Putting Energy First, 2

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In the session entitled
‘Changing the Future Course of Transportation in Peel’

Prospects

- The last two presentations make eminent sense if fossil fuels remain affordable.
- But, a case was made earlier today that they could rise very steeply during the next decade or two.
- European and other experience suggest that little will change until retail fuel prices rise above twice current prices, i.e., to above \$2/litre for transport fuels and \$1/m^3 for natural gas.
- Until prices more than double, Canadians will drive almost as much as they do now, and make few other changes in how they use energy.

Radical changes to occur when prices are four times higher

1. Fourfold increases, to $4/L transport fuels and $2/$m^3$ natural gas, could have a >50% chance of happening during the next 15 years.

2. This will be a ‘soft landing’: civilization will be continuing in the face of severe energy constraints. In the new equilibrium, a gradual decline in production of oil (and natural gas) would be matched by progressively more efficient use and a transition to use of other fuels.

3. Electricity will dominate end-use fuels, because it can be sustainably produced, locally and at a distance, with most changes occurring in *production* rather than in use.

4. Much electricity will be locally generated, chiefly from sun and wind. Many communities could be self-sufficient, linked by the grid. Oil and natural gas use will be more than 75% below current levels.

Transport will be mostly electric, often grid-connected

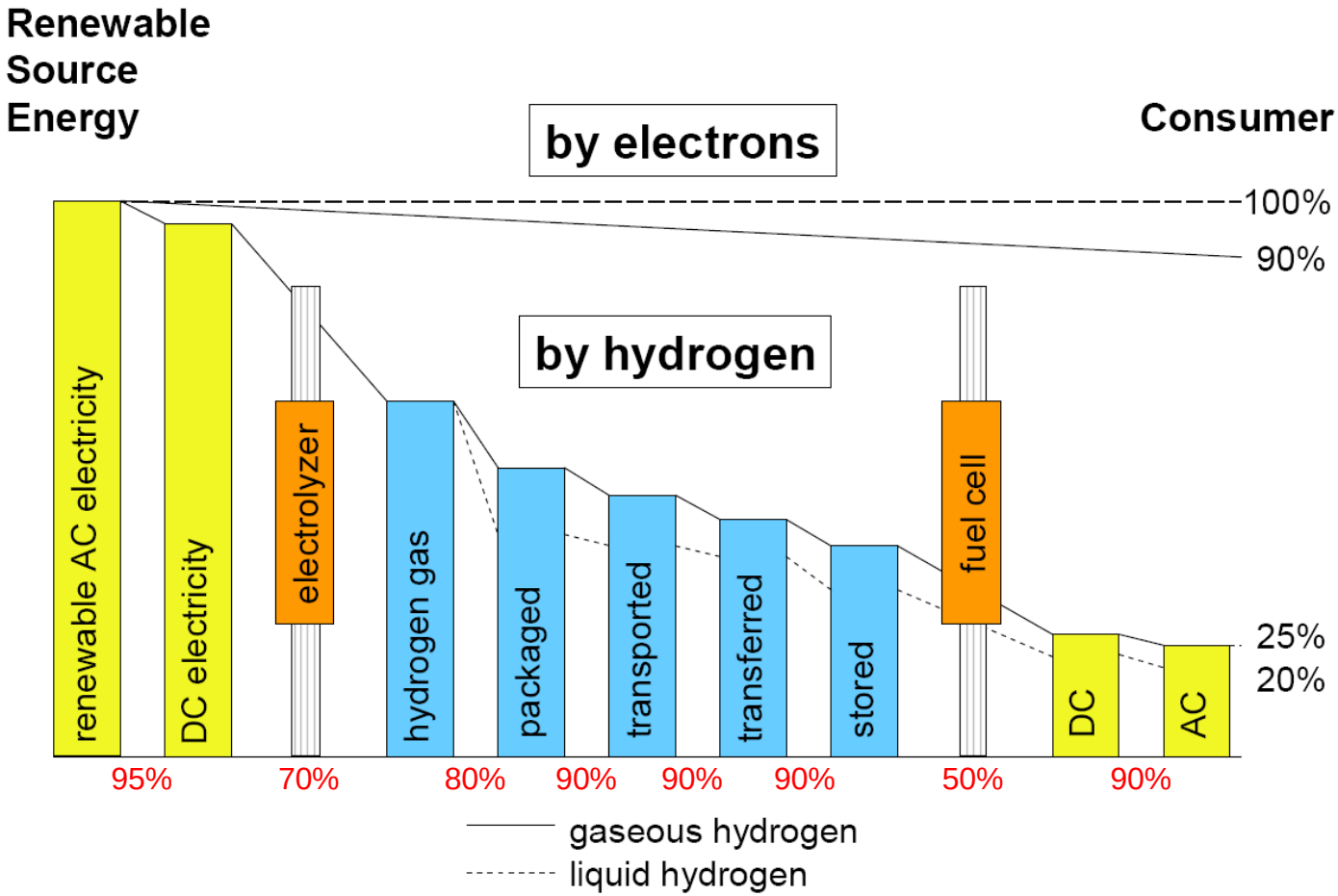
- Grid-connected vehicles that get their motive energy while moving from overhead wires or 'third rails' rather than from an on-board source.

- 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 (except small batteries for limited off-grid movement).

- 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.

Transport of renewable electricity by hydrogen and electrons (why the hydrogen fuel cell future won't work)



Approximate efficiencies of processes are in red.

Source: Bossel (2005)

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

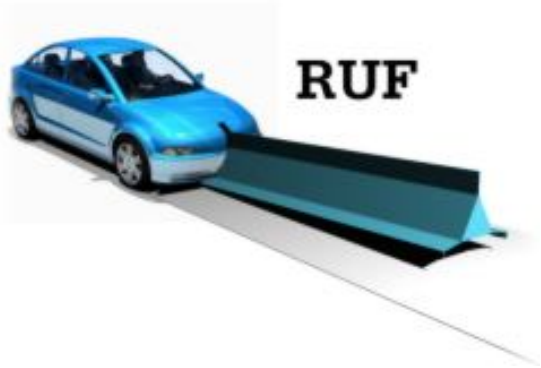
Vehicle type	Fuel	Occupancy (pers./veh.)	Energy use (mJ/pkm)
Intercity rail	Diesel		2.20
School bus	Diesel	19.5	1.02
Intercity bus	Diesel	16.8	0.90
Intercity rail	Electricity		0.64

Amtrak Acela at Boston South station

German ICE

Personal vehicles (PRT)

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)

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?

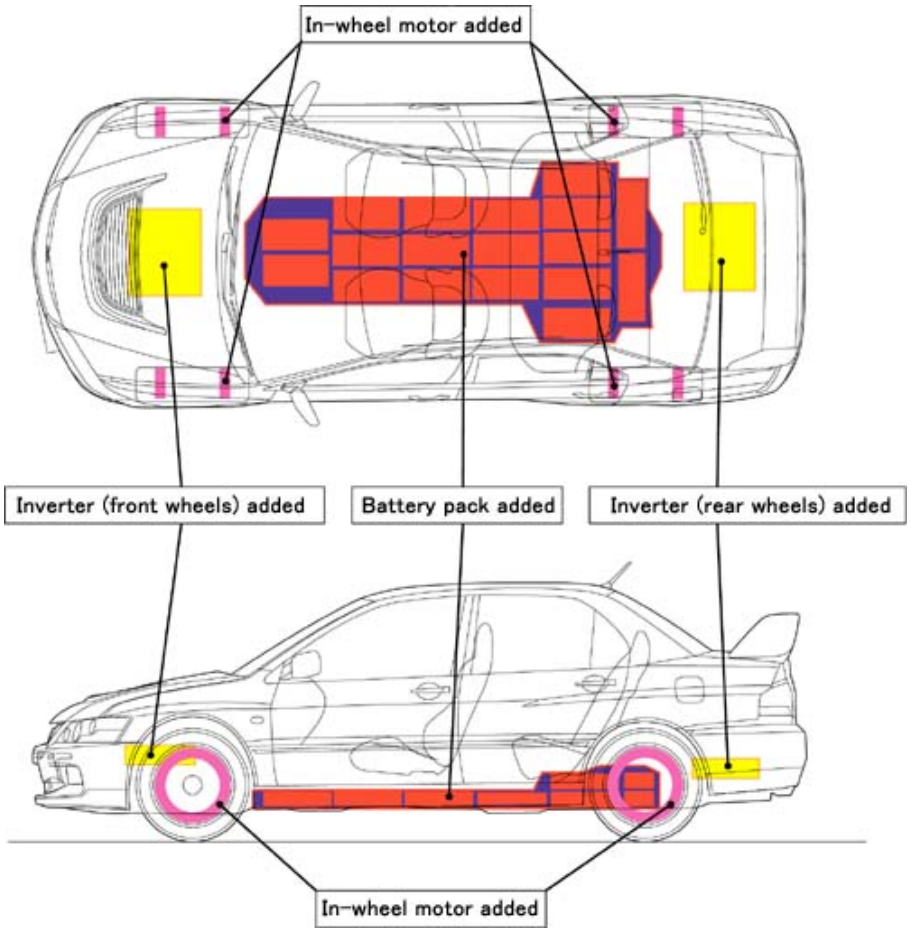
Prevalence of Electric Mobility

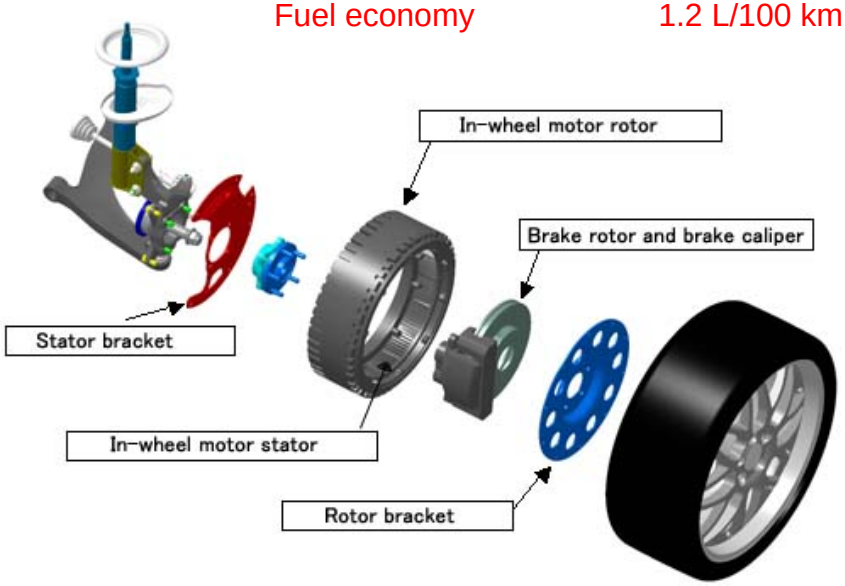
Jurisdiction	Transit vehicle	Annual trips (millions)
City of Toronto	All vehicles	418.1
	Subway and SRT**	173.6
	Streetcars	42.5
	Electric share (%)	52%
Greater Montreal	All	437.8
	Electric train	7.5
	Subway	217.5
	Electric share (%)	51%
Greater Vancouver Regional District	All	155.6
	Skytrain	36.6
	Trolley buses	39.2
	Electric share (%)	49%
City of Calgary	All	80.6
	Light rail	34.7
	Electric share (%)	43%
City of Edmonton	All	84.0
	Light rail	11.7
	Trolley buses	6.5
	Electric share (%)	22%

Electric cars are coming (from Bossel)

Mitsubishi Lancer Evolution MIEV:

Length	4490 mm
Width	1770 mm
Curb weight	1590 kg
Seating	5
Max. Power	4 x 50 = 200 kW
Max. speed	180 km/h
Range/charge	250 km
Lithium-ion	90Ah at 14.8 V
No. of batteries	24
Max. energy stored	32 kWh
Gasoline equivalent	3 Liters
Fuel economy	1.2 L/100 km





Source: Mitsubishi Corporate Press Release of August 24, 2005

Plug-in hybrids could be a route to grid connection

- Plug-in hybrids are regular hybrids with a much larger batteries that can be charged from a household socket. Gasoline use is reduced by as much as 100%—typically 50%.

- It's a short step to all-battery vehicles, or to charging while in motion, i.e., occasional grid connection.

- And, it could be a short step from occasional to regular grid connection, i.e., to PRT (thus, no need to buy heavy batteries and carry them around).

- Putting energy first for transport means embracing electric vehicles of many kinds, mostly grid-connected. Begin in Peel municipalities with trolley bus rapid transit (TBRT), arranging land uses for low-energy movement of people and freight.