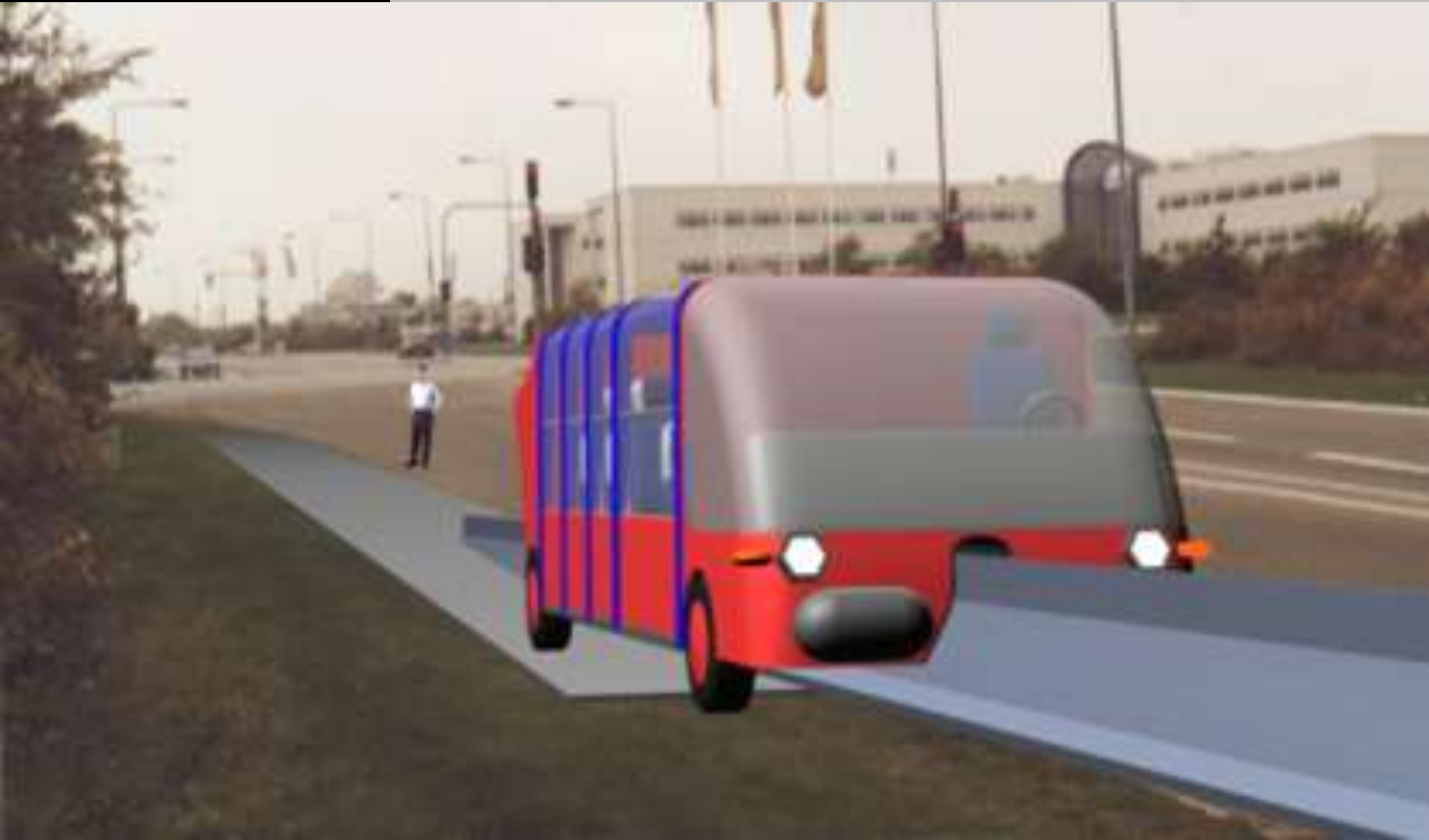
Trucks can have grid-connected electric traction, such as this truck in a Canadian-owned mine in Nevada.



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Personal Rapid Transit (PRT) is grid-connected

How might personal automobiles be grid-connected? This is one kind of suggestion.



Personal Rapid Transit (PRT) is grid-connected

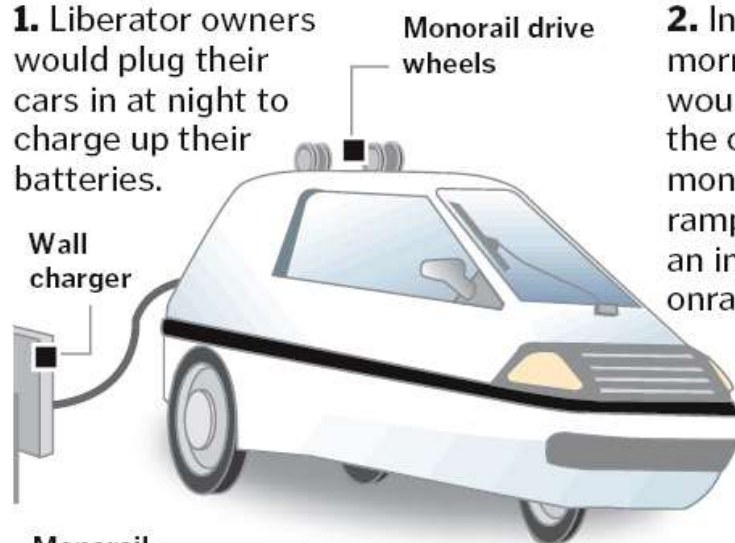
Here is another.

The monorail may just be the road of tomorrow

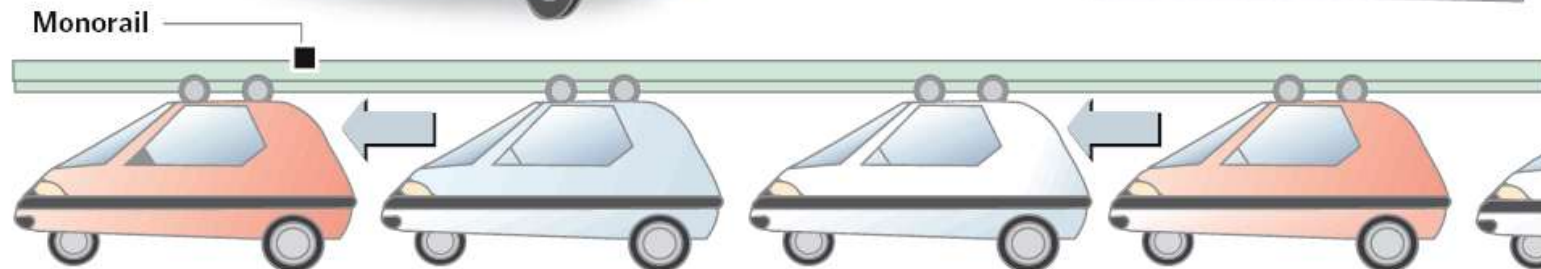
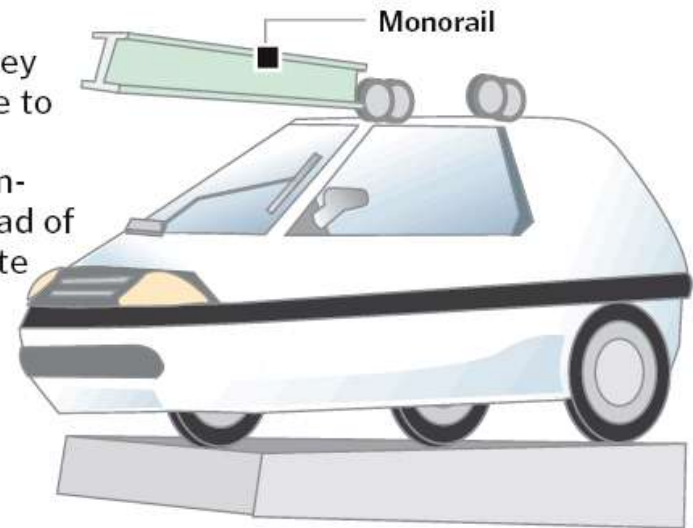
Cincinnati investors Jay Andress and Andy Webster have developed the MonoMobile Liberator, an electric car that could use city streets or a monorail to get around town.

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

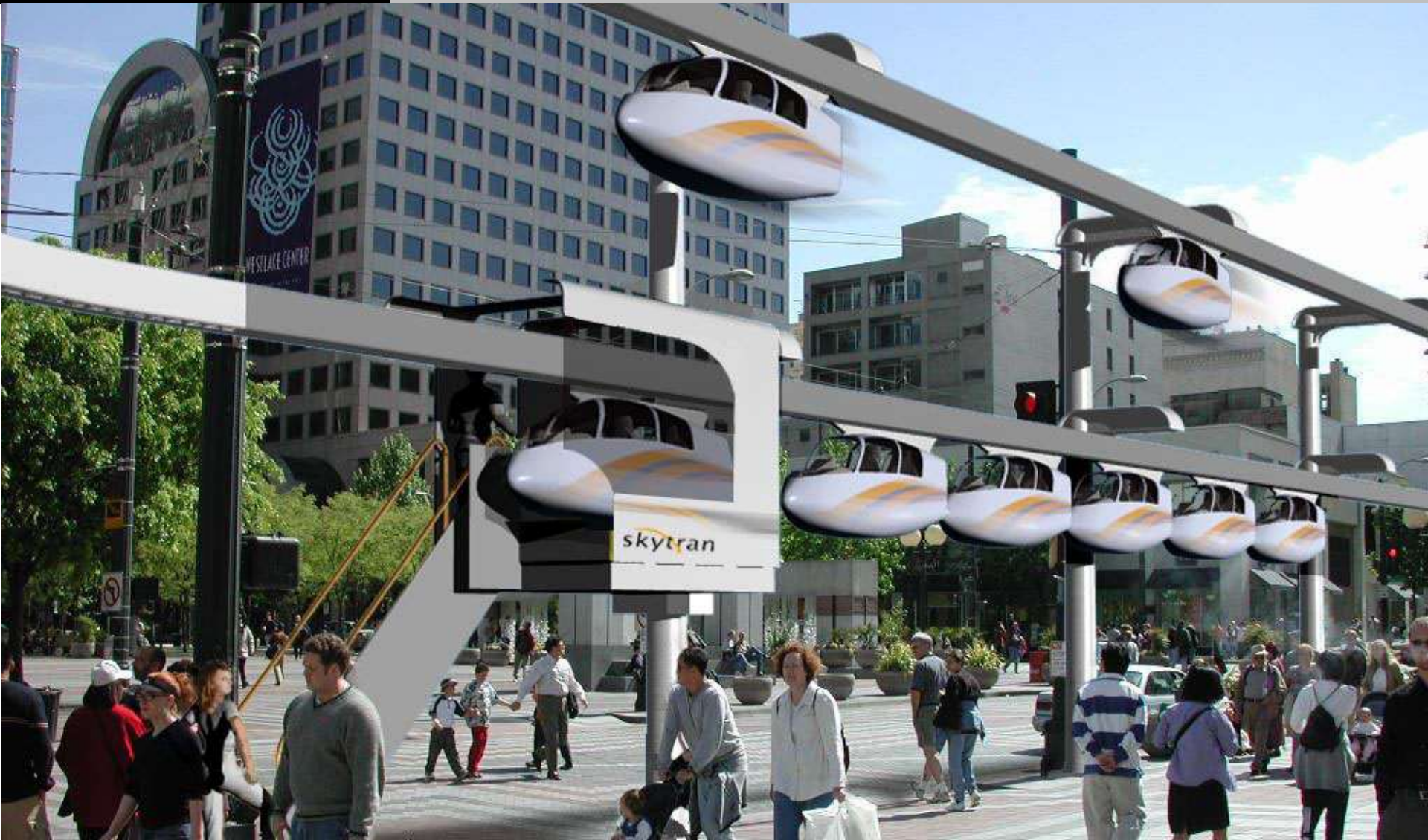
September 26, 2009

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.



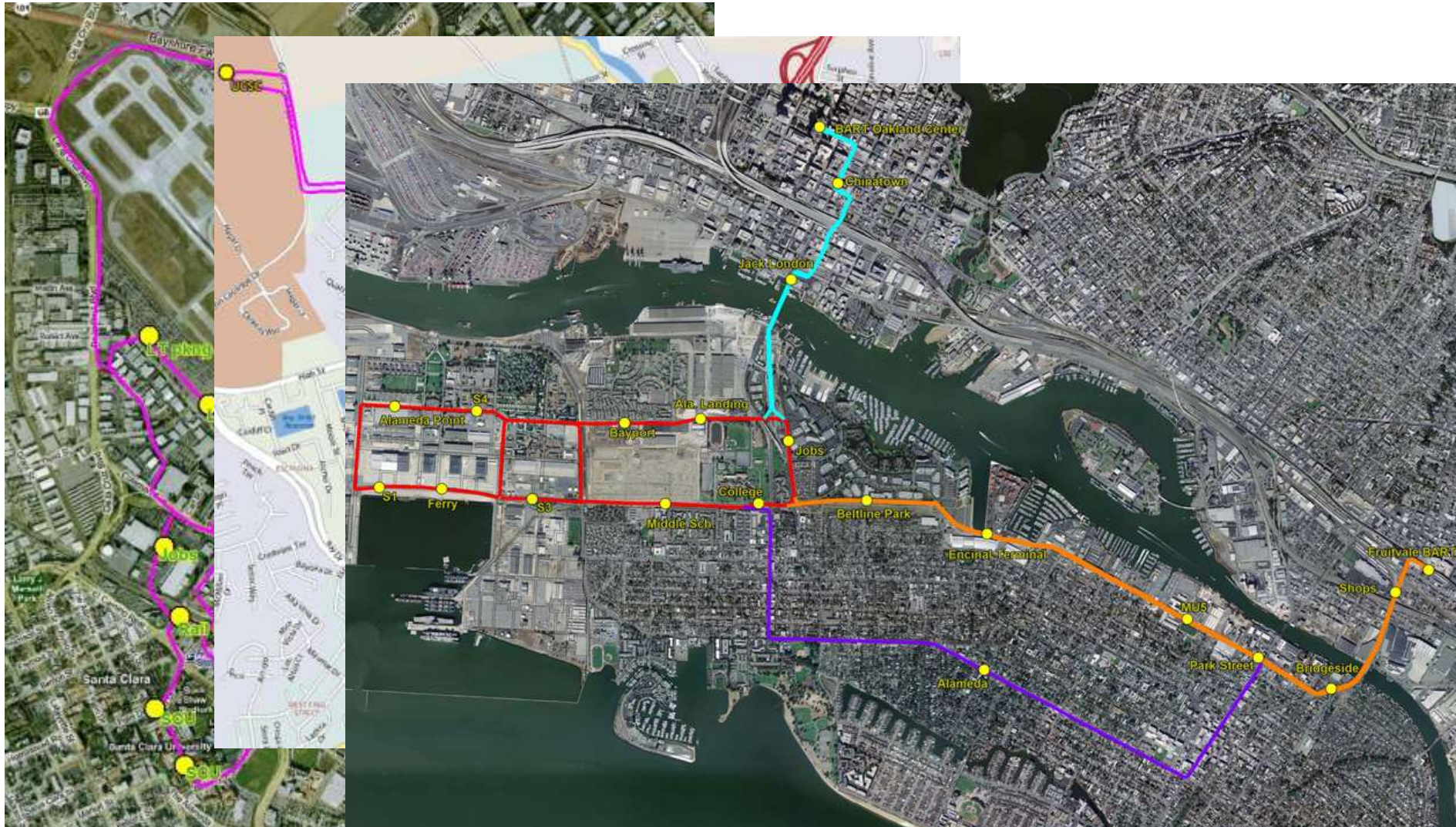
Personal Rapid
Transit (PRT) is
grid-connected

And this proposal for
Götgatan, Stockholm, Sweden.



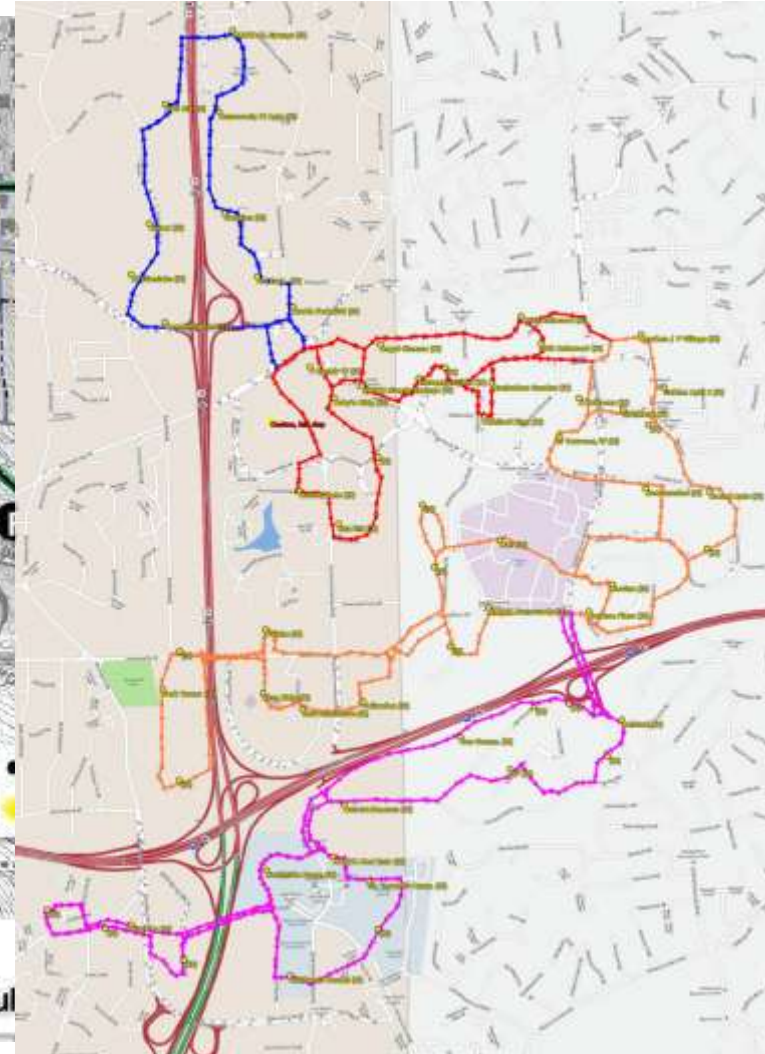
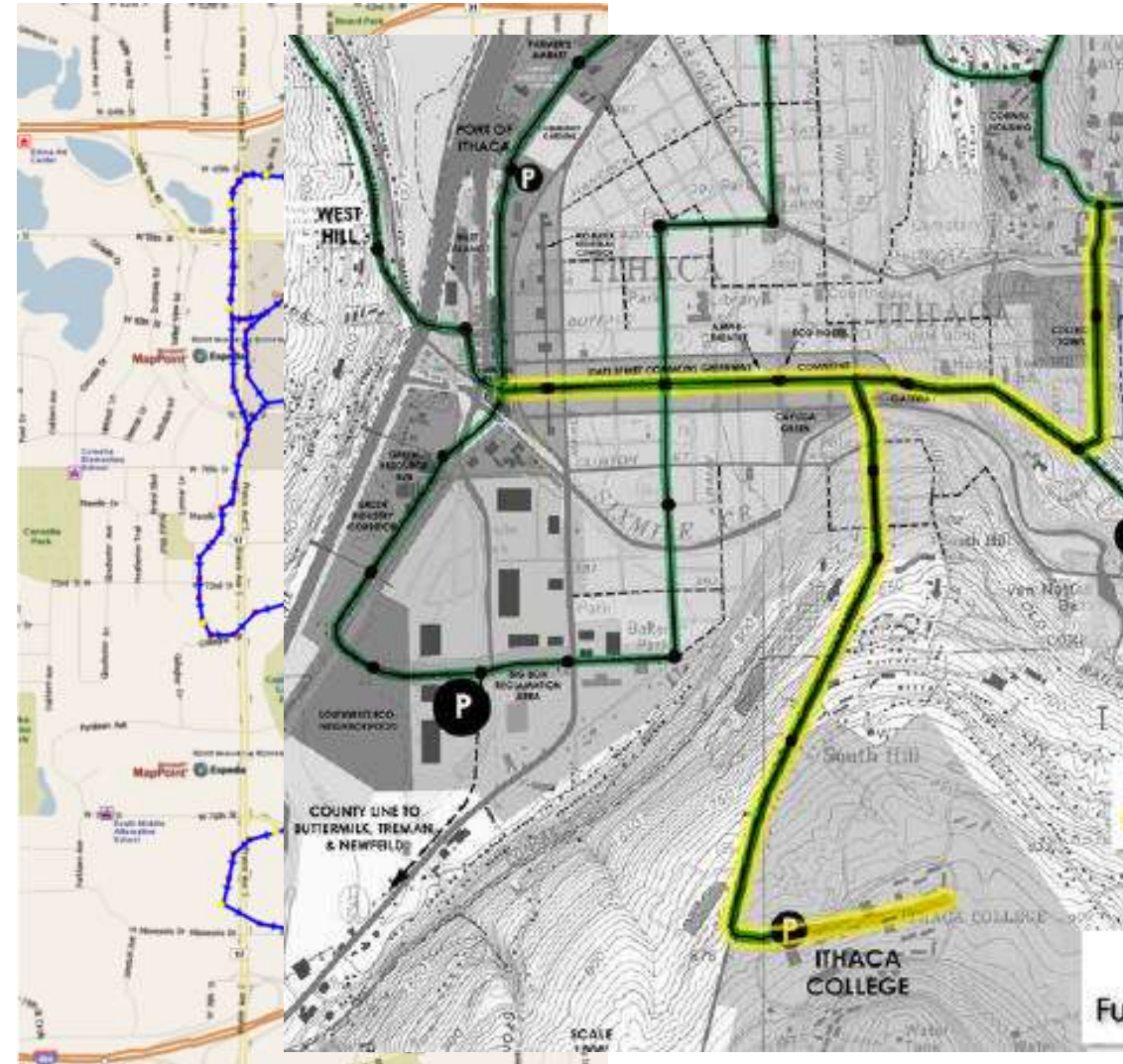
Personal Rapid Transit (PRT) is grid-connected

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.



Personal Rapid
Transit (PRT) is
grid-connected

Virginia is interested.

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)

Personal Rapid Transit (PRT) is grid-connected

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?

	Construction cost in \$million/km	Time for a 6.4-km direct trip in minutes	Time for a 12.8-km trip, one transfer, in minutes	Average capacity persons/hour/direction	Yearly millions of person-kilometres for each two-way km of service	Capital cost per person-kilometre in dollars	Operating cost per person-kilometre in dollars	Total cost per person-kilometre in dollars	Total cost compared with PRT
Subway	300	15.0	35.0	14,400	189.2	0.10	0.25	0.35	1.05
LRT subway	300	19.0	43.0	3,300	43.4	0.45	0.42	0.87	2.59
LRT surface	69	19.0	43.0	3,300	43.4	0.10	0.42	0.52	1.56
PRT (two-way)	30	11.4	21.9	4,100	53.9	0.04	0.30	0.34	1.00

Main source: Carnegie & Hoffman, *Viability of PRT in New Jersey*, Report to the Governor and Legislature, February 2007

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).



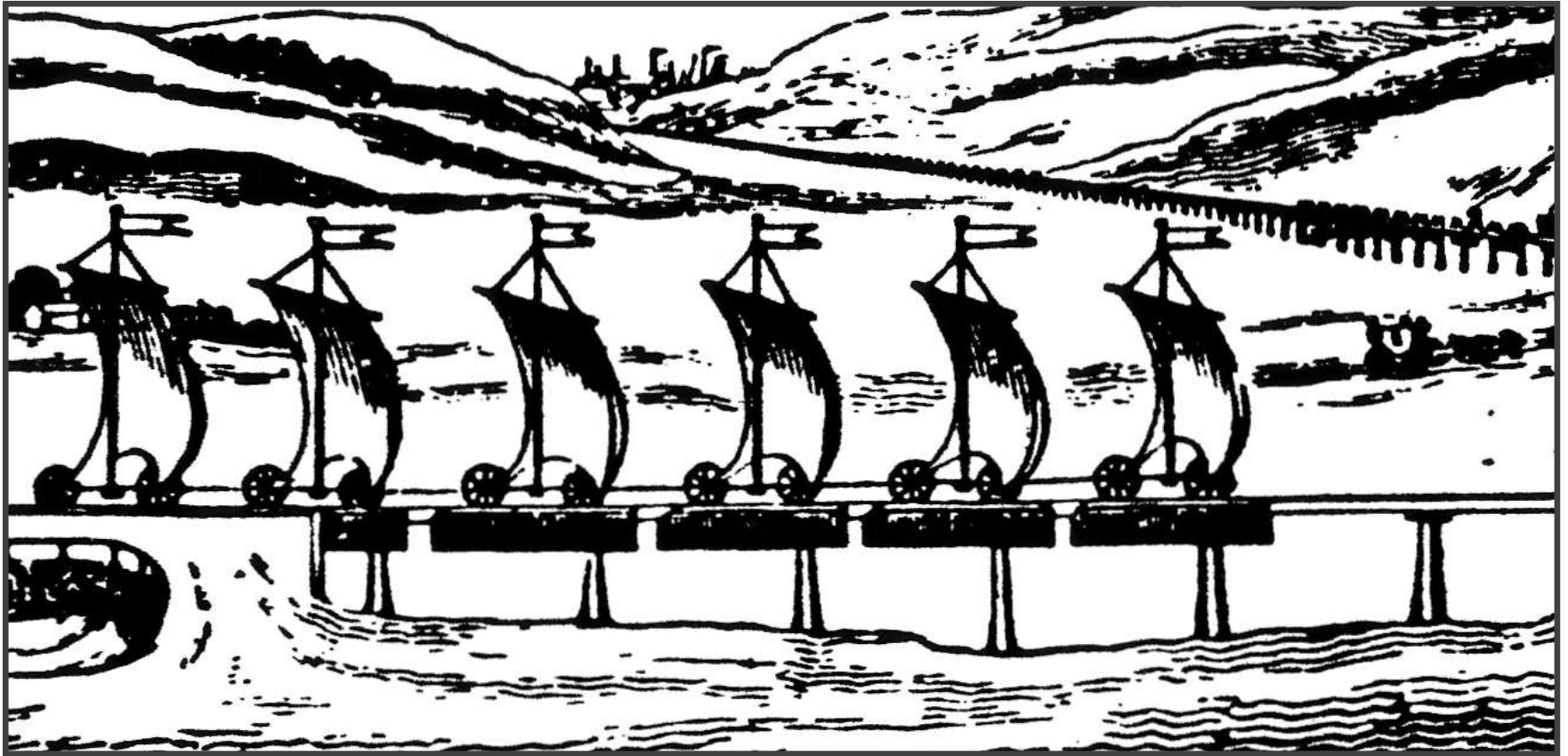
Personal Rapid Transit (PRT) is grid-connected

Trams with underground powering had been in operation for decades. Here is a shot from 1919. Note the exposed operator.



And, of course, PRT can be very eco-friendly

Monorail using sails proposed by Henry R. Palmer in 1828



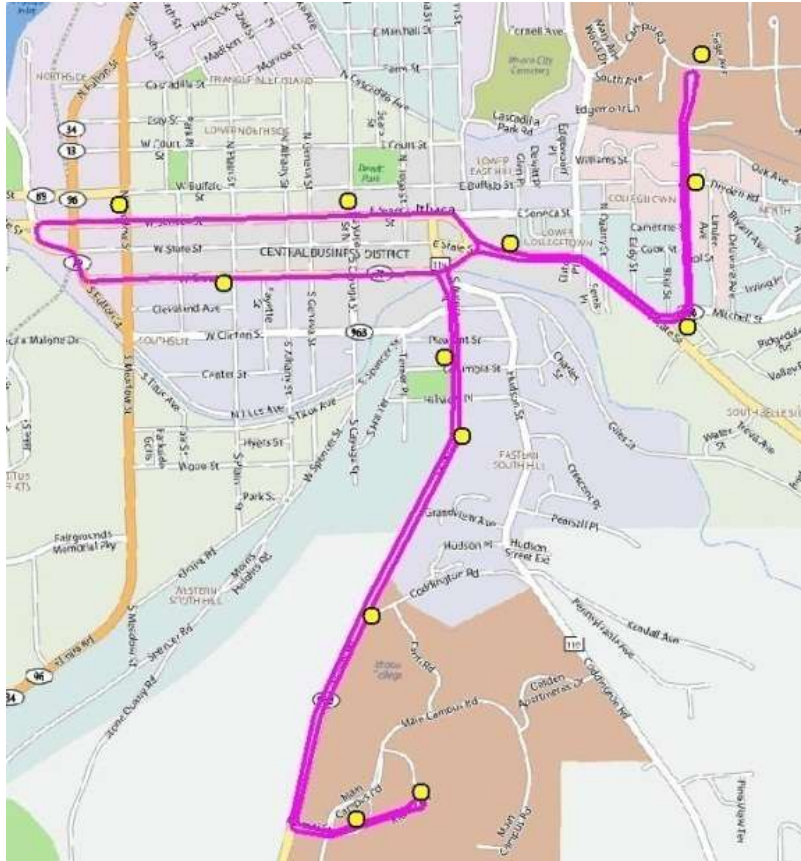
Source: Marshall (1938) via Nakićenović (2006)

THANKS FOR YOUR INTEREST!

Unused slides

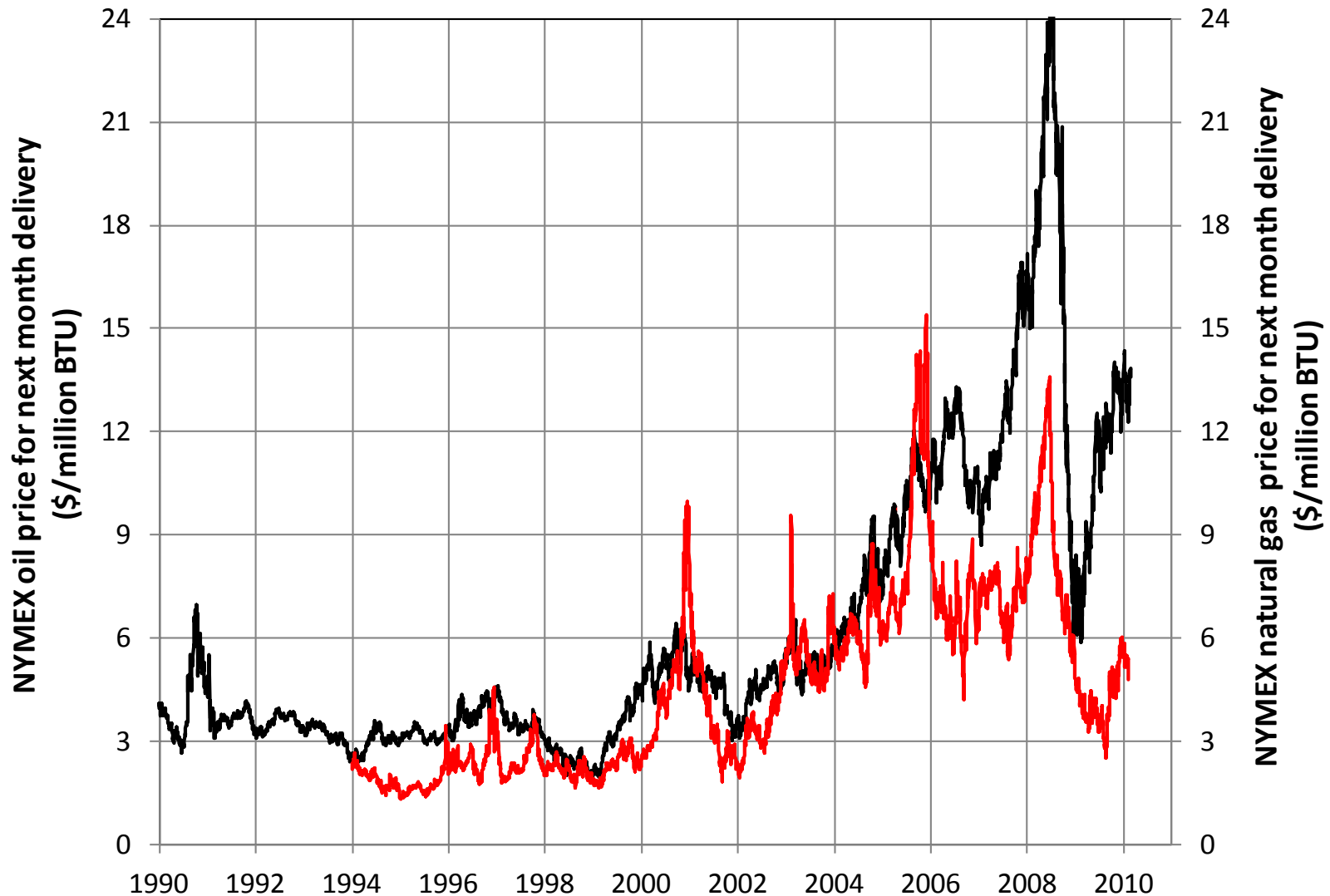
There is so much development going on right in this area. In 5 or 10 years we'll have gridlock on (recently expanded) Highway 101/85 merge. We'll need an alternative. The proposal to connect Google, NASA, and Caltrain makes sense as an alternative. **PRT will be like a dam breaking.** We're all frustrated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

Google employee



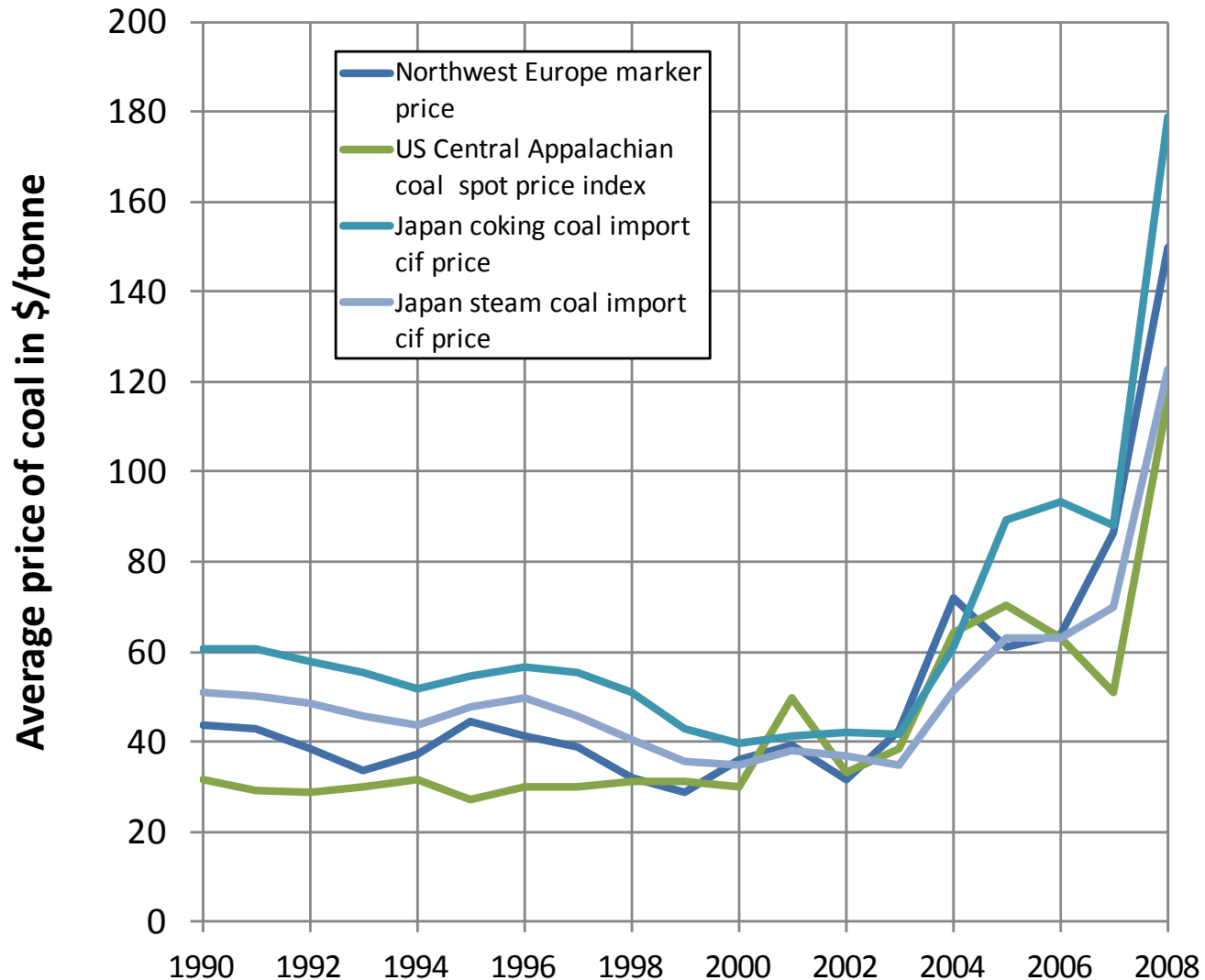
Energy turmoil in 2008-2009

Here are oil and natural gas prices per unit of energy. Oil has mostly been more valuable, 2003-2006 being the main exception



Energy turmoil in 2008-2009

Other coal prices went up steeply in 2008.
(Later data are not available.)



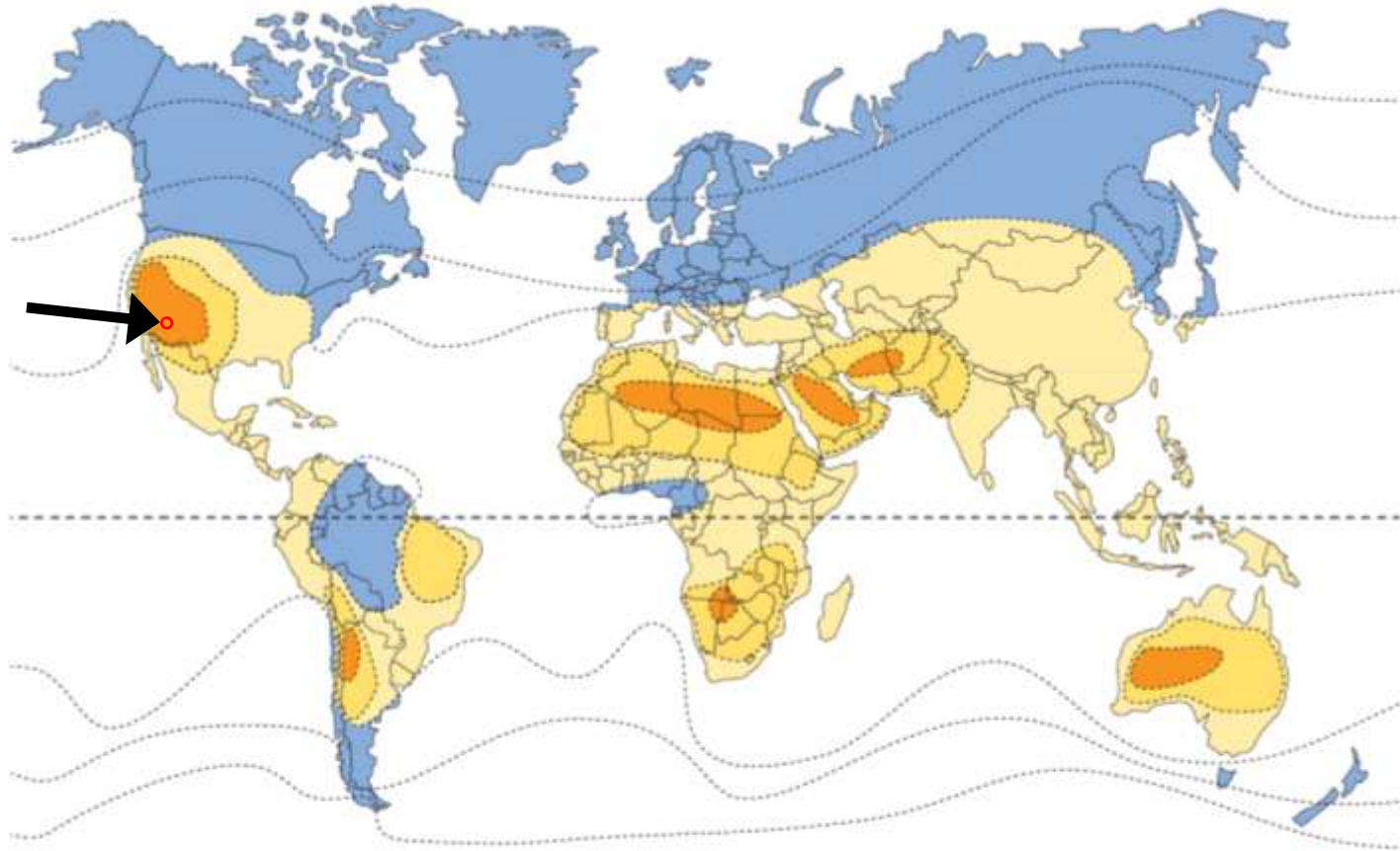
Energy turmoil in 2008-2009

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



Suitability for solar thermal power plants:

■ Excellent ■ Good ■ Suitable ■ Unsuitable