

# 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<sup>3</sup> 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.

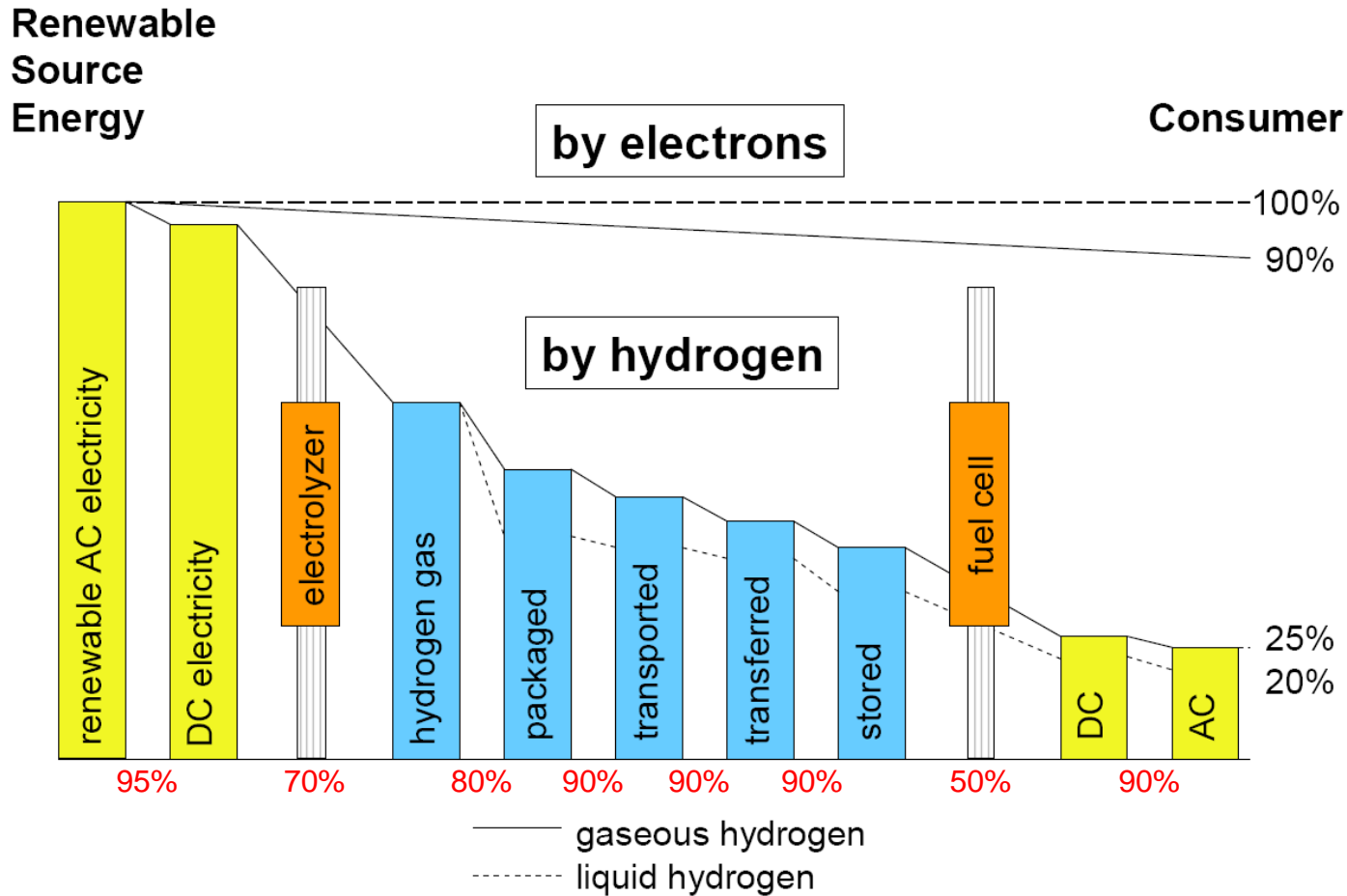
## Radical changes to occur when prices are four times higher

1. Fourfold increases, to \$4/L transport fuels and \$2/m<sup>3</sup> 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

Amtrak Acela at Boston South station



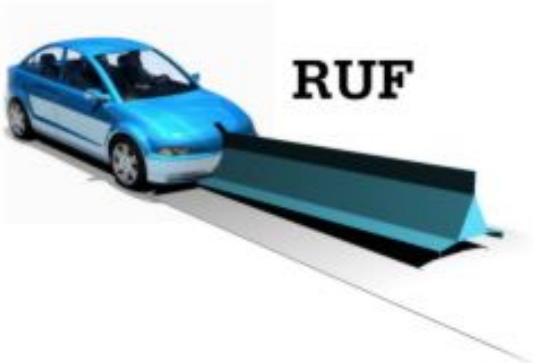
Vehicle type	Fuel	Occupancy (pers./veh.)	Energy use (mJ/pkm)
Intercity rail	Diesel		2.20
School bus	Diesel	19.5	1.02
Intercity bus	Diesel	16.8	0.90
Intercity rail	Electricity		0.64



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
<b>Personal Rapid Transit</b>	<b>Electricity</b>	<b>1.65</b>	<b>0.49</b>



Skyweb Express (Cincinnati concept)



# Freight transport

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



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

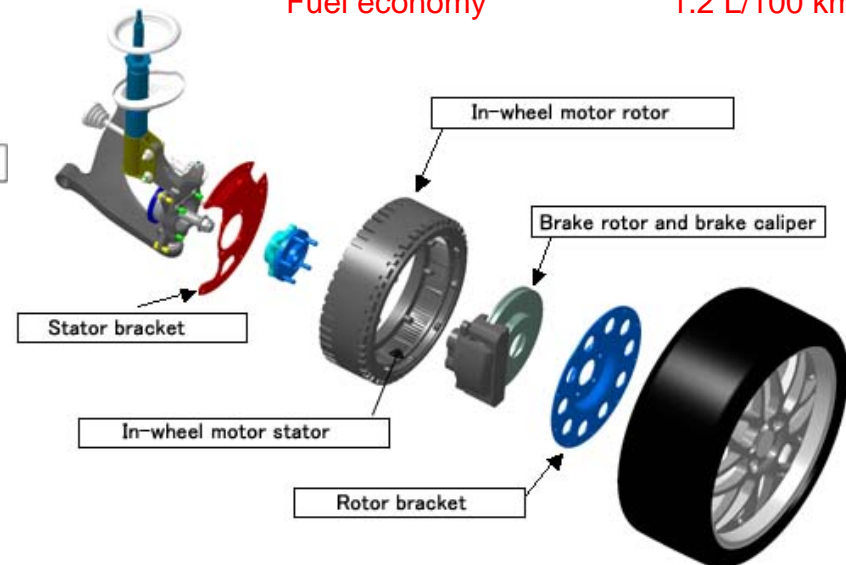
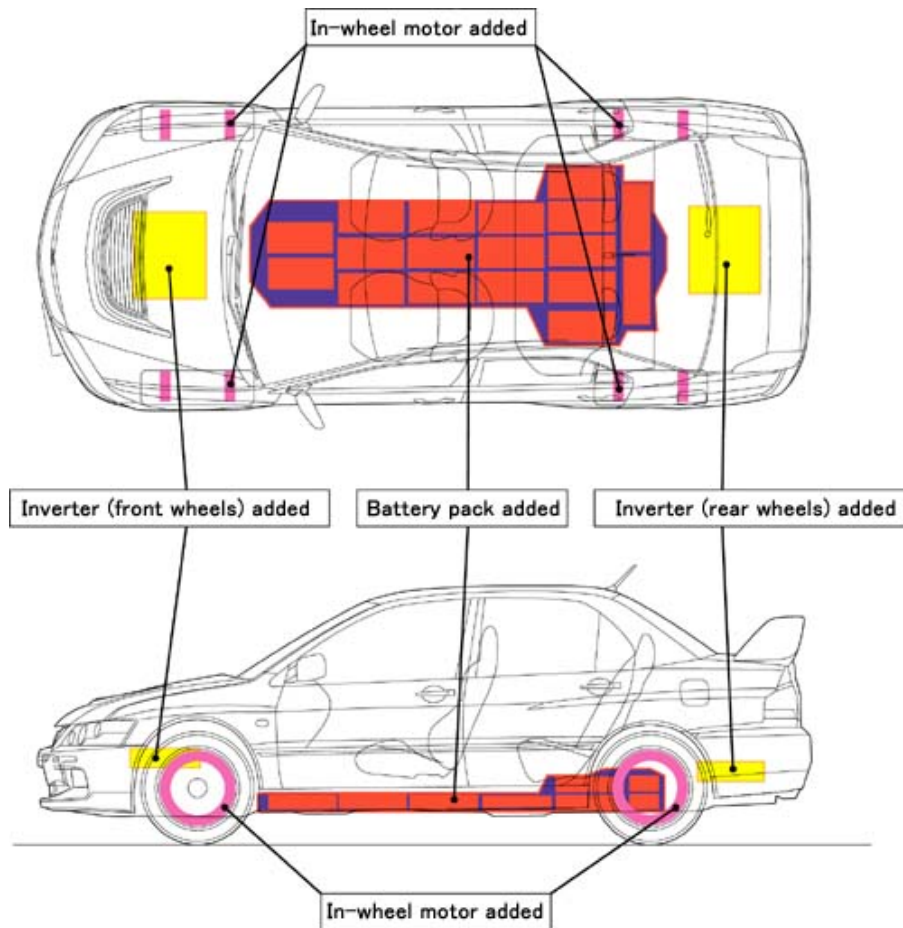
## Prevalence of Electric Mobility

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
<b>Fuel economy</b>	<b>1.2 L/100 km</b>



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.