Hybrid technologies and greenhouse gas reduction: doing less with more

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Themes

- What is a 'hybrid technology'?
  - » Examples
    - – Hybrid motor vehicles
    - – Hybrid ('solar') water heaters
- What is their place in greenhouse reduction?
- What should be public policy stance to hybrids?

What is a hybrid?

- Two technologies (or more!) doing the work of one
- Motivations for development:
  - » As a technical exercise
    - – (perhaps with R&D rationale)
  - » As a marketing exercise
- How to achieve those goals:
  - » maximise some metric (selected by proponent)
    - – eg litres/100 km (for vehicles)
    - – eg '% solar contribution' (for solar water heaters)

Hybrid car options

Energy source	Drive train	Examples
Grid electricity	Electric	Lots
Liquid fuel	Int combustion	Nearly all cars
Liquid fuel, battery storage	Electric and int. combust	Toyota, GM, Honda et al
Fuel/electric, battery storage	Electric and int. combust	Converted Prius
Fuel/electric, battery storage	Electric only + IC generator	GM Volt

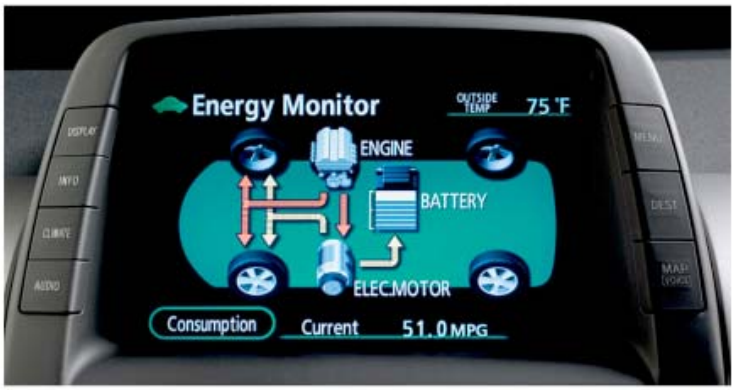
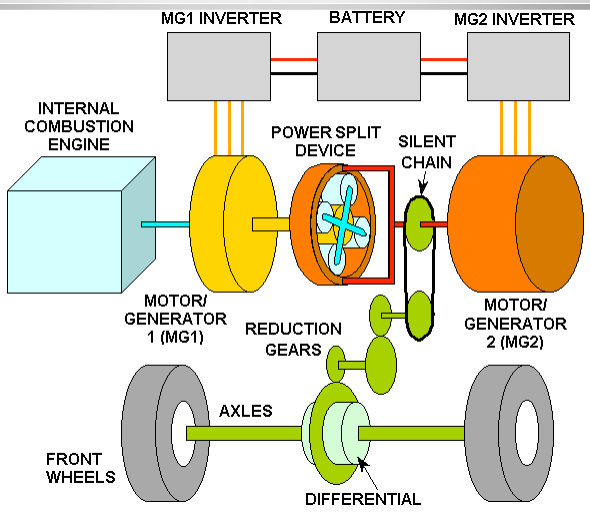


Figure 1. Toyota Prius. The dashboard of the Toyota Prius is an example of a valuable conceptual model.
(image: Toyota.com, downloaded 7/11/2008)



Characteristics

- Heavy, complex and expensive
  - » 1500 cc engine: bigger than most European cars! + battery pack + electric motors + controls
  - » A lot of the energy used to lug around the extra bits
- Additional materials & toxics disposal issue
- Fuel efficiency/emissions advantages marginal
  - » Negated by new generation of diesels
  - » If embodied energy were included, could be negative
- Marketing & R&D dominant to date
  - » Toyota & GM now hybridizing larger cars, not smaller
  - » But some European makers hybridising small diesels

Most efficient cars in Aust.

	Engine		Comb l/100km	Urban l/100km	Ex-urb l/100km	gCO_2/km
SMART fortwo	1.0 L, 3	2 dr, 2 seats	4.4	5.2	3.9	105
Toyota Prius	1.5 L, 5	4 dr, 5 seat	4.4			106
Fiat 500, diesel	1.3 L, 4	2 dr, 4 seat	4.2			110
Fiat 500, petrol	1.2 L, 4	2 dr, 4 seat	5.0			118
Fiat Punto, diesel	1.3 L, 4	4 dr, 5 seat	4.4			115
Fiat Punto, petrol	1.4 L, 4	4 dr, 5 seat	5.7			134
30 diesel models… up to 2.0 L.. before						
Toyota Yaris	1.3 L	4 dr, 5 seat	6.0			141

Europe wtd avg gCO_2/km 2007

FIAT	137
Peugeot	142
Citroen	142
Renault	146
Toyota	149
Ford	149
Opel/Vauxhall	153
Volkswagen	162
BMW	177
Mercedes	188

Cost of CO_2 reductions

- Say Prius to Punto: 7 g/km advantage
- 15,000 km/yr = 105 kg/yr advantage
- The less you drive, the less you save
- 1.26 tonnes over 12 yrs (excludes embodied)
- Cost premium $12,400 ($ 37.4k vs $25 k)
- $ 9,800/t CO_2 avoided!
- Toyota now hybridizing large cars, not small
  - » Has convinced Govt to paying for hybrid Camry
- Too expensive for large scale GH reduction

Water heating: gCO_2/MJ UE

- Depends on performance of water heater and GH-intensity of energy used
  - » Electricity around 270-300 g/MJ, Gas 60
- End use efficiency (UE/purchased energy)
  - » Conventional elec & gas: 0.8 to 0.9
  - » Heat pump: 2.0 to 2.5
  - » Solar-elec, solar-gas: 2.0 to 4.0
    - – Depends on configuration, type, design, use, installation (on roof), location (in Australia)


Rheem


GAS
Rinnai 26
INFINITY

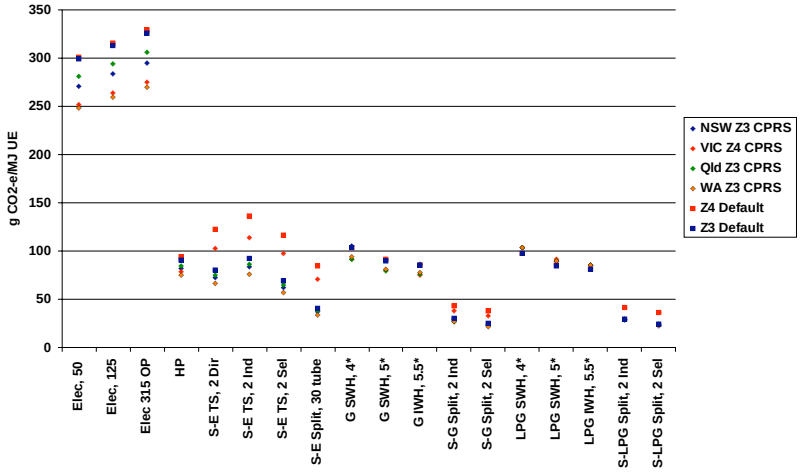

Solahart
FREE HEAT


Rinnai
Rinnai
Electric Boost
Gas Boost

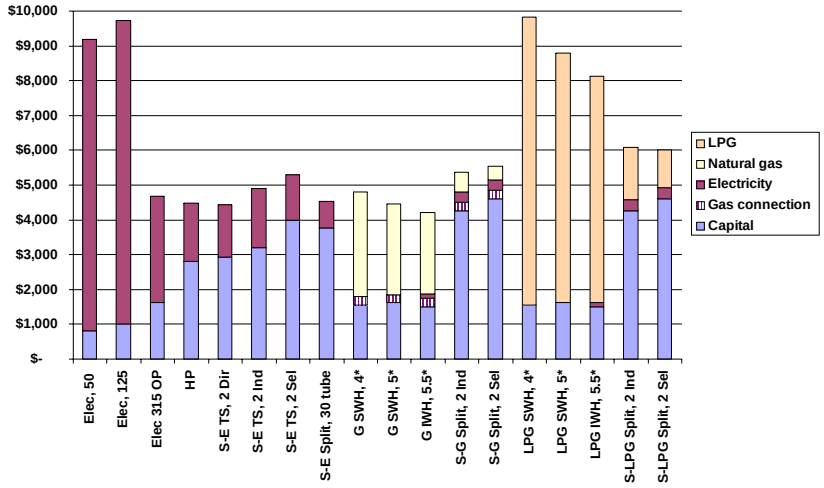
Solar-thermal WH as a hybrid

- Fossil-renewable hybrid
  - » or just an efficent way to heat water, like a heat pump?)
- Up to 3 complete WHs to do job of one
- Electric to sol-elec (excl subsidies)
  - » saves about 36 t CO_2-e over 13 yrs; \$35/t CO_2-e
  - » 30 x reduction of Prius, 1/280 cost
- Gas to solar-gas
  - » saves about 11 t CO_2-e over 13 yrs; \$160/t CO2-e
- The less hot water you use, the less you save

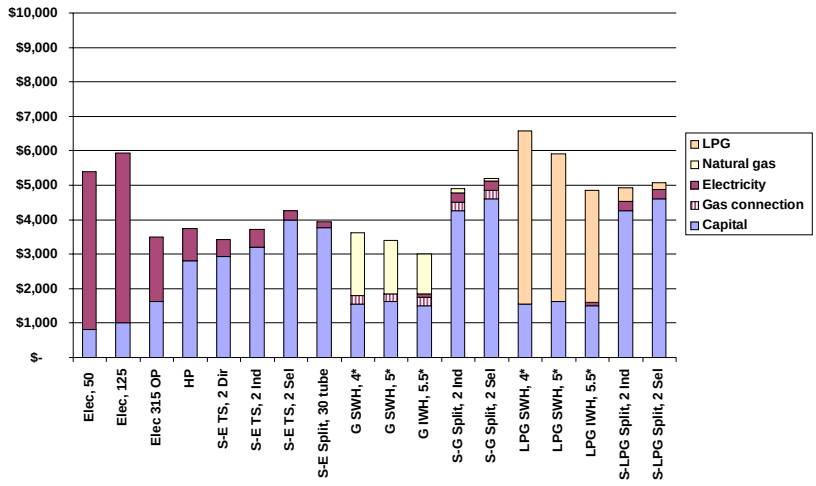
GH Intensity of water heaters



Costs – high hot water use



Costs – low hot water use



Some observations

- Solar & HP getting huge subsidies
  - » RECs: about $1,000 per unit (around $80M/yr)
  - » Direct subsidies: $1,600 from CW; up to $1,000 from some States; buyers only pay for installation
- Distorting MRET scheme
  - » Produces over 25% of RECs, depresses prices
- Savings will fall with elec GH-intensity
- But cheaper GH savings than Prius
  - » But vehicle hybrids not subsidised – until now

Conclusions

- Hybrid vehicles too costly for GH-reduction
  - » Could have longer term value in overall grid management as means of distributed storage
  - » Public support should be limited to this objective
- Solar-elec useful for rapid GH-reduction
  - » Solar–gas much less so
  - » Could have limited window: if grid becomes cleaner, electric WH could again be best option
    - – Can use as energy sink, without reducing efficiency
- Ultimately, simpler is better