

PHEV Adoption

Ed Innes, MSc(EE)
September 29, 2009

Local Media Misperception



Source: January 14, 2009 Winnipeg Free Press

PHEV Power Quality Testing



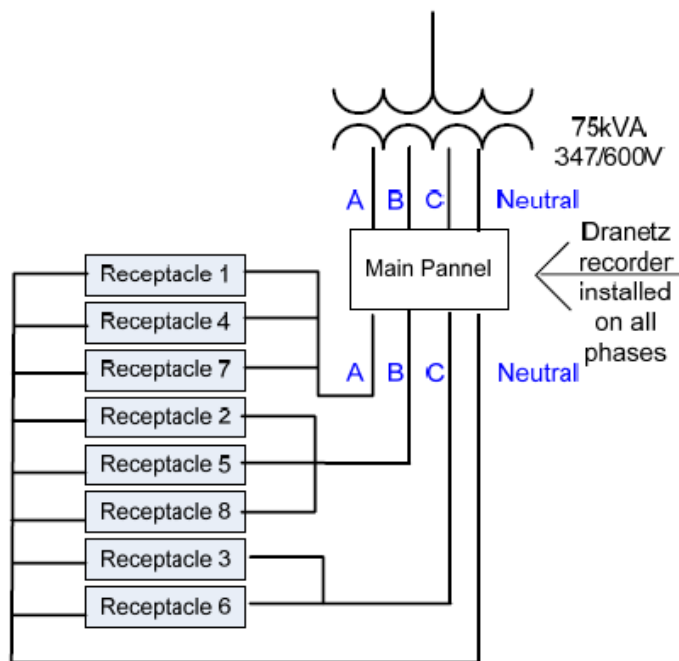
- 8 Hymotion Prius PHEV conversions tested
- All plugged into ordinary block heater outlets
- Total of 12 Hymotion PHEVs in Manitoba

Source: Jeff Blais, Manitoba Hydro

10/5/2009

PHEV Power Quality Testing

Manitoba Hydro Supply and Monitoring Location
PHEV - 1320 Pacific
Winnipeg, Manitoba



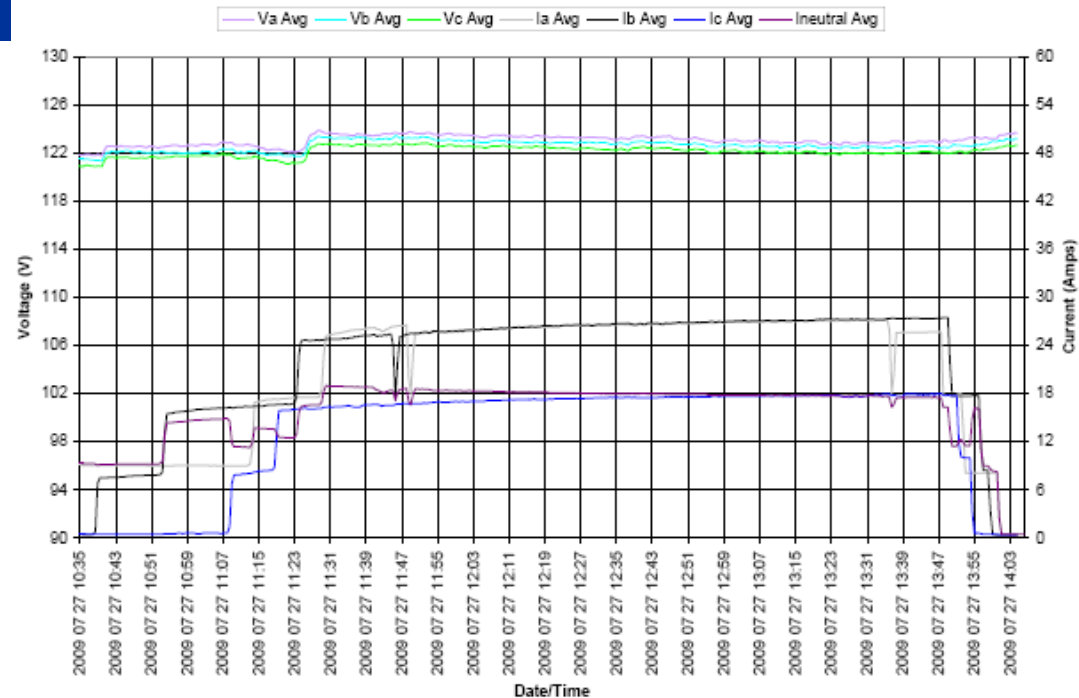
- 208/120 Volt, 3 phase supply
- $8 \div 3 =$ unbalanced phases

Source: Jeff Blais, Manitoba Hydro

10/5/2009

PHEV Power Quality Testing

PHEV - 1320 Pacific Ave
Main Panel - Average Voltage and Current
2009 07 27 10:35 to 2009 07 27 14:04



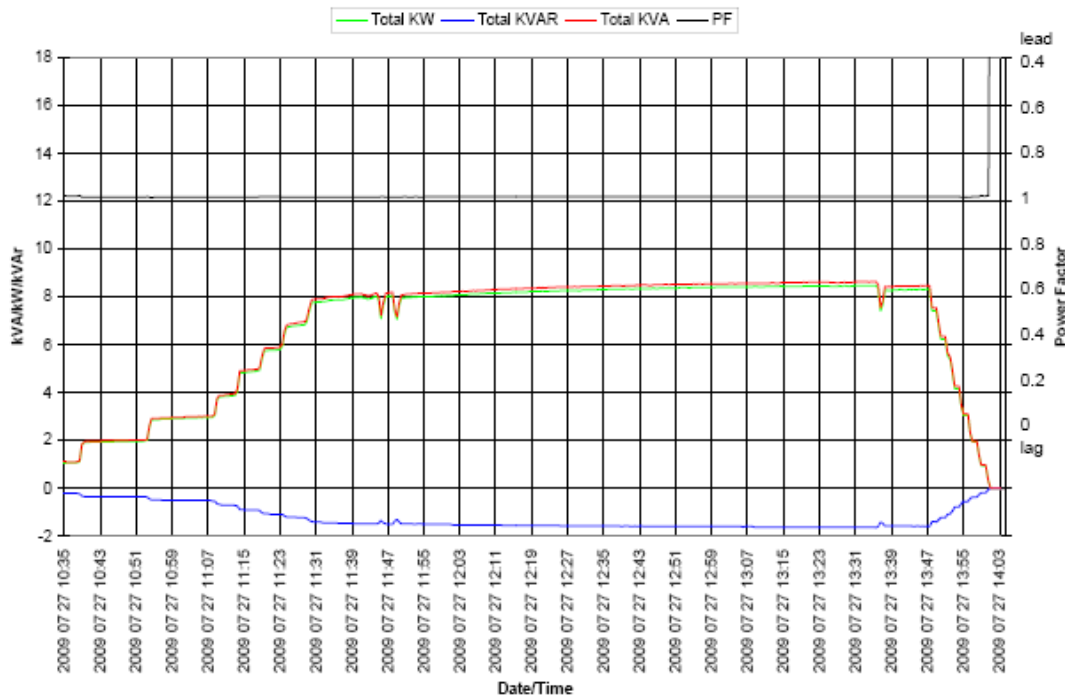
Voltage:

Current:

- Voltage 120.0-123.9; imbalance max 5%, avg 4%
- Current shows plug-in pattern of all 8 PHEVs

PHEV Power Quality Testing

PHEV - 1320 Pacific Ave
Main Panel - Power and Power Factor
2009 07 27 10:35 to 2009 07 27 14:04



- 8.6 kVA peak demand
- Power factor 0.98 leading

Source: Jeff Blais, Manitoba Hydro

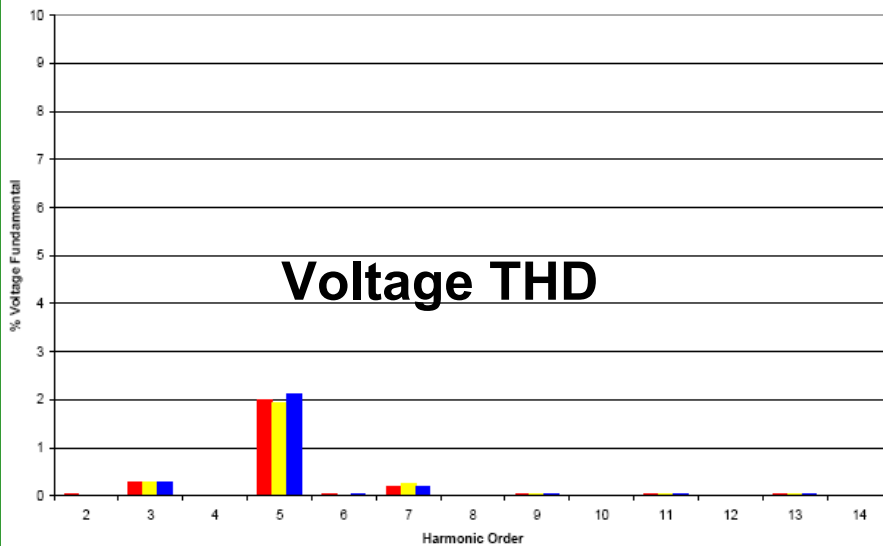
10/5/2009

PHEV Power Quality Testing

PHEV - 1320 Pacific Ave

Main Panel - Individual Voltage Harmonics Averaged Over Monitoring Period
2009 07 27 10:35 to 2009 07 27 14:04

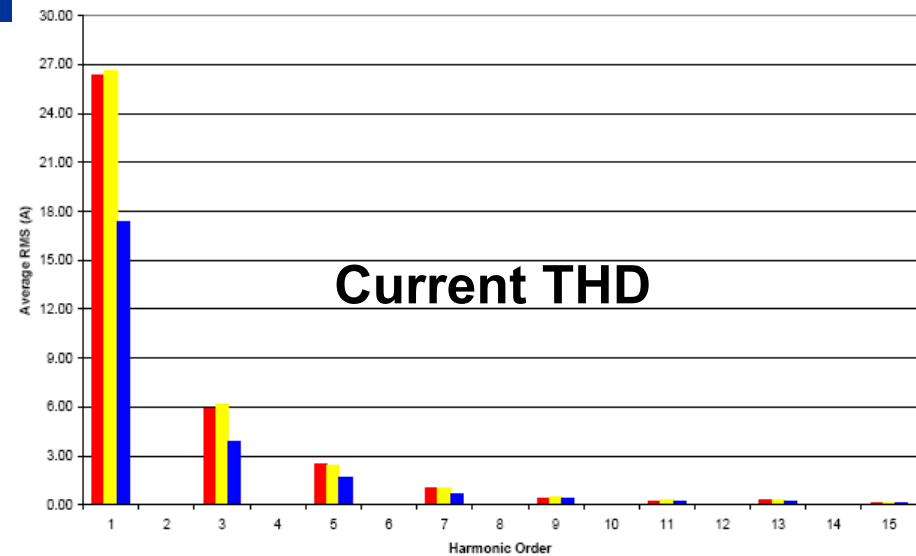
Va Vb Vc



PHEV - 1320 Pacific Ave

Main Panel - Individual Current Harmonics (Average RMS Current) - 95%
2009 07 27 10:35 to 2009 07 27 14:04

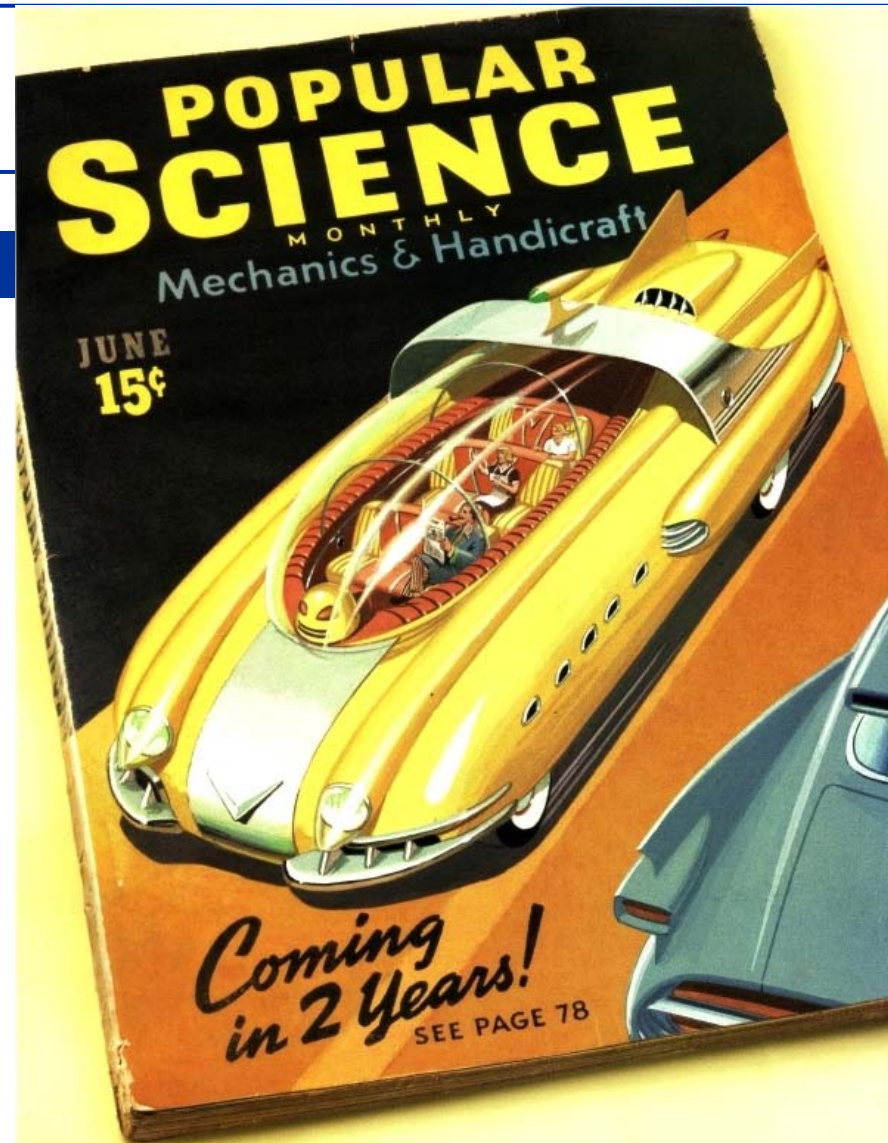
IA IB IC



- Max voltage total harmonic distortion (THD) 2.3%
- Mostly 5th harmonic
- Max current THD (3rd harmonic) 6.97 Amp

Source: Jeff Blais, Manitoba Hydro

10/5/2009



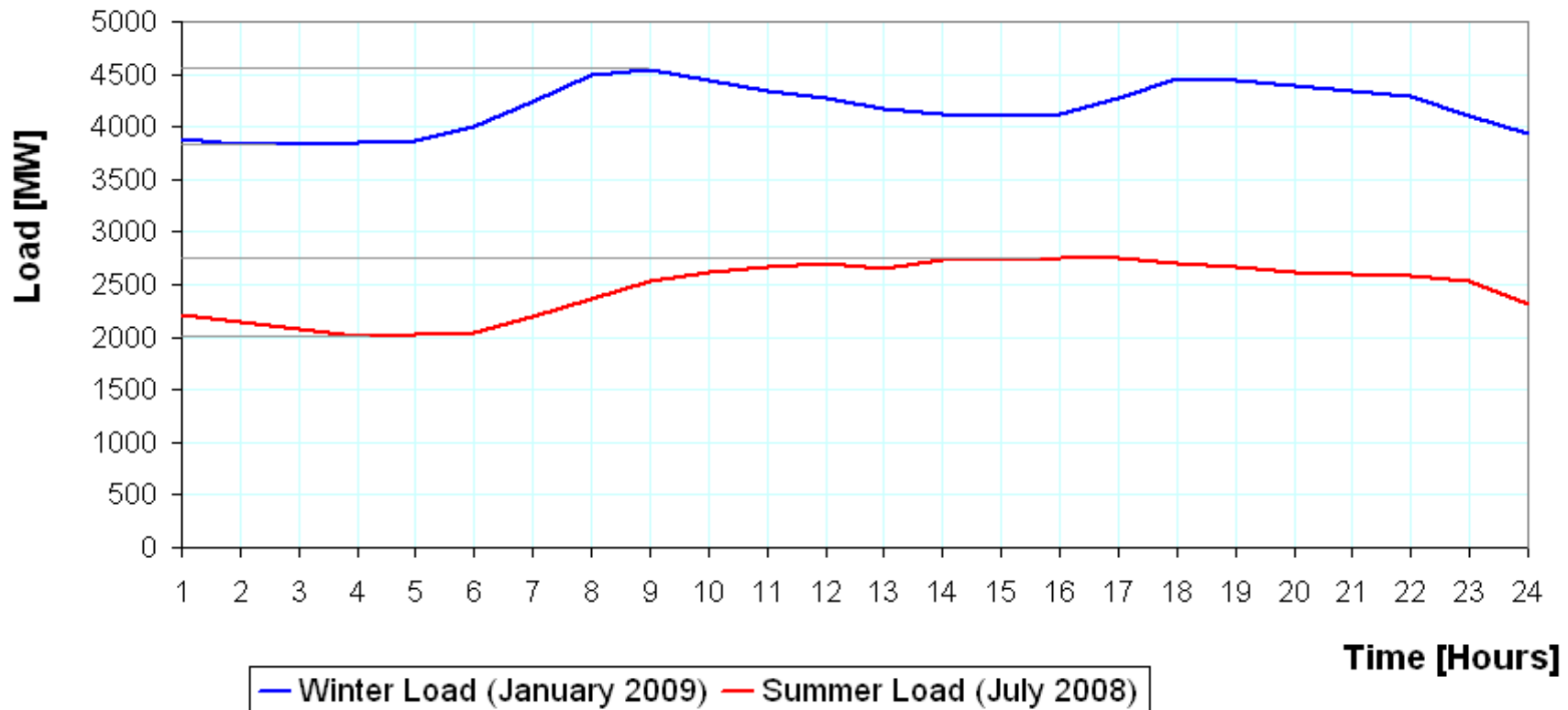
Where are the cars we were promised?



Electric Mobility Canada

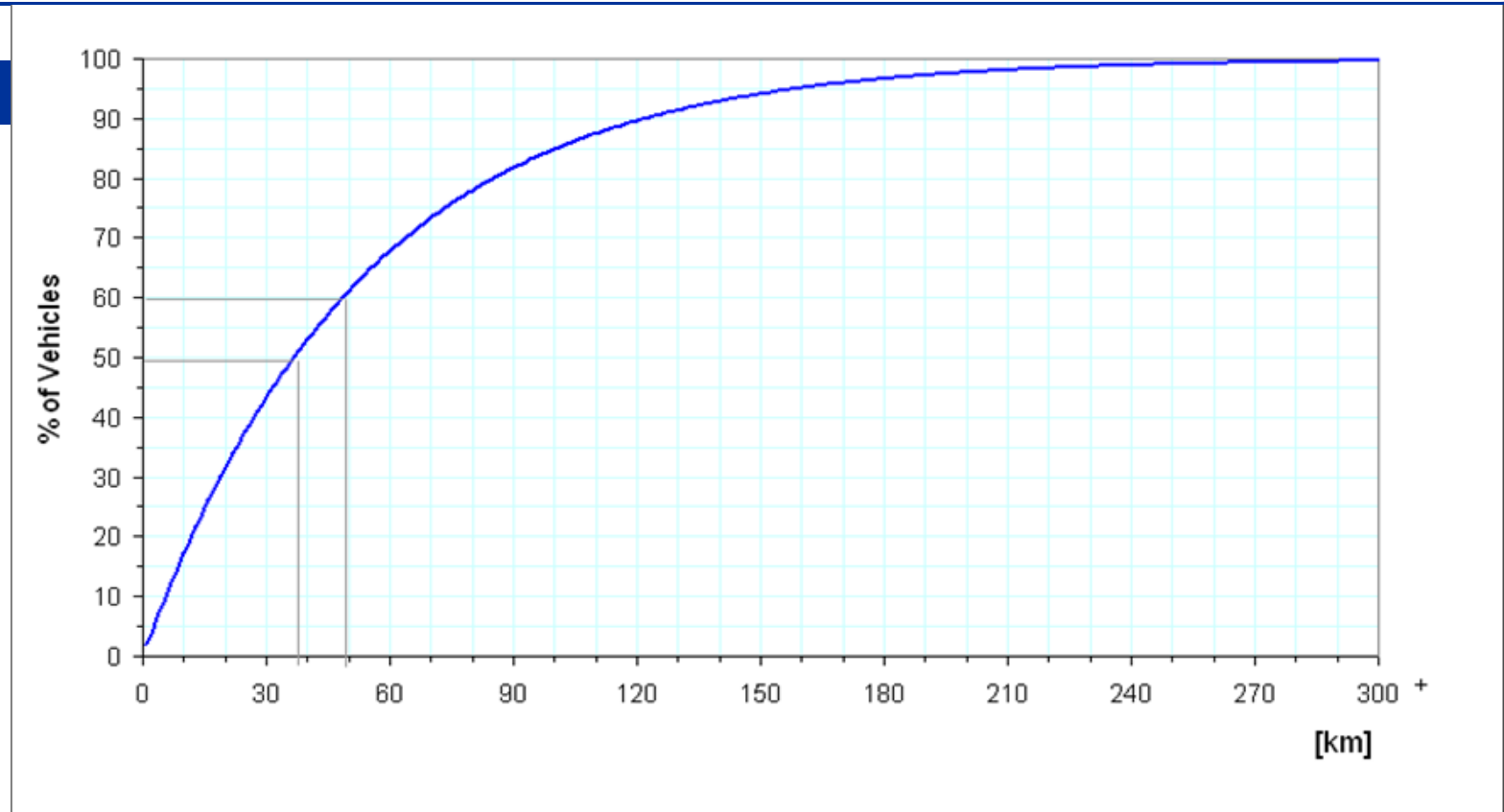
Mobilité électrique Canada

Manitoba Diurnal Load Variability



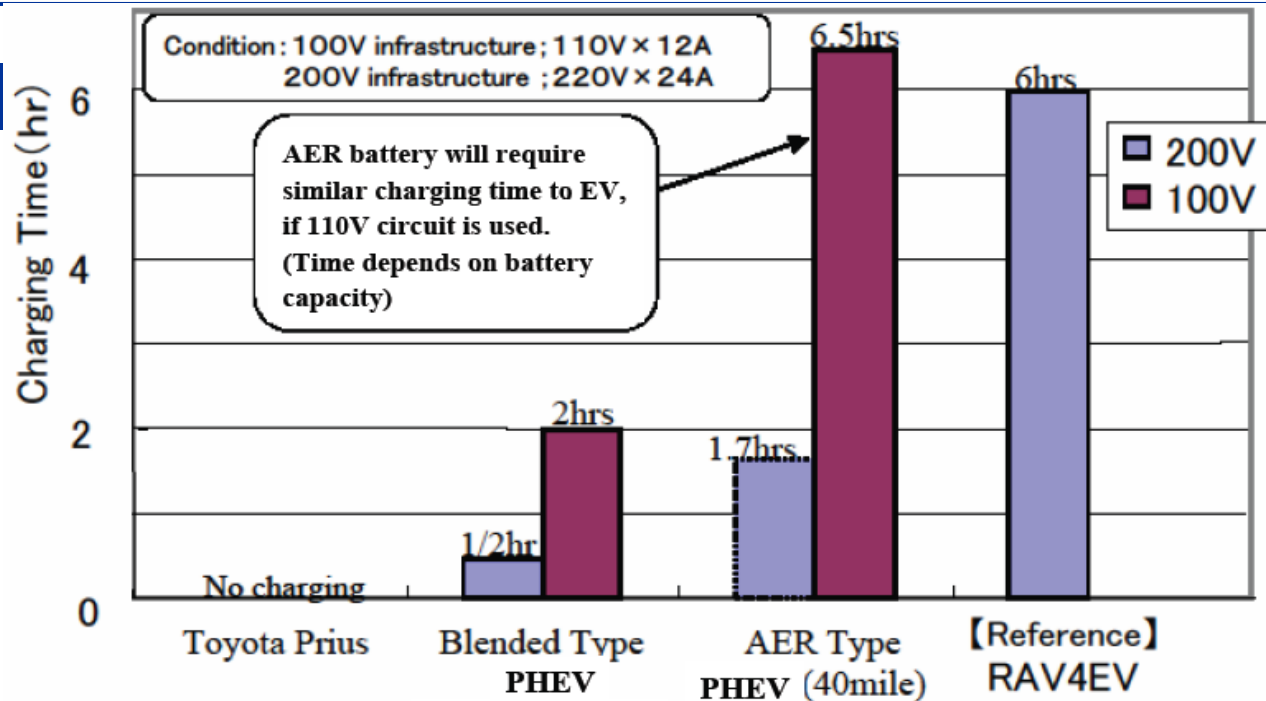
- Winter peak

% of Vehicles With Average Daily km



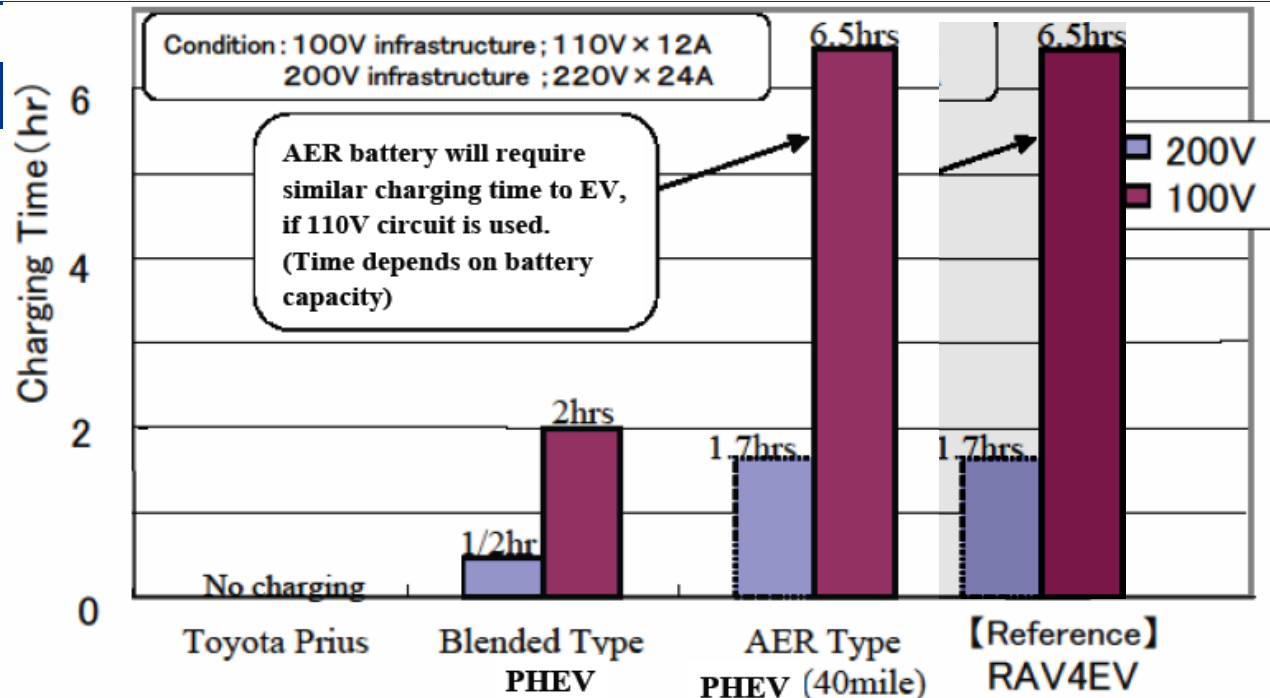
- 60% of vehicles less than 50 km every day
- 50% of vehicles less than 37 km

Charging Time Error



AER PHEV battery requires same charging time as EV !

Charging Time Error



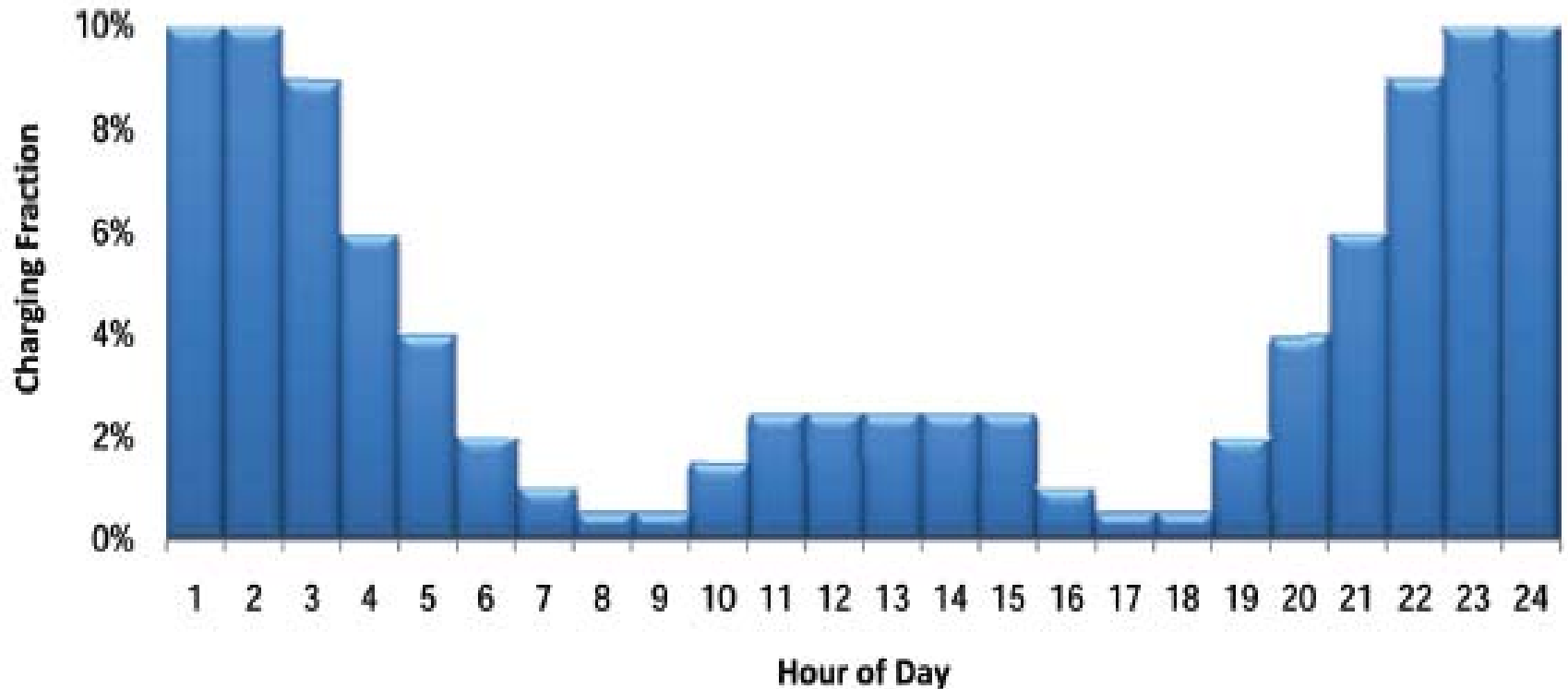
15,000 miles per year

44,000 miles per year!!!

AER PHEV battery requires ~~same~~ charging time as EV !

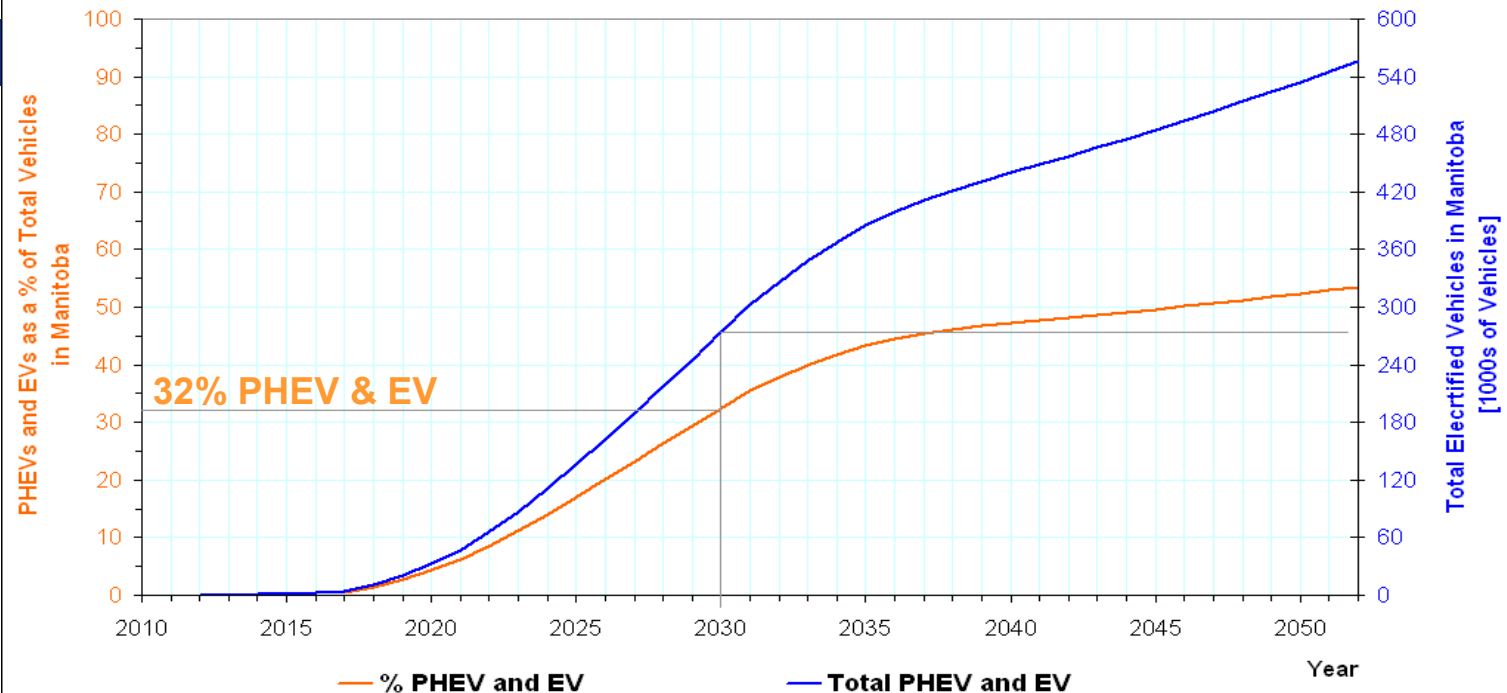
- Charging time is limited by the amount of driving.
- It is not solely dictated by the size of the battery!

Charging Profile



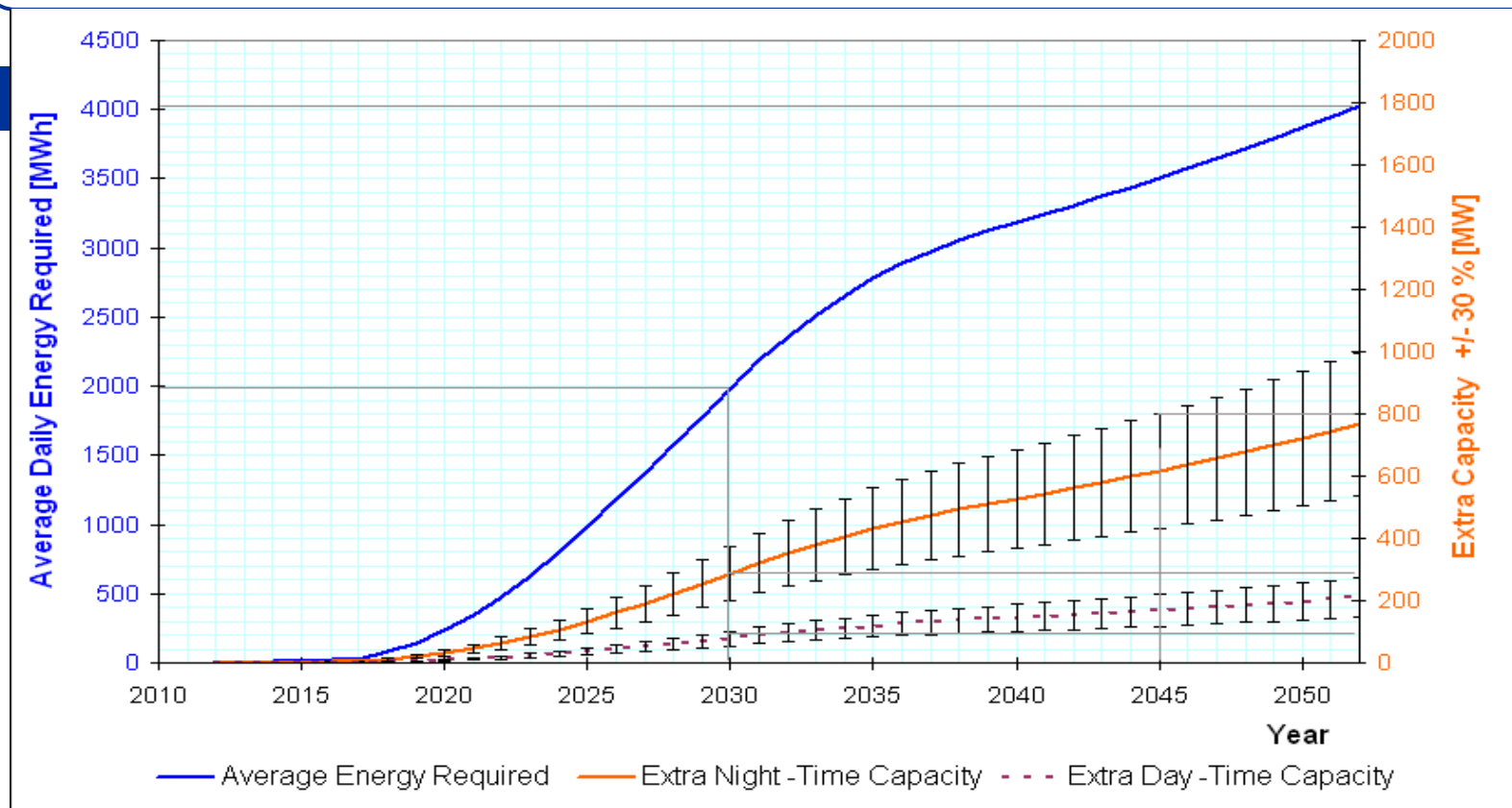
- 74% of charging occurs at night between 10 pm and 6 am

Medium EPRI PHEV Adoption Scenario



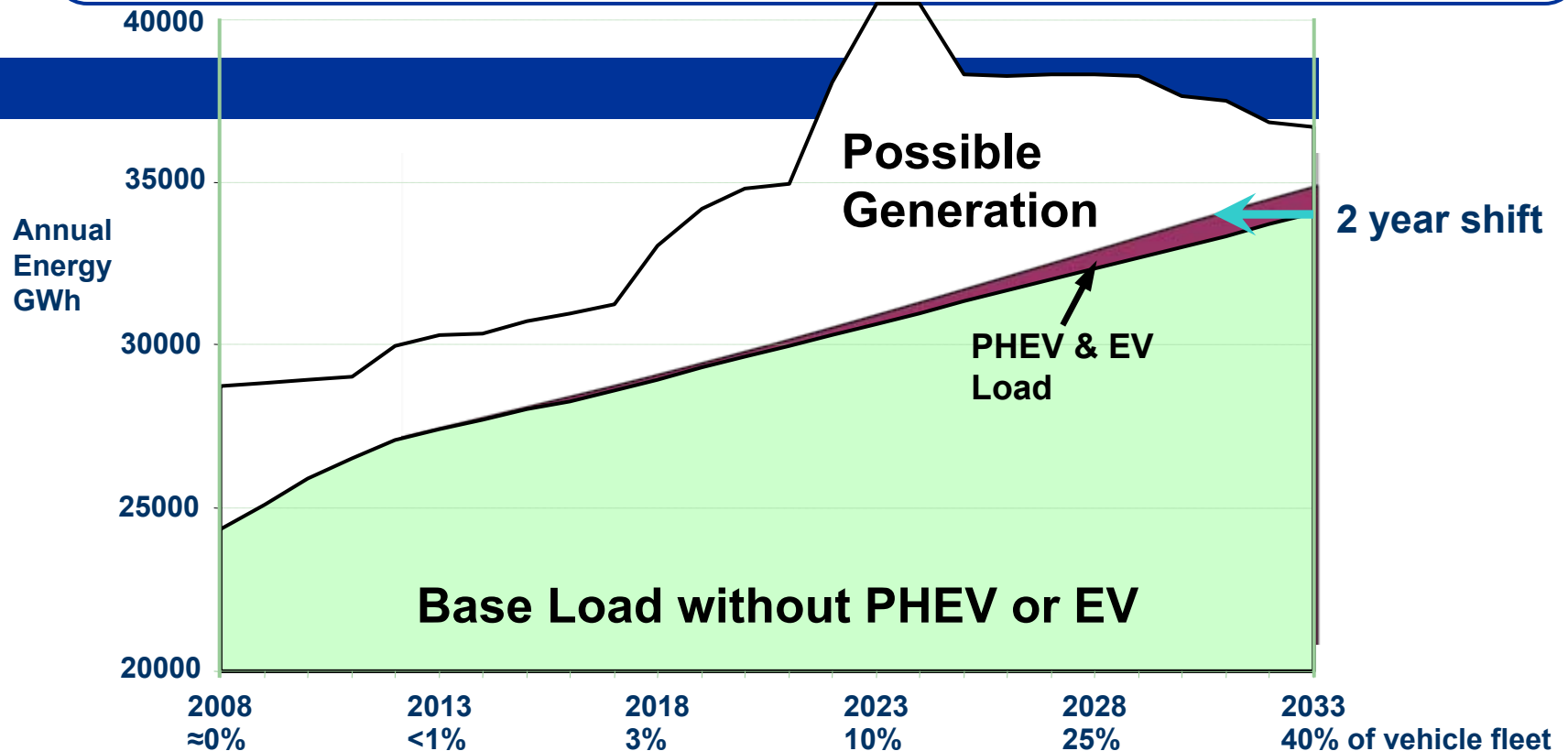
- Approximately 48,000 new vehicles sold in Manitoba in 2008
- 651,000 vehicles in 2008, estimated to be 1,040,000 by 2052

Extra Capacity and Daily Energy



- 720 GWh (1,970 MWh/day) in 2030 (similar to Pine Falls dam)

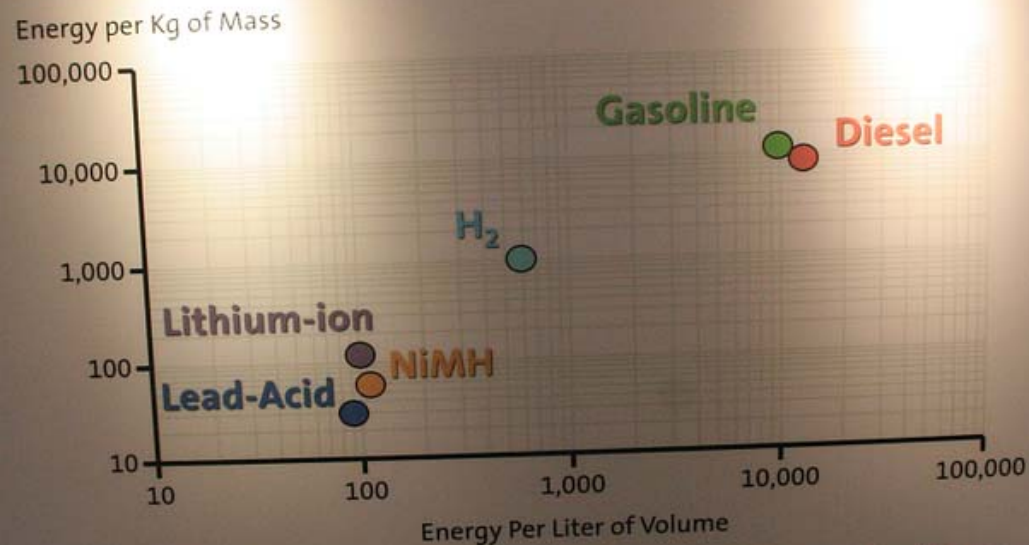
Aggressive PHEV & EV Adoption in Manitoba



- Additional load is an “insignificant” 3% increase
- 2 year shift (8%) is significant

Energy Storage Calculation Errors

Energy Storage Density Remains a Key Challenge

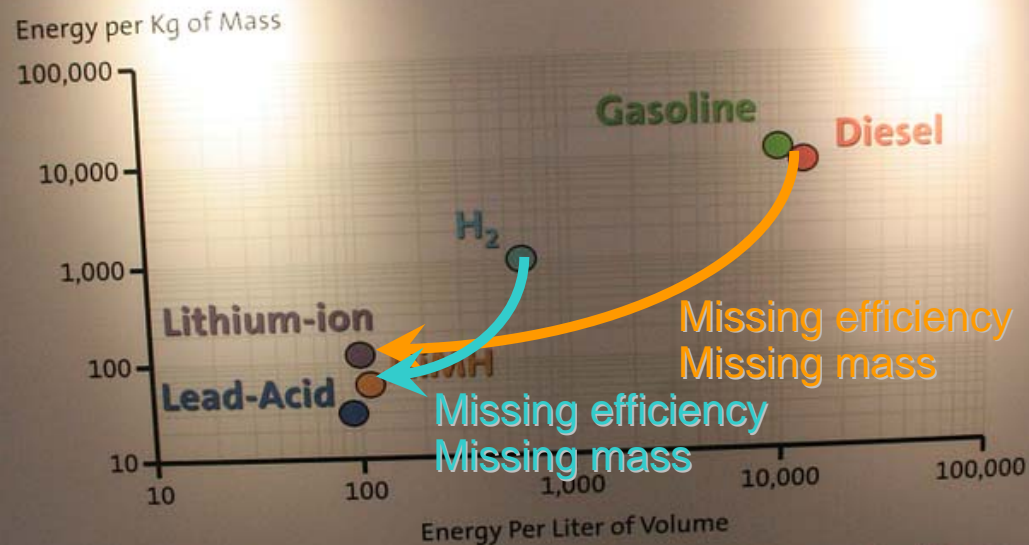


- Battery improvement expected, but still 100x lower density than liquid fuels
- Hydrogen has significantly higher energy density than current batteries

- Numerators missing % efficiency
- Denominators missing relevant mass

Energy Storage Calculation Errors

Energy Storage Density Remains a Key Challenge

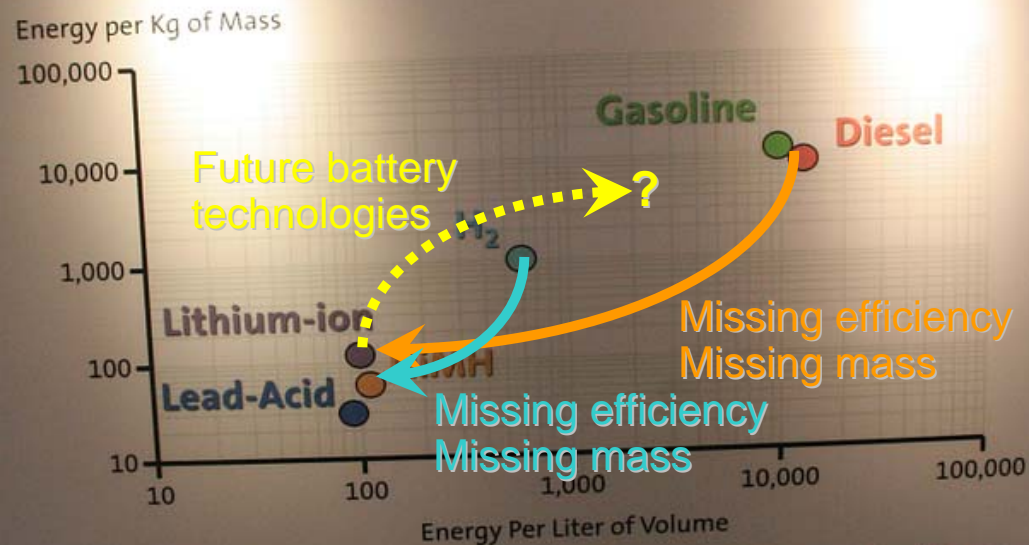


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A Final Thought...



“First they ignore you, then they laugh at you, then they fight you, then you win.”

Mahatma Gandhi 1869-1948

ACHIEVING THE RARE AND FINAL STAGE OF OIL GRIEF:

#6 SMUG SATISFACTION.

MITSUBISHI 185-WATT SOLAR PANELS

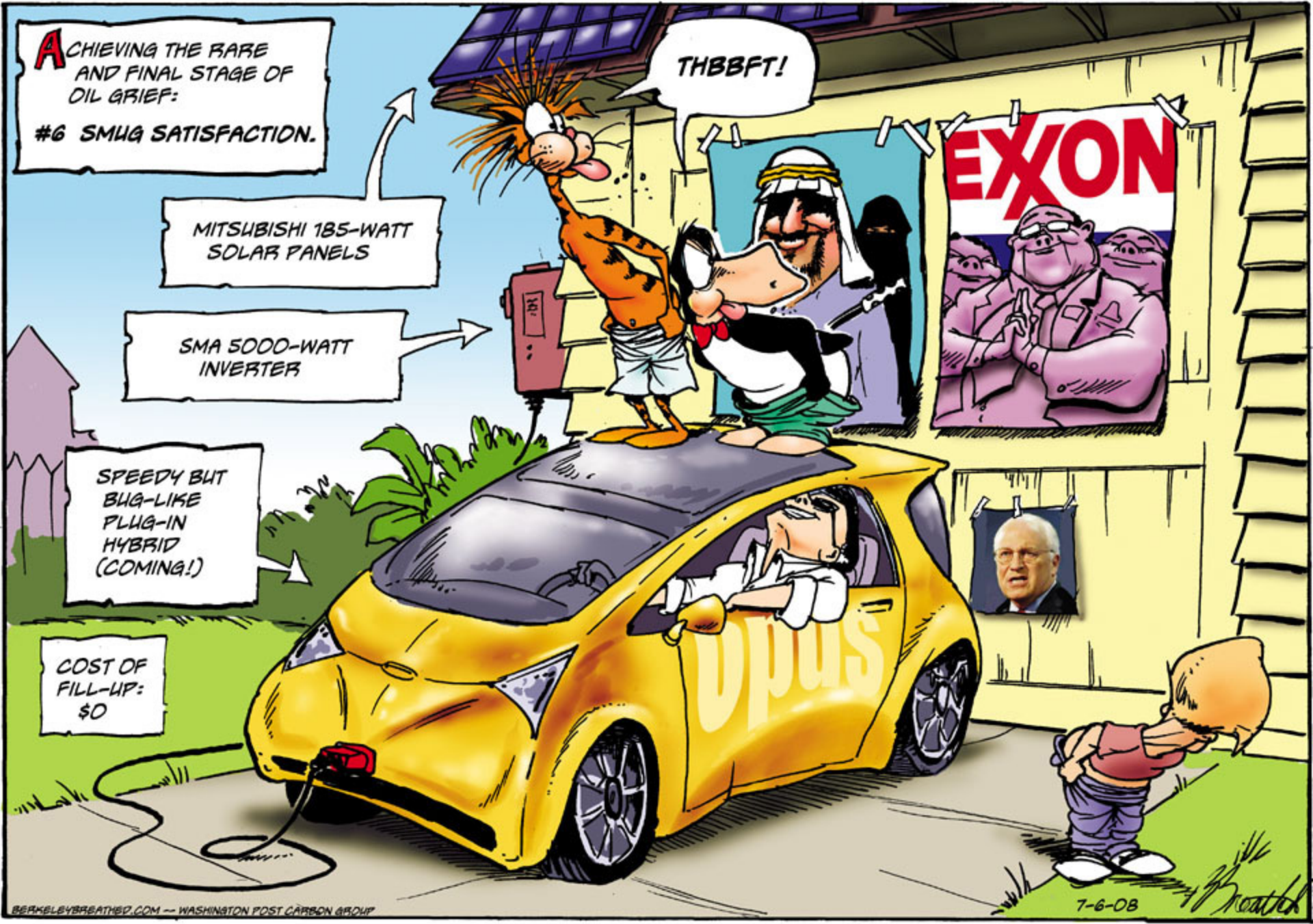
SMA 5000-WATT INVERTER

SPEEDY BUT BUG-LIKE PLUG-IN HYBRID (COMING!)

COST OF FILL-UP: \$0

THBBFT!

EXXON



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