Hamilton: Electric City

Richard Gilbert

Presentation at the
Annual General Meeting of
Environment Hamilton
Hamilton Central Library
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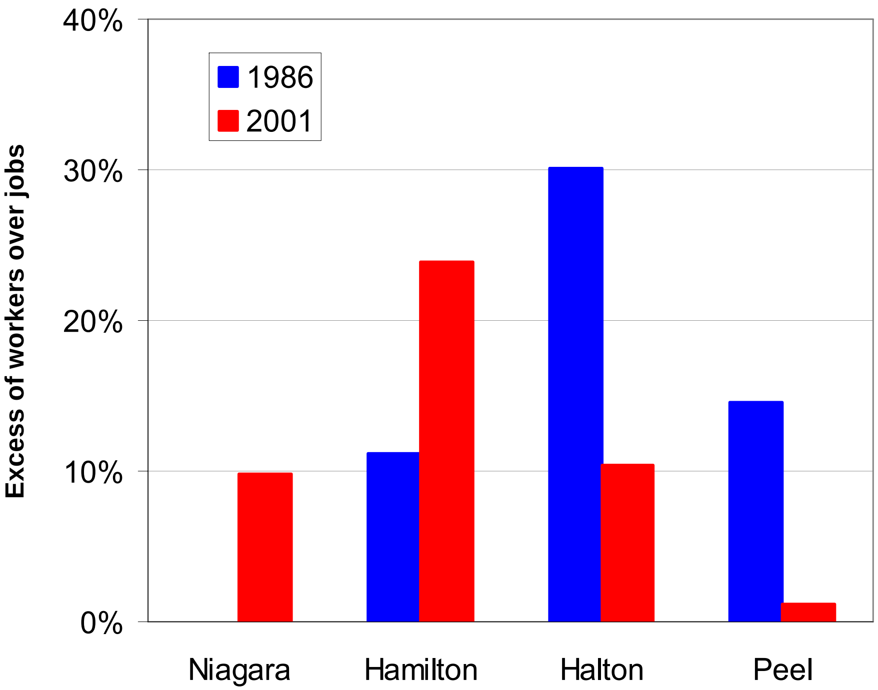
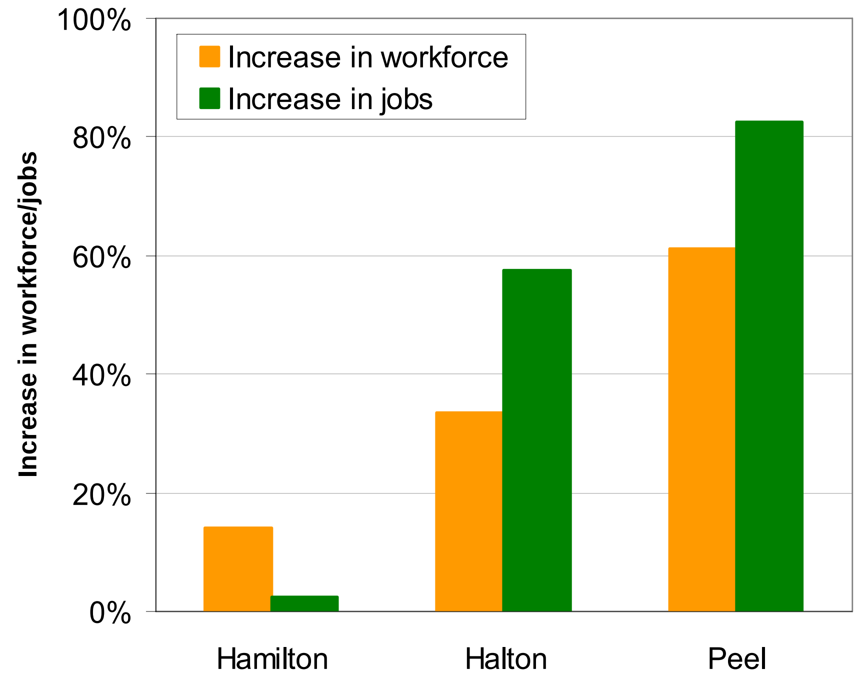
Here's the nub of Hamilton's economic challenge: the growing jobs deficit





Data source for both charts: *Transportation Tomorrow Survey 1986 and 2001*, Joint Program in Transportation, University of Toronto, 2006

The left-hand chart shows that increasingly Hamilton residents must travel out of the city to work. Halton and Peel are reducing the gap between workforce and jobs. Niagara Region (no 1986 data) has a much smaller gap than Hamilton.

The right-hand chart shows the same thing in a different way. Between 1986 and 2001, Halton and Peel added many more jobs than workers. Hamilton, with much lower growth in the workforce, added even fewer jobs.

Hamilton 'The Electric City'

1. In the 1880s, Hamilton was one of the first cities in the world to have widespread electric light—for streets, homes, and businesses. Hamilton was known as 'The Electric City'.

2. Hamilton could again be 'The Electric City', in the forefront of the transition to electric transport, new electricity generation, and greatly reduced reliance on fossil fuels.

3. Much of the port and the area between the port and the downtown could become a huge R&D centre for the coming energy-constrained world, with development of vehicle systems (e.g., PRT), building systems (e.g., geoexchange), and small-scale electricity generation. The whole city could become a test bed for our energy-poor, electric future.

4. The thrust of this presentation is that embracing the 'Electric City' vision could be a plausible, job-rich economic strategy for a community that chooses to face the likely energy realities of the 21st century.

This presentation has four main parts

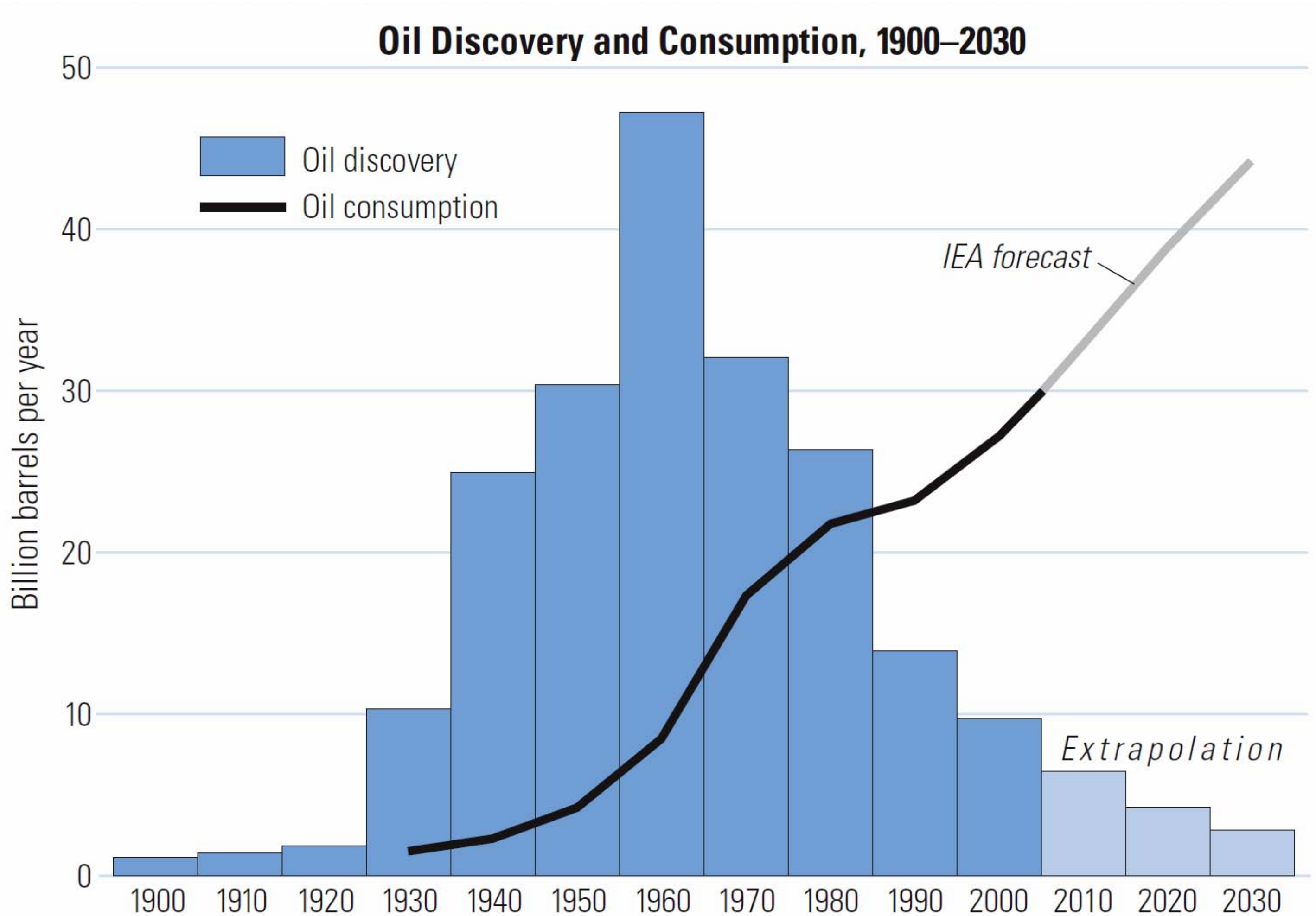
1. Energy challenges: Why there could be fourfold increases in retail prices from peaking in oil and natural gas production. [21 slides]

2. Energy consumption in Hamilton, in buildings and for transport: How they should/could be substantially reduced, with electricity's share rising from 20% of end use now to more than 50% by 2018 (remaining about the same overall). [18½ slides]

3. Energy production in Hamilton: Raise the share produced in Hamilton from essentially zero now to 100% for electricity and 50% for other energy. [8½ slides]

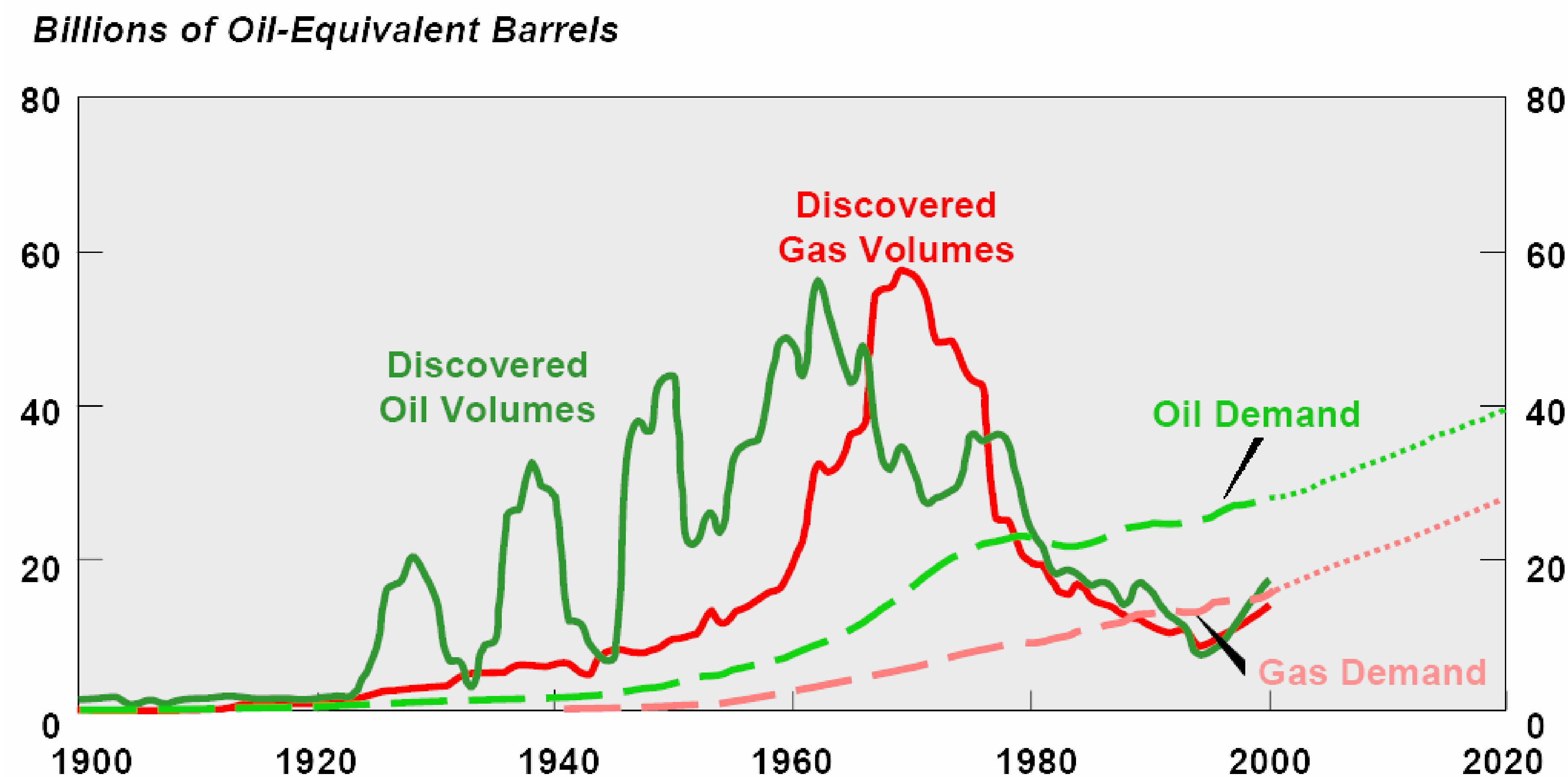
4. Energy opportunities: On both the consumption and production sides, situate Hamilton ahead of the wave rather than drowning in it; put energy first in all planning; develop and implement an economic development strategy that makes Hamilton again the 'Electric City'. [6 slides]

Here's the nub of the oil problem: discoveries are not keeping up with consumption



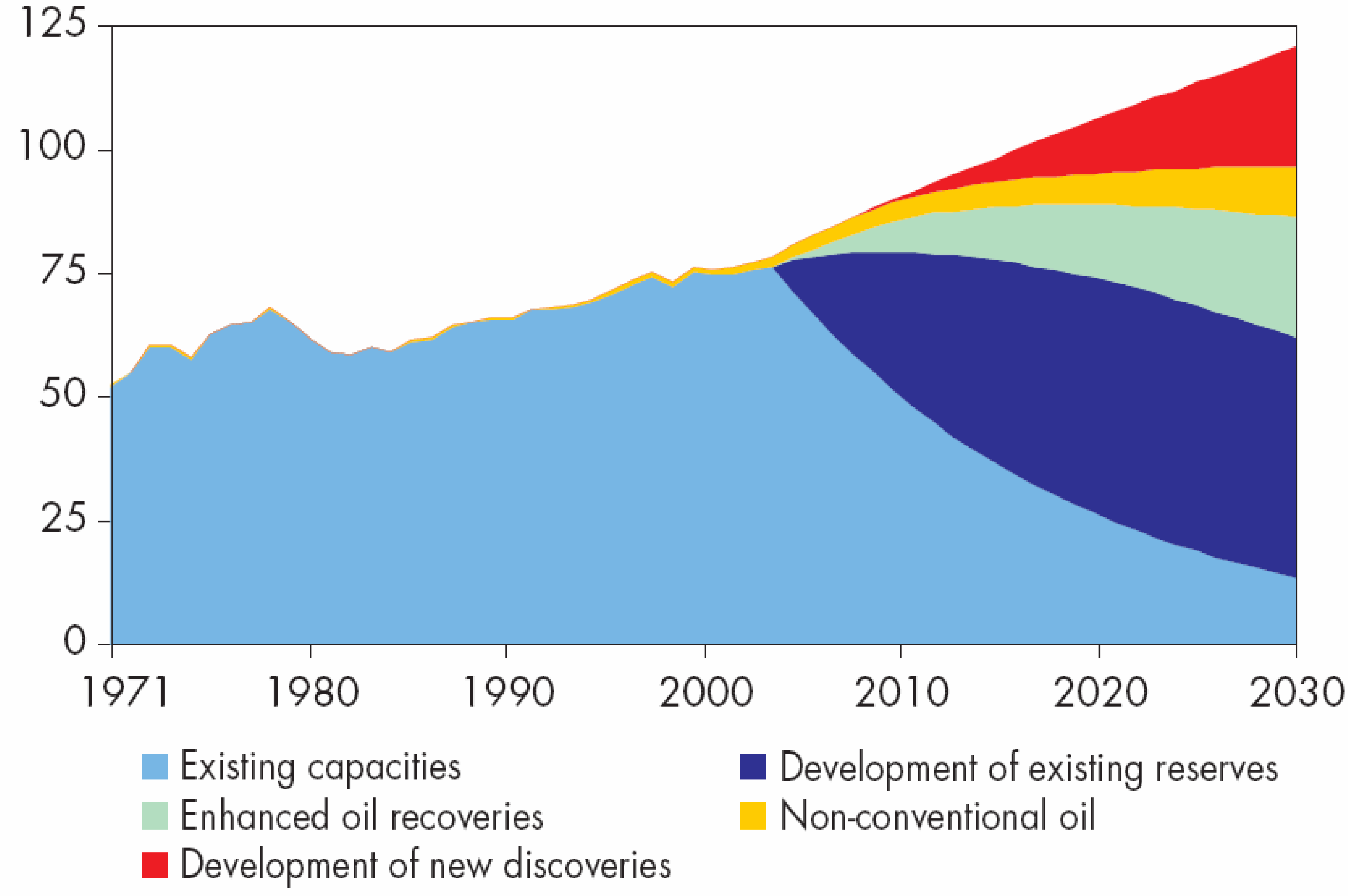
Source: Kjell Aleklett, Oil: a bumpy road ahead. *World Watch*, 19(1), 10-12, 2006

Here's the same thing from Exxon Mobil, and for natural gas



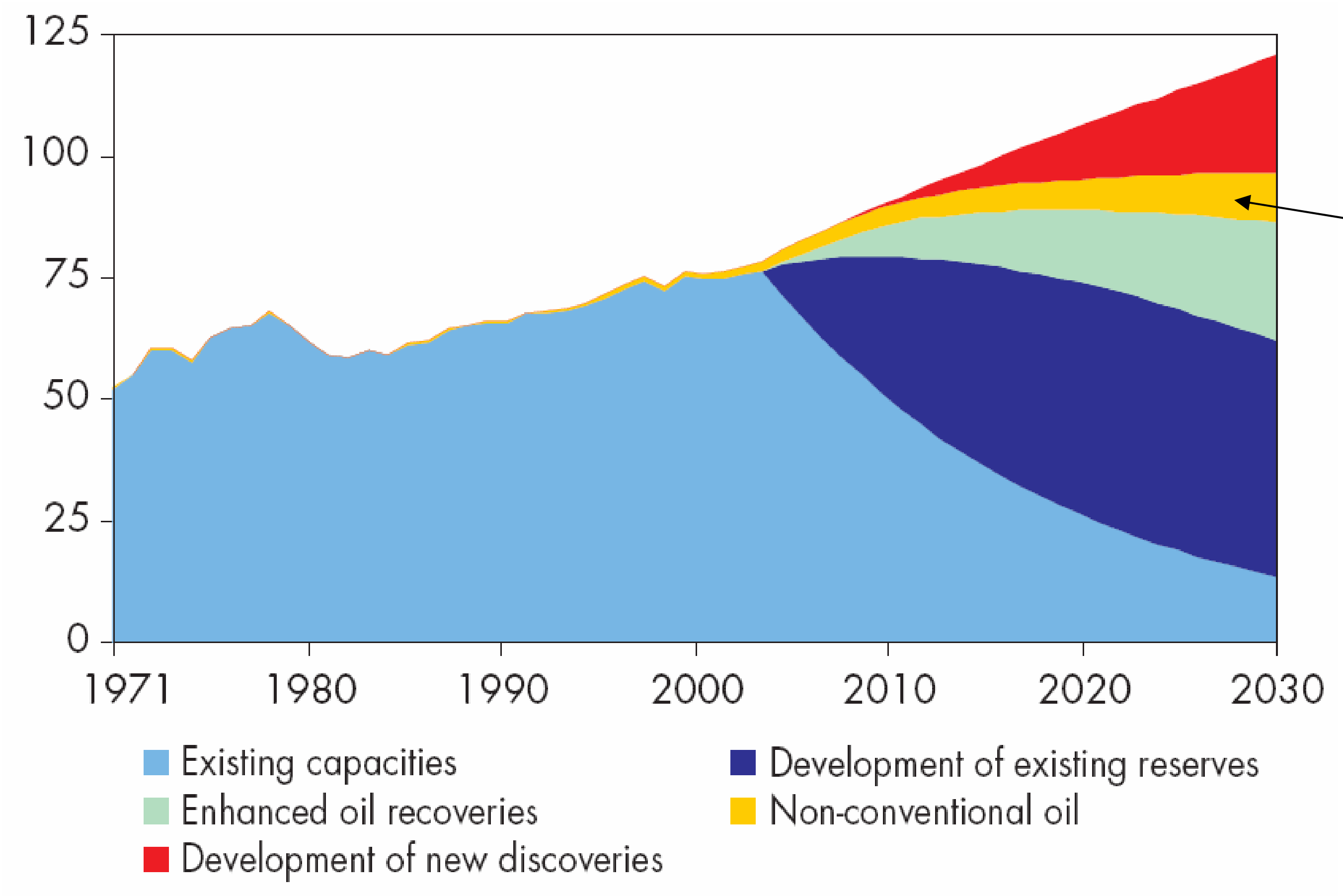
Source: Presentation by Harry J. Longwell, Executive VP, Exxon Mobil Corp., at the Offshore Technology Conference, Houston, Texas, May 2002

Here's where the International Energy Agency believes the new oil is coming from (in millions of barrels per day)



Source: *World Energy Outlook 2004*, International Energy Agency, 2006

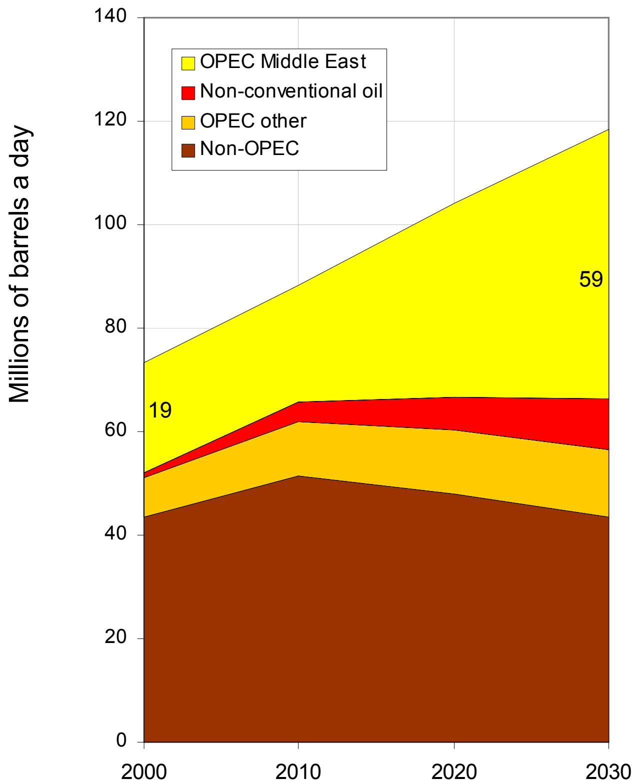
Only one of the IEA's four sources of oil —non-conventional oil—is uncontested



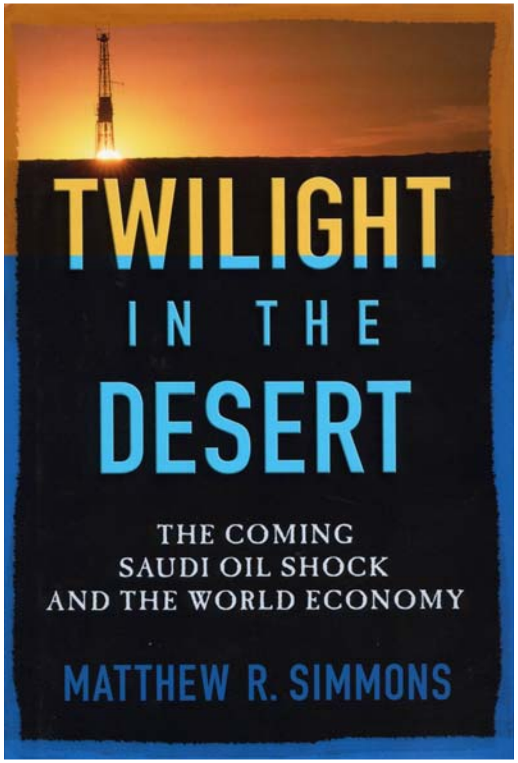
Oil from oil sands, coal, and from places that are hard to reach (e.g., Arctic, off-shore)

IEA says almost all of the new oil from the other three sources—existing reserves, new discoveries, enhanced recovery—will come from the Middle East

IEA's view of world oil production by source, 2000-2030



Simmons says there is doubt whether Saudi Arabia can even maintain the current production of 9.5 mb/d.



IEA: "Of the projected 31 mb/d rise in world oil demand between 2010 and 2030, 29 mb/d will come from OPEC Middle East … Saudi Arabia, Iraq, and Iran are likely to contribute most of the increase."

Almost all of the oil in the world is controlled by government-owned companies, who play games with data

The Economist forgot to include Shell. It fits in about here

Oil's rich list

Top 20 oil companies, by reserves, 2003

		State ownership, %	m barrels
Saudi Aramco	Saudi Arabia	100	259,400
NIOC	Iran	100	125,800
INOC	Iraq	100	115,000
KPC	Kuwait	100	99,000
PDV	Venezuela	100	77,800
Adnoc	UAE	100	55,200
Libya NOC	Libya	100	22,700
NNPC	Nigeria	100	21,200
Pemex	Mexico	100	16,000
Lukoil	Russia	8	16,000
Gazprom	Russia	73	13,600
Exxon Mobil	US	-	12,900
Yukos*	Russia	-	11,800
PetroChina	China	90	11,000
Qatar Petroleum	Qatar	100	11,000
Sonatrach	Algeria	100	10,500
BP	Britain	-	10,100
Petrobras	Brazil	32	9,800
Chevron Texaco†	US	-	8,600
Total	France	-	7,300

*Now in effect controlled by government
†Does not include newly acquired Unocal

Source: *Petroleum Intelligence Weekly*

Source: *The Economist* (April 28, 2005)

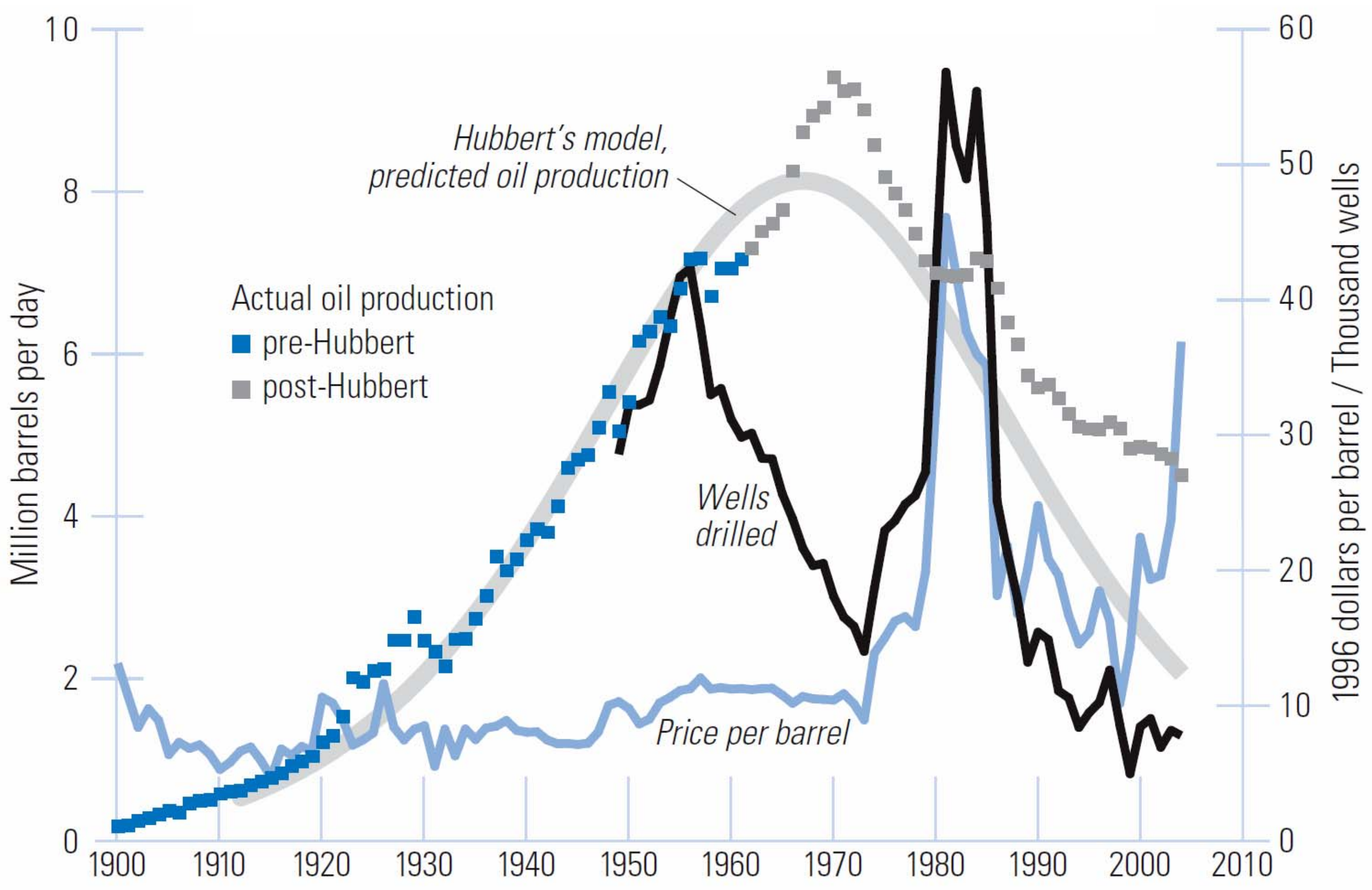
Here are the official reports on OPEC Middle East reserves

	A. Dhabi	Iran	Iraq	Kuwait	N. Zone	S.Arabia	Venezuela
1980	28	58	31	65	6.1	163	18
1981	29	58	30	66	6.0	165	18
1982	31	57	30	65	5.9	164	20
1983	31	55	41	64	5.7	162	22
1984	30	51	43	64	5.6	166	25
1985	31	49	45	90	5.4	169	26
1986	30	48	44	90	5.4	169	26
1987	31	49	47	92	5.3	167	25
1988	92	93	100	92	5.2	167	56
1989	92	93	100	92	5.2	170	58
1990	92	93	100	92	5.0	258	59
1991	92	93	100	95	5.0	259	59
1992	92	93	100	94	5.0	259	63
1993	92	93	100	94	5.0	259	63
1994	92	89	100	94	5.0	259	65
1995	92	88	100	94	5.0	259	65
1996	92	93	112	94	5.0	259	65
1997	92	93	113	94	5.0	259	72
1998	92	90	113	94	5.0	259	73
1999	92	90	113	94	5.0	261	73
2000	92	90	113	94	5.0	261	77
2001	92	90	113	94	5.0	261	78
2002	92	90	113	94	5.0	259	78
2003	92	126	115	97	5.0	259	78
2004	92	126	115	99	5.0	259	77

Source: Colin Campbell, ODAC, Edinburgh, (April 25, 2005)

It's hard to believe these figures bear much relation to reality. And yet this is what IEA projections have to be based on.

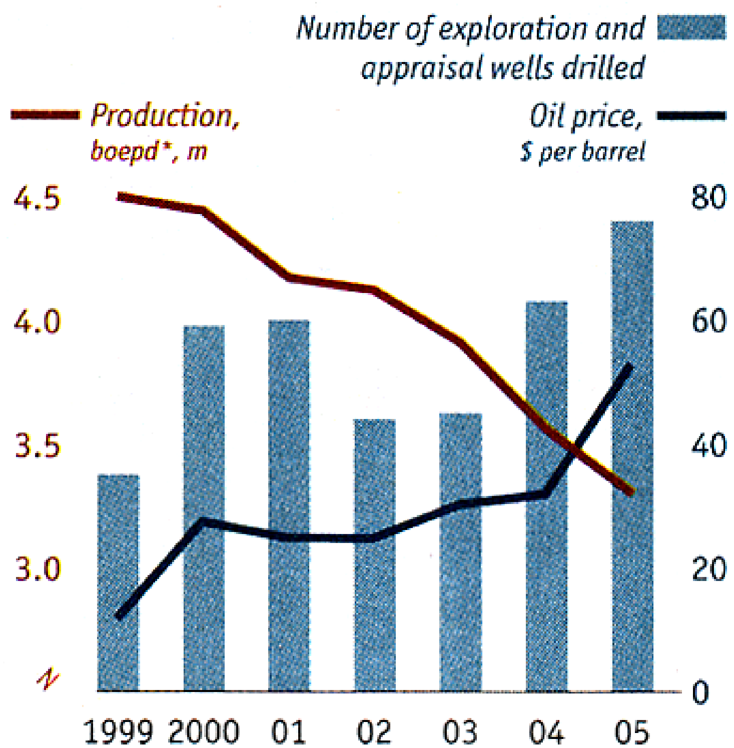
Here's the U.S. story: 48-state production peaked in early 1970s; high oil prices used to mean more drilling but not more discoveries and production



Source: Robert K. Kaufman, Planning for the peak in world oil production. *World Watch*, 19(1), 10-12, 2006

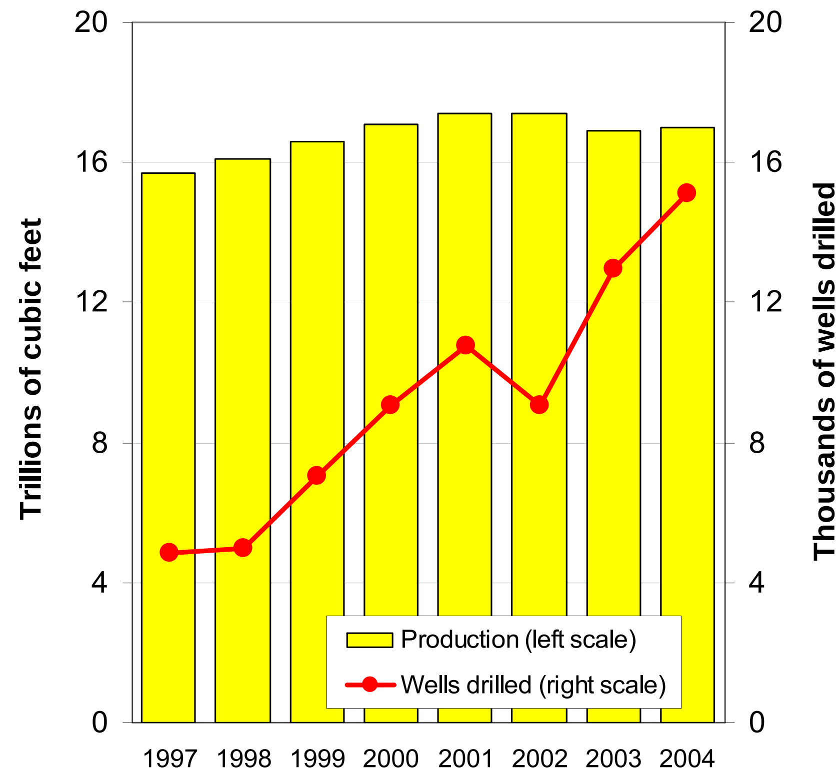
In UK part of the North Sea (on the left), drilling has risen with price, but production has declined. More drilling for natural gas in Canada (on the right) is not resulting in more production. Past the peak you have to run to stand still.

North Sea oil and natural gas



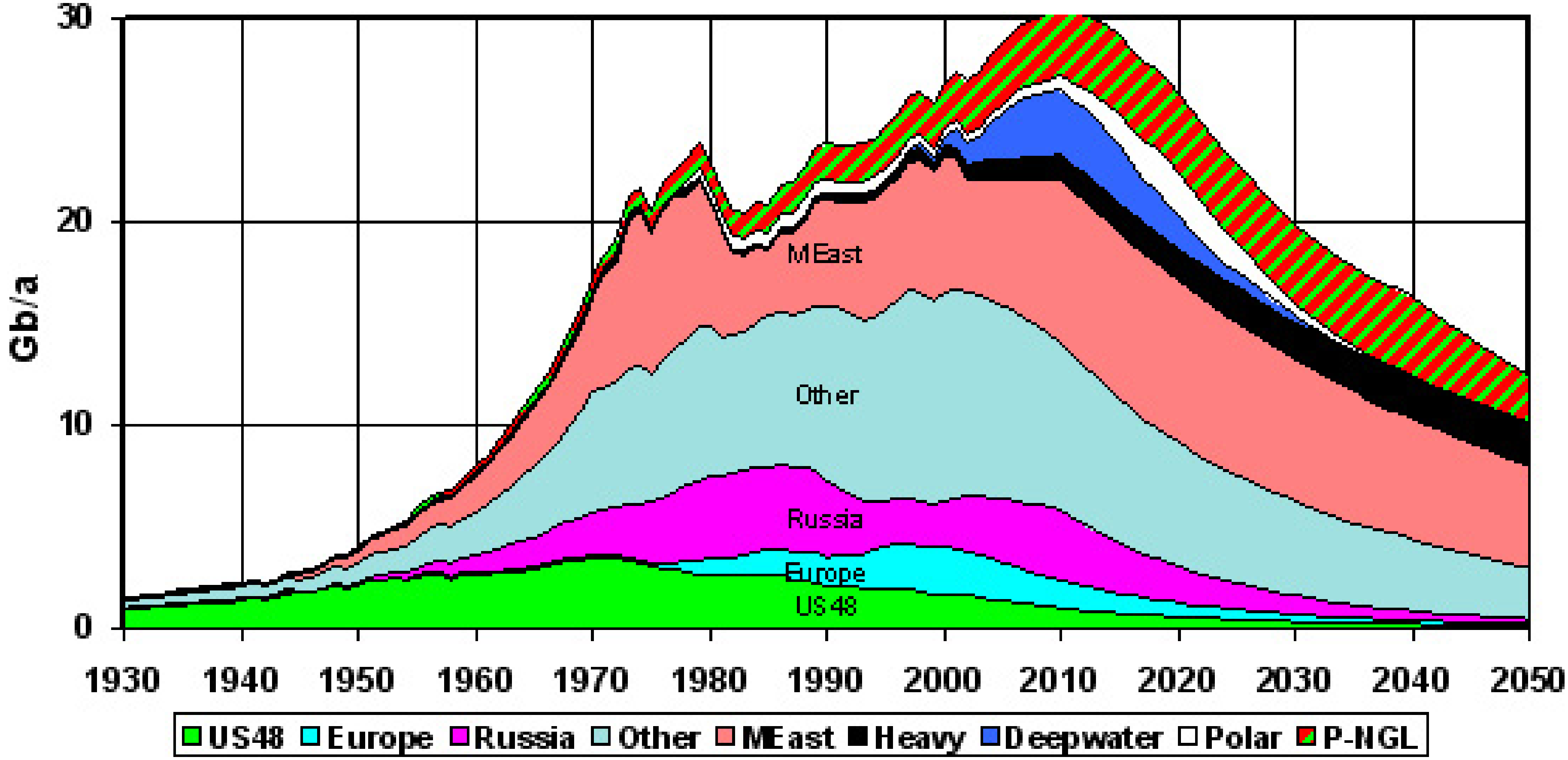
Source: *The Economist*, March 18, 2006

Canadian natural gas



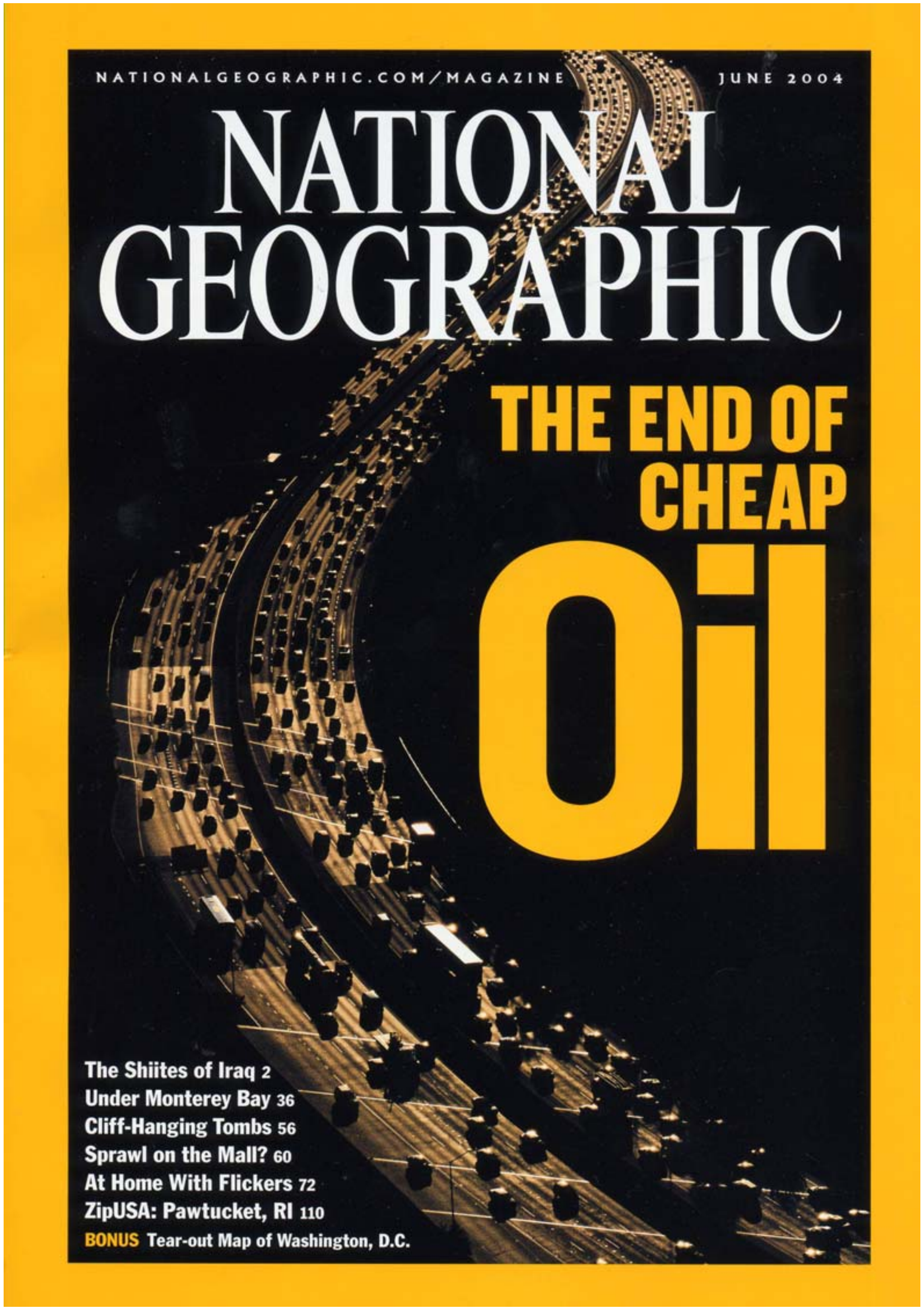
Source: Canadian Association of Petroleum Producers, March 2006

Here's the best estimate of when the world peak in liquid hydrocarbon production will occur: about 2012 (black area is oil sands)



Source: Uppsala Hydrocarbon Depletion Group

It's not a secret! The National Geographic cover of June 2004 echoed the title of a 1998 *Scientific American* article by geologists Colin Campbell and Jean Laherrère that was initially dismissed as yet another oil scare but is now seen as a seminal step in our understanding of the future availability of oil (and natural gas).



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Even the US Army Corps of Engineers is concerned about peak oil

US Army Corps of Engineers®
Engineer Research and Development Center

Energy Trends and Implications for U.S. Army Installations

Eileen T. Westervelt and Donald F. Fournier ERDC/CERL TN-05-1 September 2005

"Peak oil is at hand … Once worldwide petroleum production peaks, geopolitics and market economics will result in even more significant price increases and security risks. … Oil wars are certainly not out of the question. Disruption of world oil markets may also affect world natural gas markets as much of the natural gas reserves are collocated with the oil reserves."

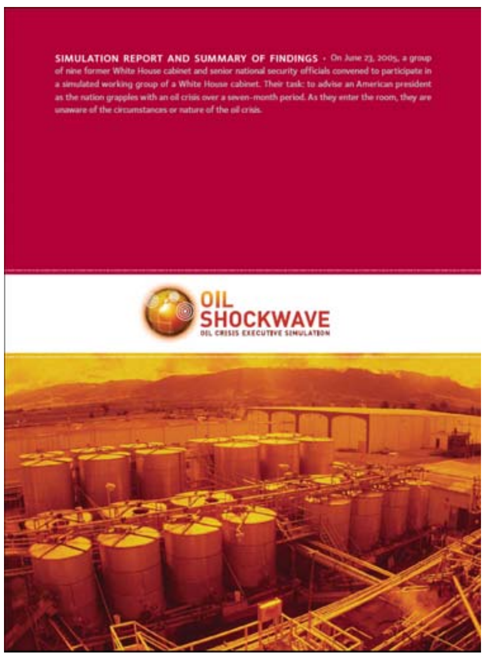
Small shortfalls can mean big price increases (two analyses)

①

Based on analysis for the U.S. by the Brookings Institution

	Shortfall in crude oil supply			
	0%	5%	10%	15%
Resulting increase in crude oil price	0%	30%	200%	550%
Crude oil price per barrel (US$)	$50	$65	$150	$320
Resulting gasoline pump price (Can$/litre)	$0.85	$1.00	$1.50	$2.50

②



The U.S. National Commission on Energy Policy concluded in June 2005 that a "4 percent global shortfall in daily supply results in a 177 percent increase in the price of oil" (from $58 to $161 per barrel).

LNG to the rescue for natural gas?

"The US Coast Guard requires a two-mile moving safety zone around each LNG tanker that enters Boston Harbor, and shuts down Boston's Logan Airport as the LNG tanker passes by. …
These extraordinary precautions are taken out of concern for spectacular destructive potential of the fire and/or explosion that might result from a LNG tank rupture."

Powers B, *Assessment of Potential Risk Associated with Location of LNG Receiving Terminal Adjacent to Bajamar and Feasible Alternative Locations*, June 2002

Why biofuels may not fill the liquid transport fuels gap

1. Ethanol and biodiesel may have some role as substitutes for present transport fuels.

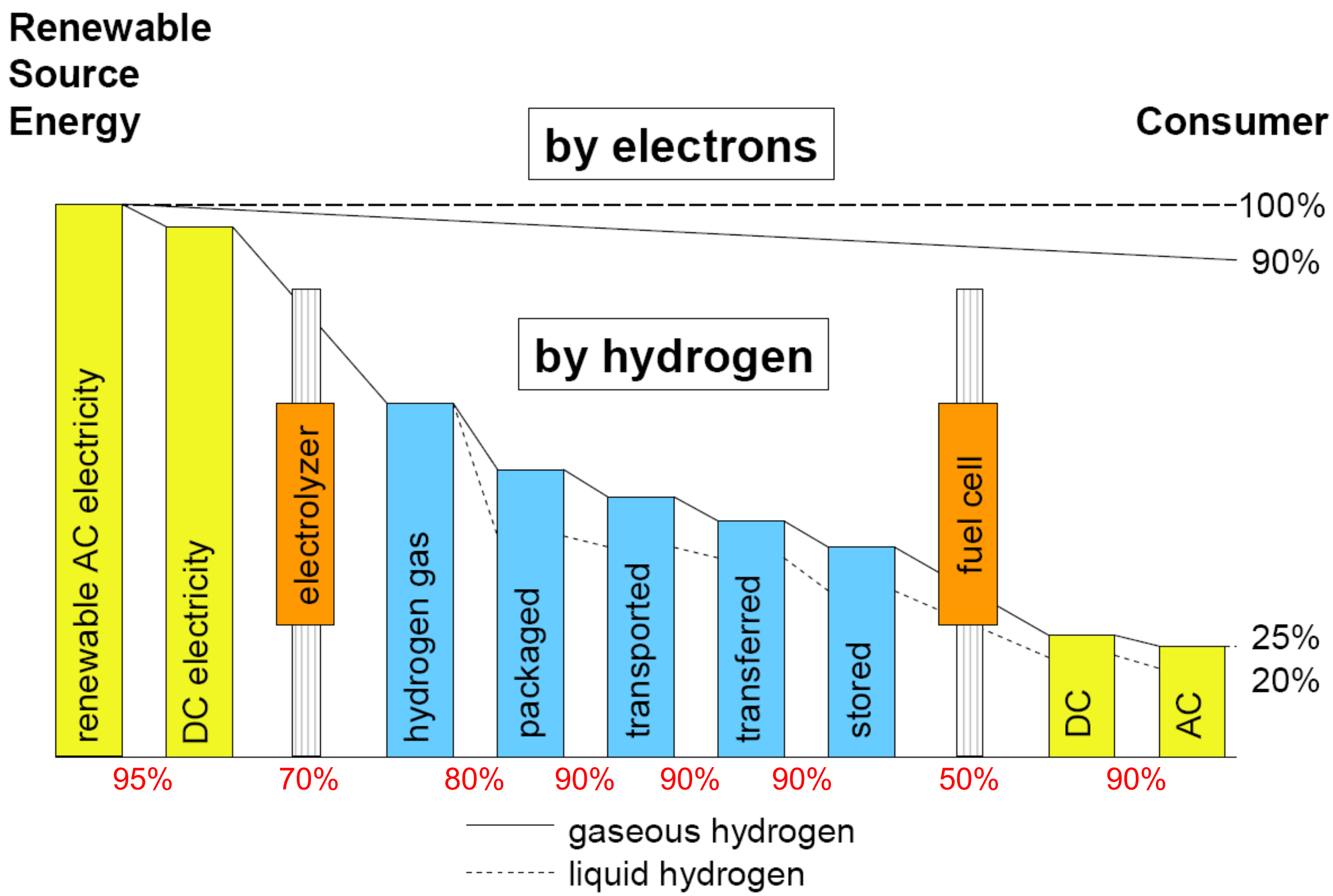
2. Ethanol production raises questions about required energy inputs and land requirements. E.g., the new Goldfield plant in Iowa uses about 100,000 tonnes of coal [!] a year to produce about 200 million litres of ethanol from about 600,000 tonnes of corn—harvested from about 1,000 square kilometres of land. The energy in the coal is about 60% of the energy in the ethanol, and more energy is required for farming and transporting the corn.

3. There are fewer questions with production of ethanol from cellulose rather than sugar (Iogen is a world leader), allowing use of wood, corn and other wastes.

4. But still the land requirement question remains, and a new question: in an energy-constrained world, in which fertilizer production is a major challenge (oil and natural gas are major feedstocks), will not waste materials be needed to replenish land?

5. It will usually make more sense to use biofuels to cogenerate electricity.

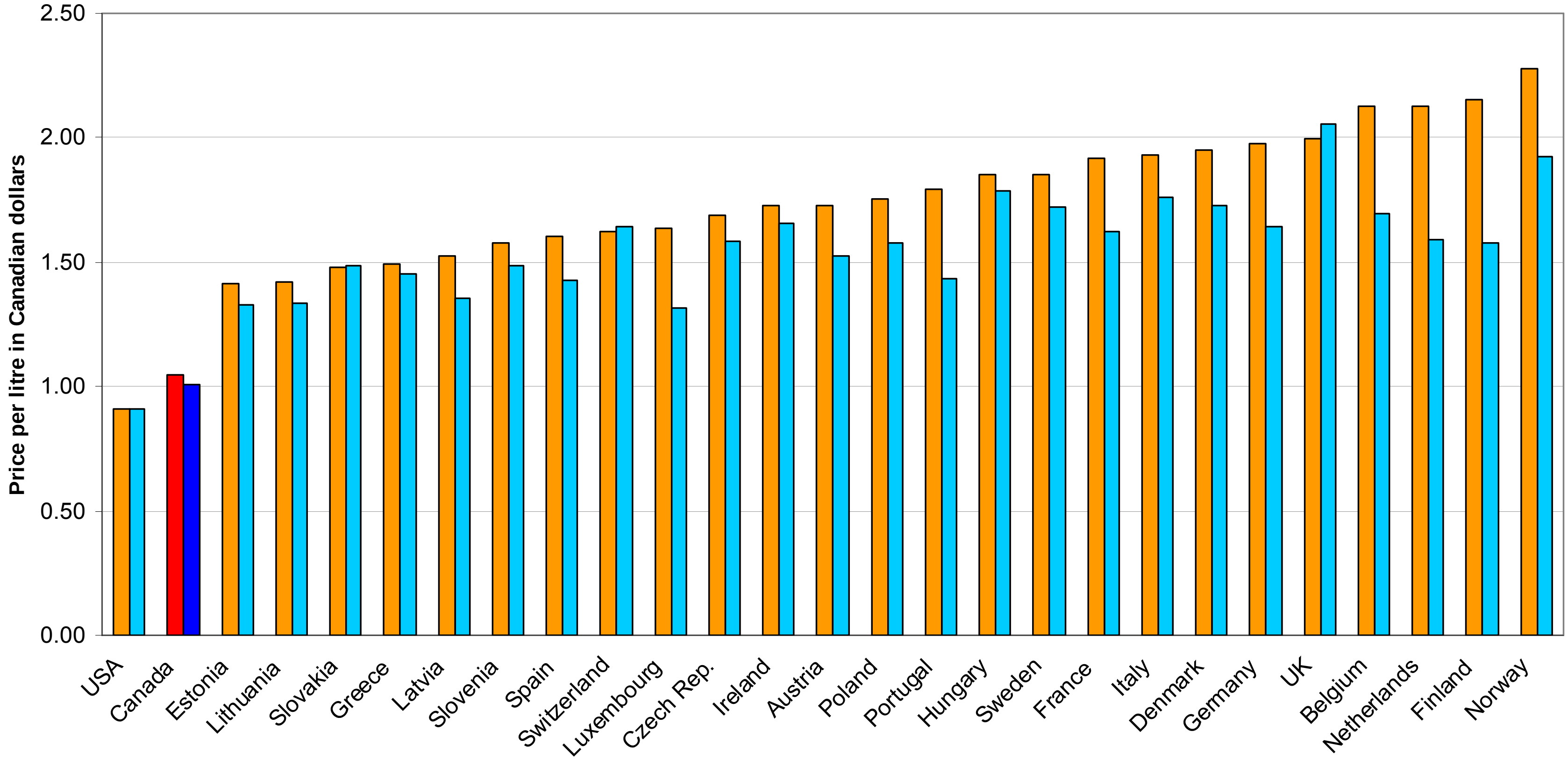
Why the hydrogen fuel cell future won't work (but grid-connected vehicles will)



Source: Bossel (2005)

Approximate efficiencies of processes are in red.

European and other gasoline prices (cheapest posted) are 150-200% of Canadian prices. The diesel fuel price difference is usually a little less. Prices below are for September 19-20, 2005, ranked by gasoline price, using official exchange rates.



Data sources: UK Automobile Association, *Japan Today*, Australian Institute of Petroleum, MJ Ervin & Associates, OANDA.com

The higher fuel prices in Europe have surprisingly little impact on travel, which is overwhelmingly by automobile on both sides of the Atlantic

Including aviation

	Kilometres travelled per person	Share by personal vehicle	Share by surface public transport	Share by aviation
Canada	16,113	81%	9%	10%
EU15	13,397	79%	15%	6%

Ignoring aviation

	Kilometres travelled per person	Share by personal vehicle	Share by surface public transport
Canada	14,529	90%	10%
EU15	12,659	84%	16%

Data sources: Natural Resources Canada, *Energy Use Data Handbook*, 2005; Statistics Canada (population data); European Commission, *Energy and Transport in Figures 2005*

Four-dollar gasoline is an optimistic perspective

1. Cheap energy is so important for our way of living, large increases in energy prices could be devastating.

2. An entirely possible outcome of the end of cheap oil (and natural gas) could be a 'hard landing' into economic depression and widespread dislocation.

3. Projecting a reasonably stable price of \$4/L implies that there is still demand for oil, i.e., economic and social life are continuing, albeit within a different framework. \$4/L implies a 'soft landing'.

4. A reasonably stable \$4/L (and \$2/m^3) also implies an orderly process whereby the long decline in production of oil (and natural gas) is being matched by progressively more efficient use and by a measured transition to use of other fuels.

Strategy for analysis

- Retail energy prices will have to rise about fourfold for there to be substantial changes in how energy is used and produced (i.e., about a fivefold increase in wholesale prices).

- What are the chances of prices rising so high during the next 25 years?

- If the odds are less than one in four, proceed with business as usual. If there are between one in four and one in two, have a ‘Plan B’ that puts energy first.

- If there is a more than 50% chance of prices being so high—i.e., they are more likely to happen than not—‘Plan A’ should be a plan that puts energy first.

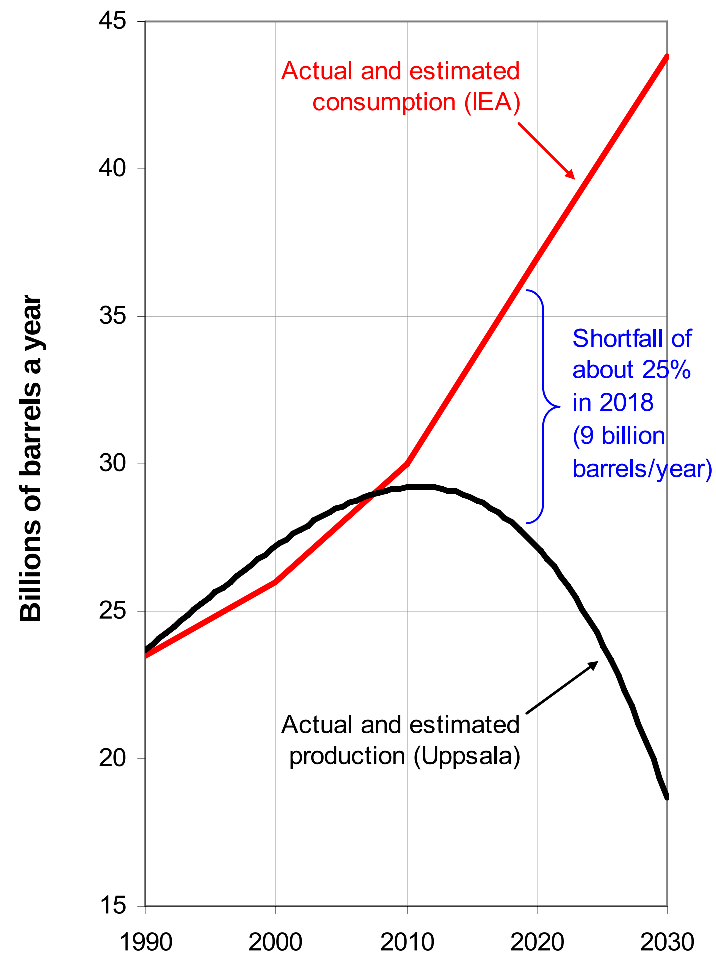
The case for Plan A

- The IEA projection of world consumption and the Uppsala University analysis of production together suggest that in 2031 there could be an oil production shortfall of more than 50%. Using the more conservative of the above two analyses of the impact of shortfall on price, this translates into a 17-fold increase in oil's 'wholesale' price.

- By 2018, about halfway through the planning period, there could be a shortfall of more than 20% and at least a six-fold increase in price.

- It may thus be reasonable to conclude that there is a more than even chance that retail—'pump'—prices of transport fuels will be at least four times higher in 2018 than they are now.

- Similar considerations apply to natural gas prices. Thus, there is need for a 'Plan A', a plan that puts energy first.



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Consumption guidelines for a Plan A (transport and buildings)

- Keep household and business energy bills to no more than 50% above current levels, assuming fourfold increase in electricity prices too. (New equipment should add no more than another 50% to total energy costs.)

- This means reduce energy use per capita by just over 60%, say by two-thirds to allow a safety margin, or lower energy bills.

- But, Hamilton's population is set to increase, from about 525,000 today to about 595,000 by 2018, i.e., by about 13%. So, an absolute reduction by about 60% could be appropriate.

- Keep the total amount of electricity use at about the same level as now, but do much more with it, particularly for transport. Electricity's share of total energy use would rise from about a fifth to about a half.

- Reduce use of oil and natural gas by about 80%.

Here's what the consumption guidelines translate to

Purpose of energy use	Actual in 2003 (petajoules)				Proposed for 2018 (petajoules)				Change in total, 2003-18
	Oil/NG	Electricity	Other	Total	Oil/NG	Electricity	Other	Total	
Movement of people	20.0	0.0	0.0	20.0	3.0	3.5	0.0	6.5	-68%
Movement of freight	11.9	0.0	0.0	11.9	4.0	1.4	0.2	5.6	-53%
In residential buildings	13.9	6.9	1.0	21.8	2.7	5.1	1.1	8.9	-59%
In other buildings	10.0	7.6	0.3	17.9	1.7	4.3	0.5	6.5	-64%
Totals for transport	31.9	0.0	0.0	31.9	7.0	4.9	0.2	12.1	-62%
Totals for buildings	23.9	14.5	1.3	39.7	4.4	9.4	1.6	15.4	-61%
Overall totals	55.8	14.5	1.3	71.6	11.4	14.3	1.8	27.5	-62%

Source for 2003 data: Ontario section of Natural Resources Canada, *Comprehensive Energy Use Data*, 2006;

Additional factors for transport

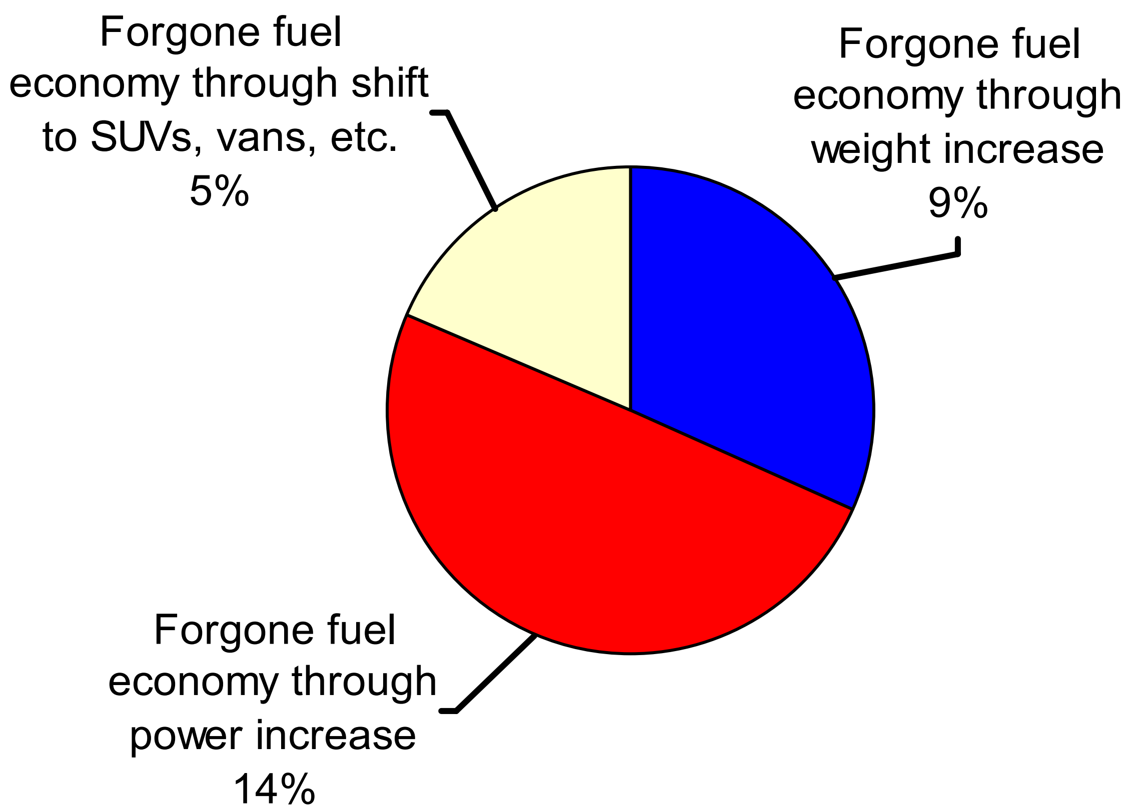
- Maintain the amount of motorized travel by Hamilton residents (excluding aviation) to near current levels. A 15-20% reduction per capita is proposed, mostly to offset population growth, mostly achieved through shift to walking and bicycling and through shortening of journeys.

- Reduce automobile use by about a third; increase transit use about threefold; introduce personal rapid transport; reduce fossil fuel use for moving people by about 85%; add more electricity use for transport than fossil fuel use.

- Increase the amount of movement of goods in, to, and from Hamilton by about 9%, almost keeping pace with population growth.

- Reduce truck use, and use many electric trucks; increase rail and marine use; reduce fossil fuel use for moving goods by about two-thirds; replace some of this with more use of electricity.

First note that internal combustion engines can be a lot better. Here are the elements of the 28% per cent forgone fuel economy (US, 1998-2004)



Source: U.S. Environmental Protection Agency, 2005

Here are details about the movement of people

Mode	2003				2018			
	PKM (millions)	Fuel use/ PKM (MJ)	Total petroleum use (PJ)	Total electricity use (PJ)	PKM (millions)	Fuel use/ PKM (MJ)	Total petroleum use (PJ)	Total electricity use (PJ)
Car (ICE)	7,500	2.5	19.0	0.0	1,500	2.0	3.0	0.0
Car (electric)	0				1,500	1.0	0.0	1.5
PRT	0				2,000	0.5	0.0	1.0
Transit	750	1.3	1.0	0.0	2,000	0.5	0.0	1.0
Totals	8,250		20.0	0.0	8,000		3.0	3.5

Note: PKM = Person-Kilometre. ICE = Internal Combustion Engine. PRT = Personal Rapid Transport. MJ = MegaJoule. PJ = PetaJoule

Source for 2003 data: Ontario section of Natural Resources Canada, *Comprehensive Energy Use Data*, 2006;

Here are details about the movement of freight

Mode	2003				2018			
	TKM (millions)	Fuel use/ TKM (MJ)	Total petroleum use (PJ)	Total electricity use (PJ)	PKM (millions)	Fuel use/ PKM (MJ)	Total petroleum use (PJ)	Total electricity use (PJ)
Truck (ICE)	3,300	3.2	10.7		1,250	2.5	3.1	0.0
Truck (electric)					1,000	1.0	0.0	1.0
Rail	3,200	0.2	0.7		4,000	0.1	0.0	0.4
Marine	2,000	0.4	0.5		3,000	0.3	0.9	0.0
Totals	8,500		11.9		9,250		4.0	1.4

Note: TKM = Tonne-Kilometre. ICE = Internal Combustion Engine. MJ = MegaJoule. PJ = PetaJoule

Source for 2003 data: Ontario section of Natural Resources Canada, *Comprehensive Energy Use Data*, 2006;

What are grid-connected (tethered) vehicles?

- Electrically driven vehicles that get their motive energy while moving from an overhead wire(s) or third rail rather than from an on-board source.

- They have high ‘wire-to-wheel’ fuel efficiency for four reasons:
  - >95% of applied energy is converted to traction
  - electric motors are lighter than internal combustion engines (ICEs)
  - constant torque at all speeds means no oversizing
  - there is no fuel to carry.

- Overall efficiency and environmental impacts depend on the distribution system (perhaps a 10% loss) and the primary fuel source, which can range from inefficient and dirty (e.g., coal) to efficient and clean (e.g., sun and wind).

- Grid-connected systems can use a wide range of fuels and switch among them without disrupting transport activity, allowing smooth transitions towards sustainable transport.

Public transit within cities

Montreal

Vehicle type	Fuel	Occupancy (pers./veh.)	Energy use (mJ/pkm)
Transit bus (U.S.)	Diesel	9.3	2.73
Trolleybus (U.S.)	Electricity	14.6	0.88
Light rail (streetcar)	Electricity	26.5	0.76
Heavy rail (subway)	Electricity		0.58

Calgary

Vancouver

Public transit between cities

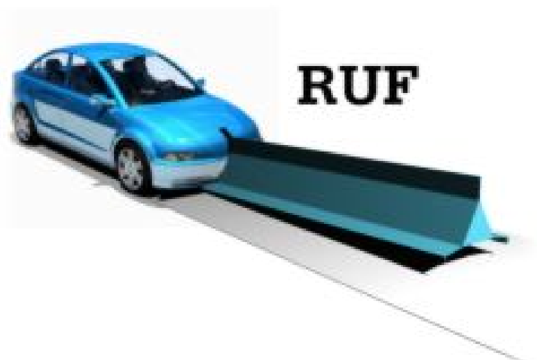
Vehicle type	Fuel	Occupancy (pers./veh.)	Energy use (mJ/pkm)
Intercity rail	Diesel		2.20
School bus	Diesel	19.5	1.02
Intercity bus	Diesel	16.8	0.90
Intercity rail	Electricity		0.64

Amtrak Acela at Boston South station

German ICE

Personal vehicles

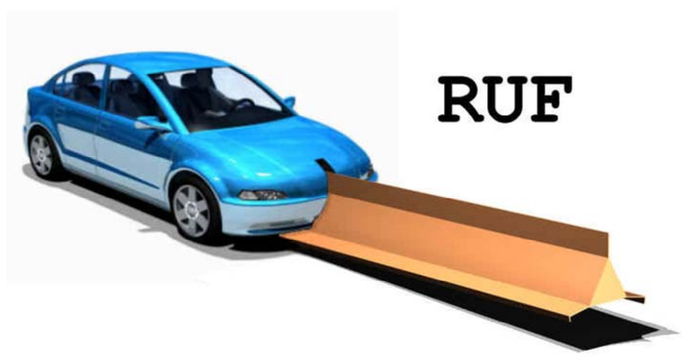
Düsseldorf Airport SkyTrain



Vehicle type	Fuel	Occupancy (pers./veh.)	Energy use (mJ/pkm)
SUVs, vans, etc.	Gasoline	1.70	3.27
Large cars	Gasoline	1.65	2.55
Small cars	Gasoline	1.65	2.02
Motorcycles	Gasoline	1.10	1.46
Fuel-cell car	Hydrogen	1.65	0.92
Hybrid electric car	Gasoline	1.65	0.90
Very small car	Diesel	1.30	0.89
Personal Rapid Transit	Electricity	1.65	0.49

Skyweb Express (Cincinnati concept)

More on PRT

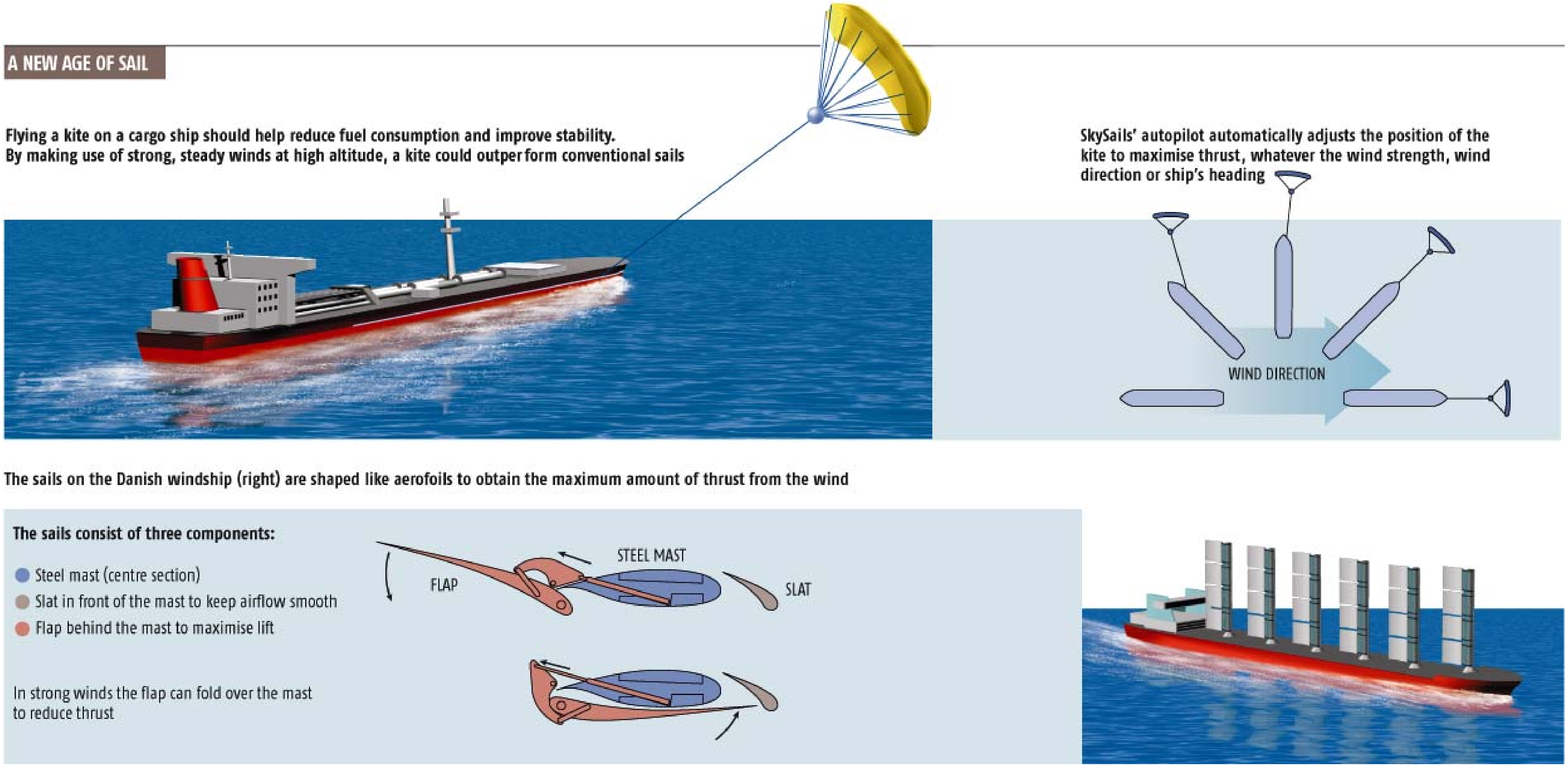


Freight transport

Trolley truck operating at the Quebec Cartier
iron ore mine, Lac Jeannine, 1970s

Vehicle type	Fuel	Energy use (mJ/tkm)
Truck	Diesel	0.45
Train	Diesel	0.20
Train	Electricity	0.06
Truck	Electricity	0.15?

A return to wind? (Our transport future will be more like this than more air travel and freight movement)



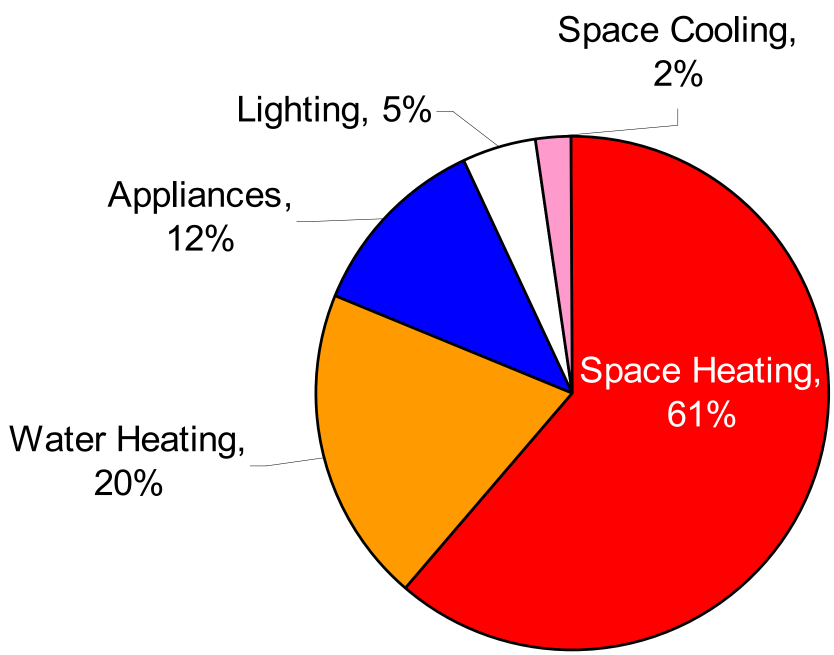
Source: Hamer (2005)

Fuel is now >75% of shipping costs. Kites reduce fuel use by about a third. <3-year payback. Coming into use in 2006. Winched in to pass under the Burlington Skyway (to be used chiefly by grid-connected vehicles powered in part by massive wind turbines mounted on the Skyway and nearby).

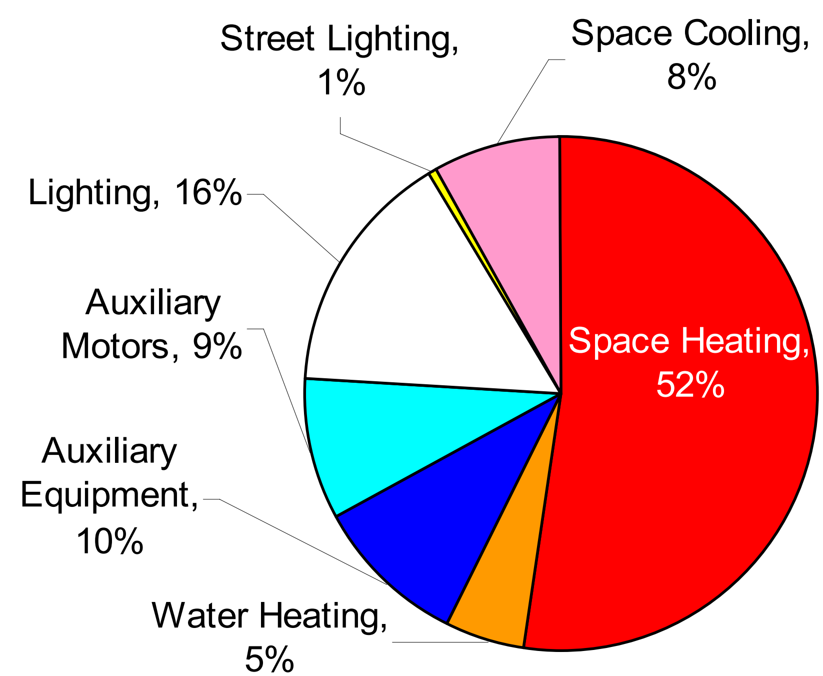
Source: Economist September 17, 2005

Here's how energy is used in buildings in Ontario

Residential uses



Commercial and institutional uses



Data source: Ontario section of Natural Resources Canada, *Comprehensive Energy Use Data*, 2006;

Additional guidelines for energy use in buildings

- About the same reduction in overall energy use as for transport (≈60%), and the same level of reduction in fossil fuel use (≈85%), even though more energy is used in buildings than for transport.
- As for transport, there would be a shift to electricity use. Now electricity is 37% of in-building energy use, becomes 61%. Transport energy use is now 0% electricity, becomes 54%.
- Big difference is that buildings but not vehicles can be a source of energy (discussed later).

Here are details about how energy use in buildings could change

	Actual in 2003 (petajoules)				Proposed for 2018 (petajoules)				Change 2003-18
	Oil/NG	Electricity	Other	Total	Oil/NG	Electricity	Other	Total	
Residential									
Space/water heating/cooling	13.9	3.2	1.0	18.1	2.7	3.7	1.1	7.6	-58%
Other	0.0	3.7	0.0	3.7	0.0	1.4	0.0	1.4	-61%
Commercial									
Space/water heating/cooling	10.0	1.6	0.3	11.9	1.7	1.9	0.5	4.1	-66%
Other	0.0	6.0	0.0	6.0	0.0	2.4	0.0	2.4	-61%
Totals	23.9	14.5	1.3	39.7	4.4	9.4	1.6	15.5	-61%

Source for 2003 data: Ontario section of Natural Resources Canada, *Comprehensive Energy Use Data*, 2006

Here's how *new* buildings could change

House type	Annual energy consumption (kWh/m^3/year)
Typical existing house (1970)*	309
Typical new house (2002)*	203
Model National Energy Code house (2002)*	161
R-2000 house*	112
Advanced house (1991)**	33

* 198 m^2 one-story, single detached house, natural gas heating.

** 250 m^2, two-storey, single detached house heated through an integrated mechanical system, in Brampton, Ontario.

Data sources: *??*

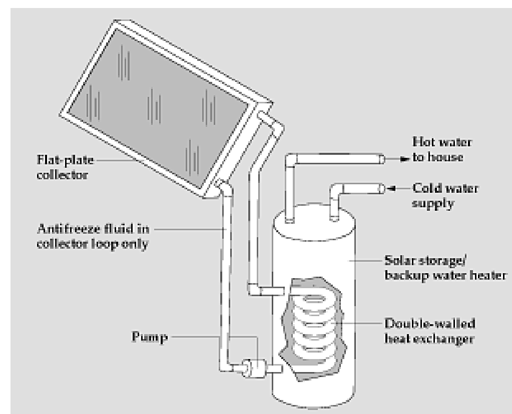
Energy production will be a priority (1)

Hamilton could become self-sufficient in electricity and produce substantial amounts of natural gas and other useful energy:

- Solar energy: electricity and hot water
- Wind energy: electricity
- Deep Lake Water Cooling (DLWC): cold water for air conditioning
- Hydroelectric power: electricity
- Energy from waste: electricity, process steam, hot water
- Biogas production: natural gas (also electricity, etc.)
- District energy: allows buildings to be heated and cooled from numerous sources (including DLWC)
- Local food production: energy for humans, reduces transport and possible shortages

Energy production will be a priority (2): solar electricity and hot water

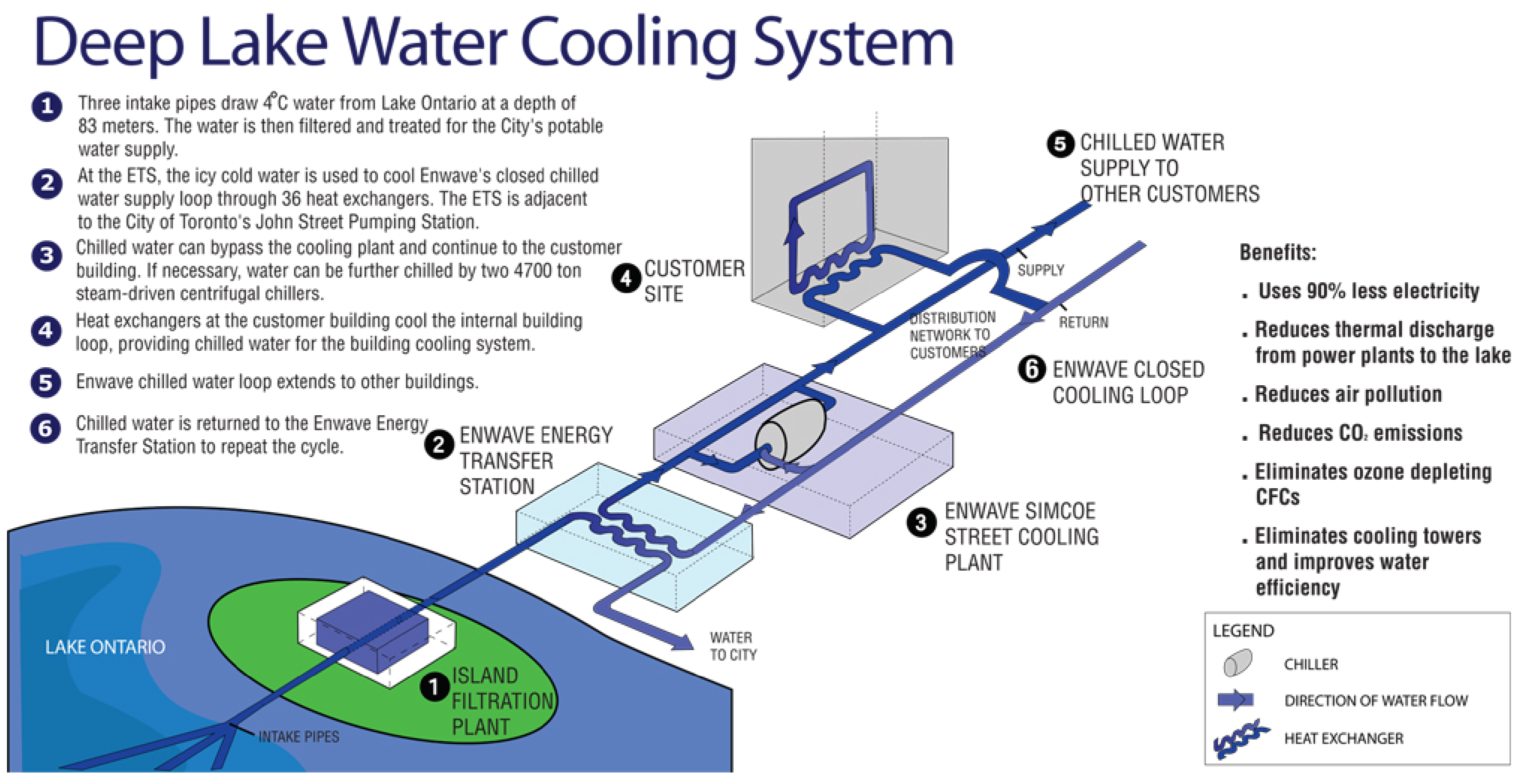
Photovoltaic panels on roofs upper left) and walls (lower left) could provide the equivalent of most of the electricity used within Hamilton's residential buildings and more than that used in commercial buildings (in total, more than half of Hamilton's 2018 consumption). Solar water heating panels (right) could provide most of Hamilton's domestic hot water.



Energy production will be a priority (3): horizontal and vertical wind turbines

Wind turbines, over farmland (left), and especially over water (below), but also—with vertical-axis turbines—in confined spaces (right) could provide the equivalent of about a quarter of Hamilton’s electricity use.

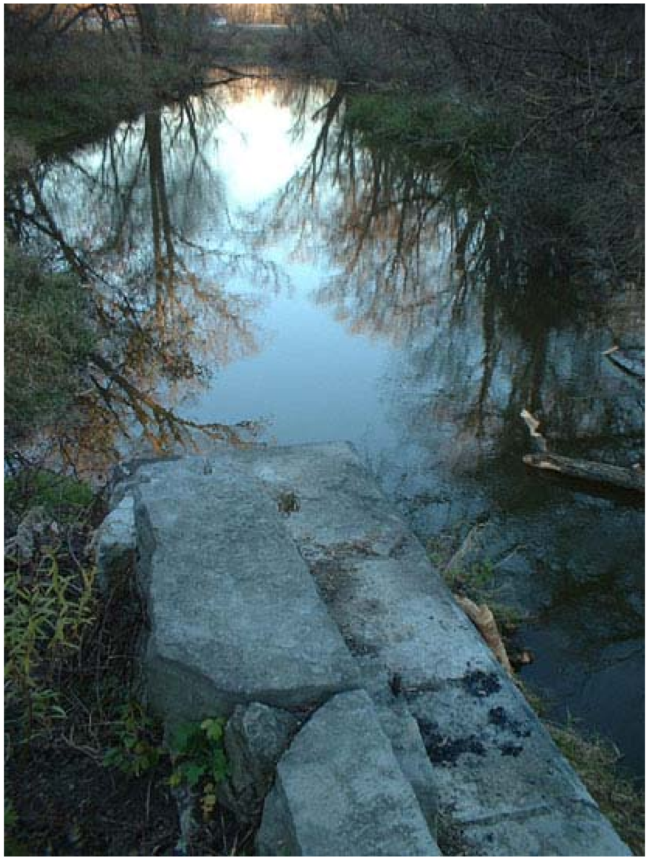
Energy production will be a priority (4):



Toronto's system provides the cooling equivalent of 250 megawatts of electric power: annually about 15% of Hamilton's proposed electricity use in 2018. Toronto's downtown is only 5 km from where Lake Ontario is 80 metres deep, Hamilton's is 20 km, but the additional underwater piping cost is relatively small and so is the temperature gain.

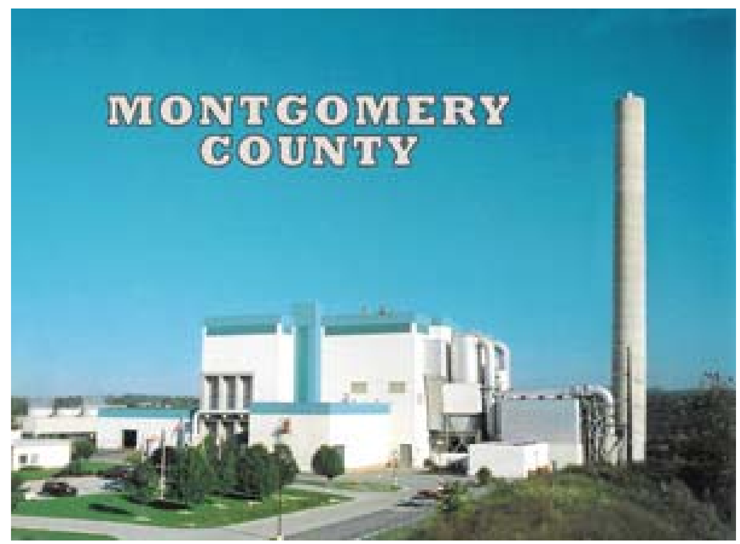
Energy production will be a priority (5): micro-hydro generation

Hamilton's first incarnation as the 'Electric City' was supported by hydroelectric power (left, from 1898). Today, several opportunities have been identified for damming Spencer Creek within Hamilton. The total output would be relatively small (0.6 mW) but could be a useful part of the base load.

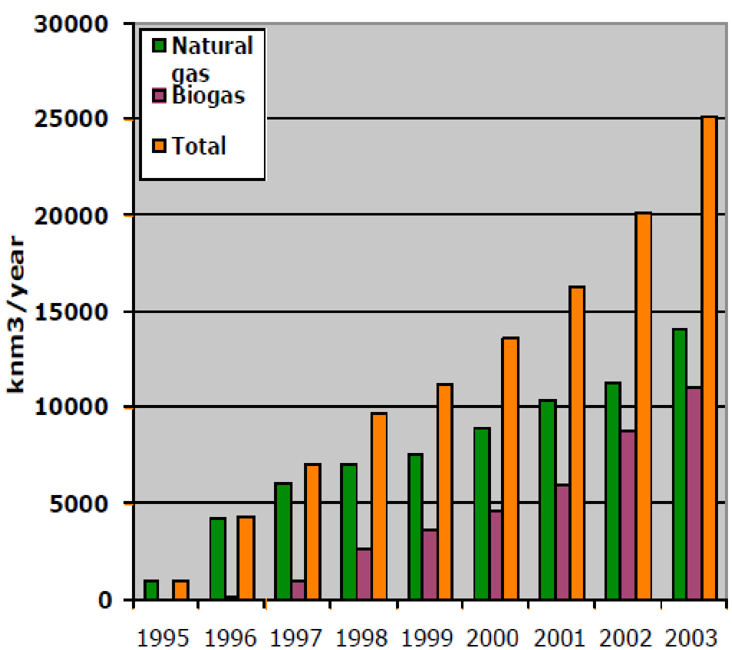


Energy production will be a priority (6): Energy From Waste (EFW)

If Hamilton were to manage half of Southern Ontario's solid waste in four plants like the Florida plant on the right, all located on the Stelco site, the product would be over 40% of Hamilton's electricity requirements in 2018, hot water enough to heat *all* Hamilton's buildings (via a district energy system), and some steam for industrial processing. Municipalities and businesses would *pay* Hamilton to take this fuel. Two conditions should be imposed: (i) all non-Hamilton waste arrives by rail or water; and (ii) for more than half of the days of the year the plants act as air cleaners, i.e., the air coming out the stacks is better than the ambient air (which will be better in 2018 than now because there will be fewer internal combustion engines. The plant on the left is in Burnaby, B.C.



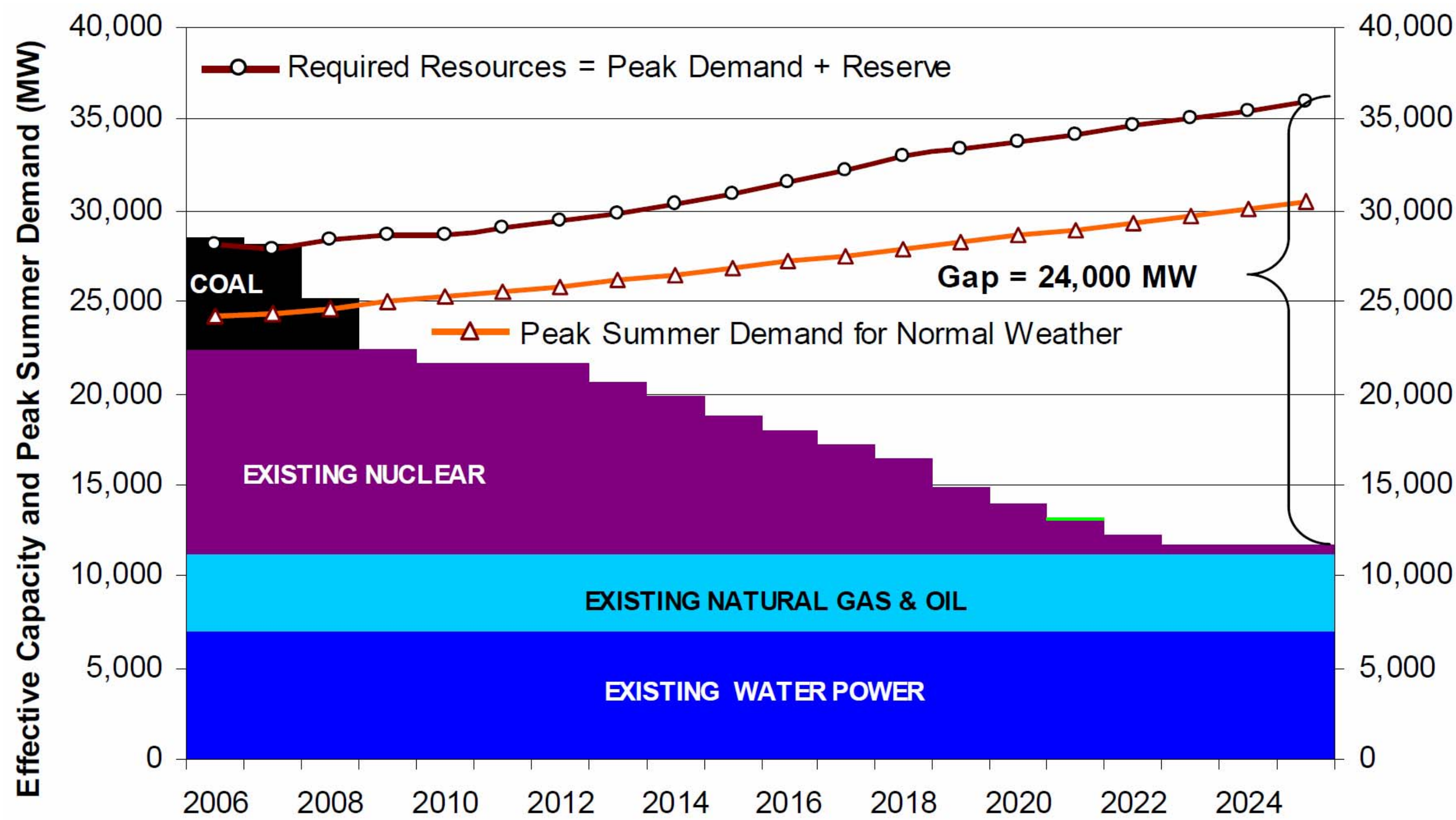
Energy production will be a priority (7): Biomethane from organic wastes



Source: Eliasson (2005)

Municipalities, businesses, and farms would also pay Hamilton to process biomass, notably animal and vegetable wastes. If the wastes are digested anaerobically and the biogas product upgraded, the result can be 'biomethane', which is essentially the same as natural gas. This is a less well tried process than production of energy from solid waste, but its use is growing rapidly. Sweden is running trains and buses with biogas/ biomethane (see top views), and several thousand cars (chart).

Ontario is open for a transformation in electricity generation



Source: Ontario Power Authority, *Supply Mix Advice*. Volume 1, Part 1-1, Page 2, Figure 1.1.2, December 9, 2005

Land-use planning principles

- Put energy first (e.g., build land uses around transport and energy production requirements)
- Avoid greenfield development*
- Don't abandon present low-density areas
- Mix uses; foster vibrant centres
- Aggressively pursue 'brownfield' development

* keep agricultural land, reduce transport costs, consider energy production opportunities; November 2005 City report suggests that 90% of new population by 2031 and 100%+ of employment can be accommodated within present urban area

‘Electric City’, an economic development strategy

- ‘Hamilton: Electric City’ means (i) embracing the prospect of very high energy prices; (ii) preparing Hamilton for the era of high-price energy; and (iii) positioning Hamilton as a leader in a new era of low energy consumption and much local production.

- This will be good for Hamilton’s economic development in five ways:
  - Hamilton will function when energy prices rise steeply.
  - Less money will leave Hamilton to pay for high-cost energy
  - Reducing energy consumption and increasing energy production are labour-intensive, and the work is local
  - Hamilton could rapidly develop a large pool of R&D and implementation know-how
  - Businesses and their investors will see Hamilton as the place to be because of the critical mass of relevant activity, the available skills, and the community dedicated to being ahead of the energy wave.

Implementing the 'Electric City' concept

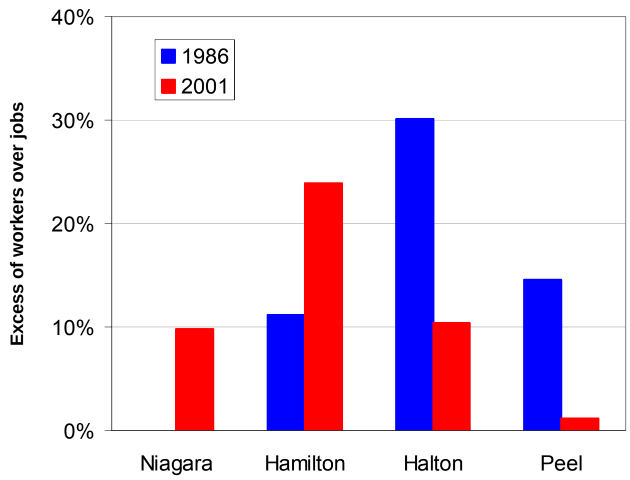
- Deepen and broaden the concept, and publicize it.
- If it captures imaginations, causes excitement, embrace the concept fully. Have it adopted as Hamilton's grand project for the 21st century, the new civic mission.
- Redo plans for land use, transport and other infrastructure, waste management, social development, and, above all, economic development so as to put energy first.
- Solve legal challenges. Figure out where the opportunities are and where the money will come from.

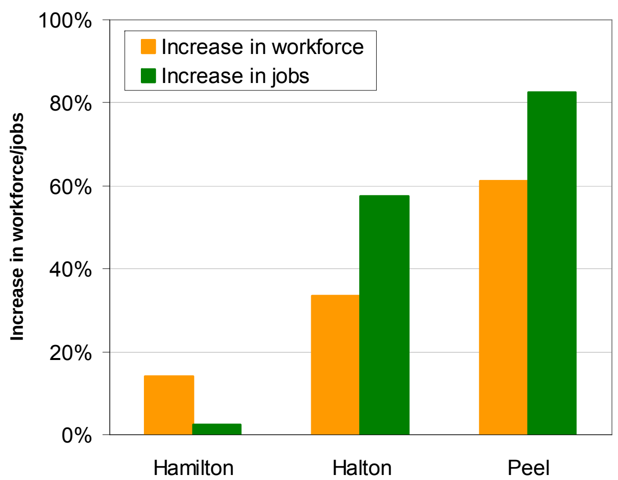
Examples of possible initiatives

- Define, promote, and develop port area and port to downtown area as major R&D centre for the coming energy-constrained world.
- Offer Hamilton as a testbed for PRT development.
- Plan for light rail or trolley buses rather than diesel bus rapid transit; build up population accordingly.
- Initiate massive 'Better Buildings Partnership' for existing commercial and residential buildings.
- Request special building code provisions re. energy efficiency (as test for the rest of Ontario) for new buildings and major retrofits.
- Offer Hamilton as testbed for massive solar collector and urban wind turbine installation (including over water and farmland).
- Invite Enwave to install Deep Lake Water Cooling. Move on opportunities to generate energy from waste.

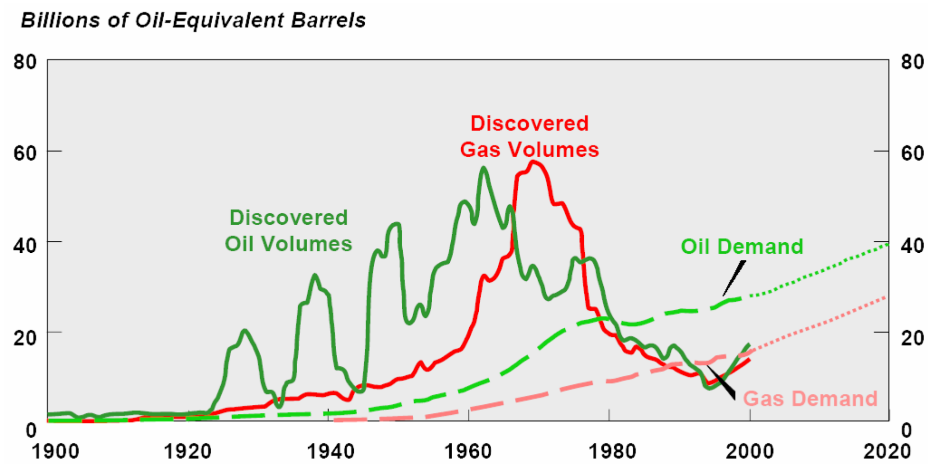
‘Electric City’ is a response to two basic challenges

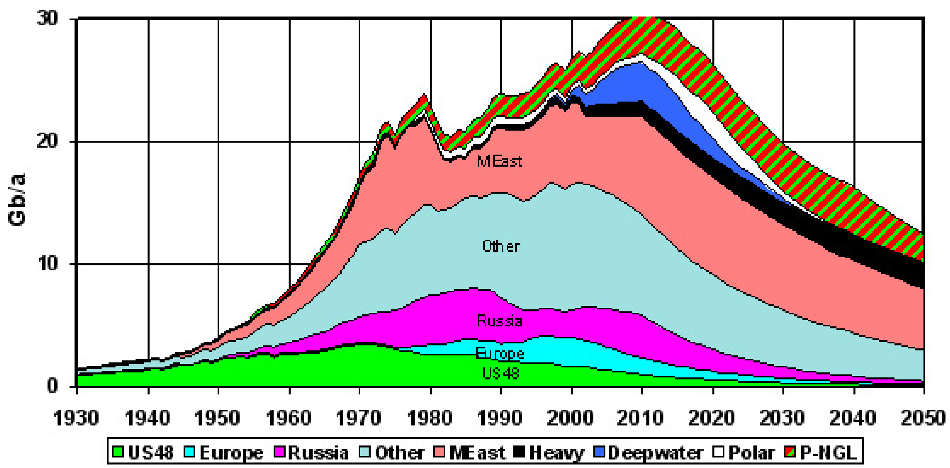
Today’s jobs deficit

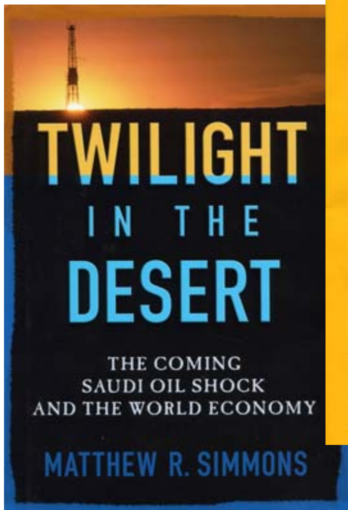


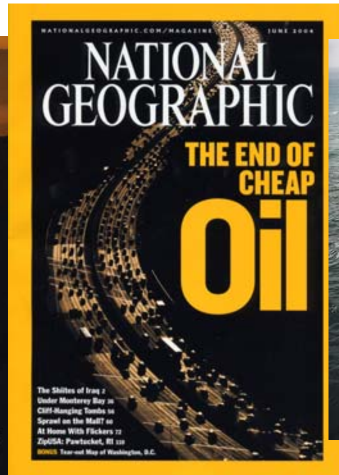


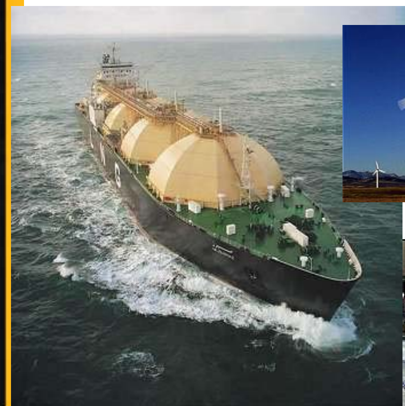
Tomorrow’s energy deficit











Calgary

THANK YOU!