Centre for Energy and Environmental Markets

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An economic assessment of Perth's hydrogen fuel cell buses

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25th Annual North American Conference of the USAEE/IAEE
Denver, Colorado, USA: 18-21 September 2005

Sustainable Transport Energy for Perth (STEP)

- **WA Government Funded**
- **2 Year evaluation of Daimler Chrysler fuel cell powered buses**

Sustainable Transport Energy Perth

DaimlerChrysler

bp

Murdoch University Perth, Western Australia

PathTransit

BALLARD

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Australian Government
Australian Greenhouse Office

UNEP

Perceived Advantages

- Reduced Air Pollution
- Reduced Greenhouse Gases
- Sustainable transport fuel
- Reduced dependence on imported sources of energy

Societal Life Cycle Costs

- Total Societal Life Cycle Costs ($/vehicle)
- =
- Initial cost of vehicle (before tax)
- + PVLC (fuel + non-fuel operation and maintenance)
- + PVLC (full fuel cycle air pollutant damages + GHG emissions damage)
- + PVLC (full fuel cycle subsidies – full fuel cycle taxes).

Method

- Capital Costs
  - Diesel
  - CNG
  - Fuel Cell – Full economies of scale
- Fuel Costs
  - Steam Methane Reforming
  - Onshore Wind and Electrolysis
  - Mature industry assumptions
- Externalities
- Oil Supply Insecurity

Hydrogen Supply Cost Projections ($US)

Technology	Future fuel/elec. resource price	Fuel cost (US$/GJ)	Other prod. Costs (US$/GJ)	Transport costs (US$/GJ)	Refuelling (US$/GJ)	Future supply cost (US$/GJ)
Gasoline/diesel	$25-29/bbl	4-5	2	<1	2	8-10
Natural gas	$3-4/GJ	3-4	n/a	<1	4	7-9
H_2 (gas) CO_2 seq.	$3-5/GJ	3.8-6.3	1.2-2.7	2	5-7	12-18
H_2 (coal) CO_2 seq.	$1-2/GJ	1.3-2.7	4.7-6.3	2	5-7	13-18
H_2 (biomass)	$2-5/GJ	2.9-7.1	5-6	2-5	5-7	14-25
H_2 (wind-onshore)	3-4c/kWh	9.8-13.1	5	2-5	5-7	22-30
H_2 (wind-offshore)	4-5.5c/kWh	13.1-18.0	5	2-5	5-7	27-37
H_2 (solar-thermal)	6-8c/kWh	19.6-26.1	5	2-5	5-7	32-42
H_2 (solar PV)	12-20c/kWh	39.2-65.4	5	2-5	5-7	52-82
H_2 (nuclear)	2.5-3.5c/kWh	8.2-11.4	5	2	5-7	20-27
H_2 (HTGR cogen.)	n/a	n/a	8-23	2	5-7	15-32

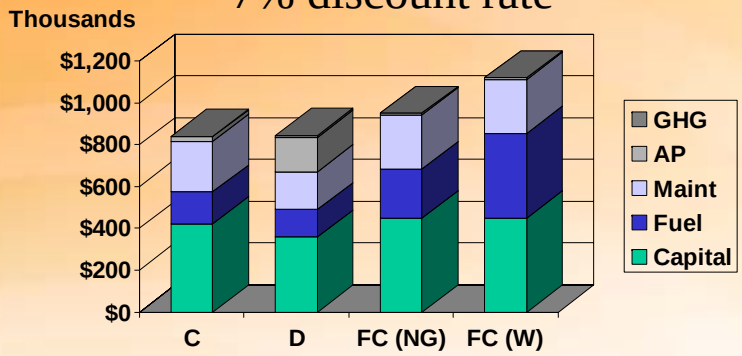
Scenarios

- Base Case
- Scenario 1
  - Diesel and CNG costs increase by 3% per annum
- Scenario 2
  - Discount rate of 3%
- Scenario 3
  - Oil price of US$50/bbl
- Scenario 4
  - Break even fuel costs

Results

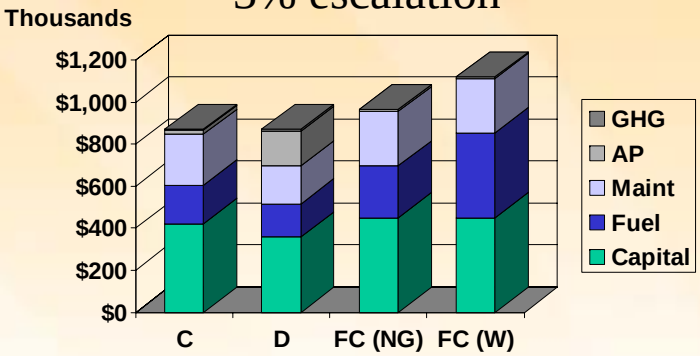
Base Case

7% discount rate



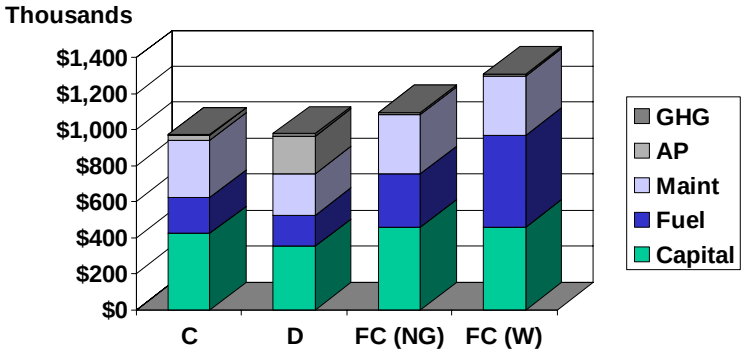
Scenario 1

3% escalation



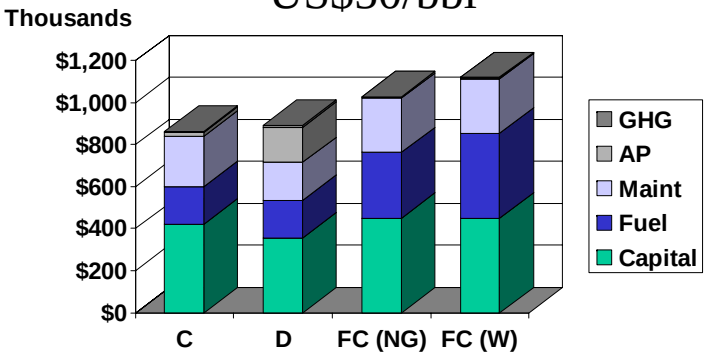
Scenario 2

3% discount rate



Scenario 3

US$50/bbl



Conclusion

- Sensitivity to discount rate
- Effects of externalities
- Reality check on capital cost and fuel cost targets
- Effect of oil price
- Cost of oil supply insecurity