An economic assessment of Perth's hydrogen fuel cell buses

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Sustainable Transport Energy for Perth (STEP)

SUSTAINABLE TRANSPORT ENERGY PERTH
DAIMLERCHRYSLER
bp
MURDOCH UNIVERSITY
PERTH, WESTERN AUSTRALIA
PathTransit
BALLARD
Natural Heritage Trust
Australian Government
Australian Greenhouse Office
UNEP

Perceived Advantages

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

Societal Life Cycle Costs

Total Societal Life Cycle Costs ($/vehicle)

=

Initial cost of vehicle

+ PVLC (Operating Costs)

+ PVLC (Emissions)

+ PVLC (full fuel cycle subsidies – full fuel cycle taxes).

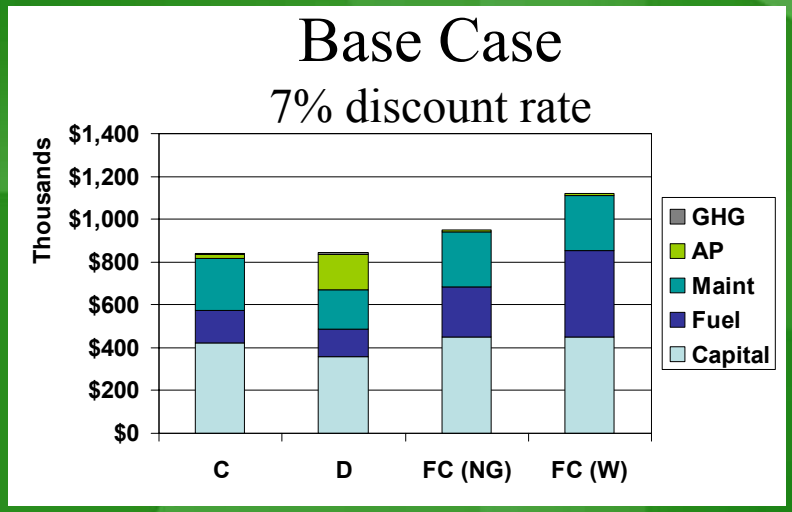
Method

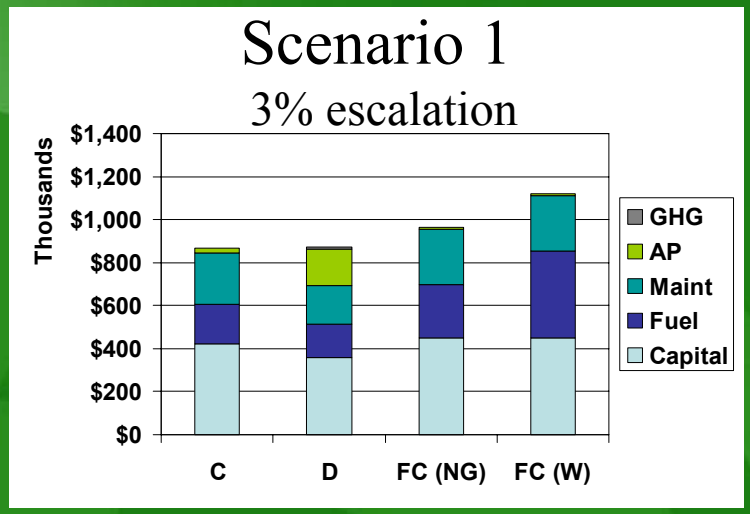
- **Capital Costs**
  - Diesel
  - CNG
  - Fuel Cell – Full economies of scale
- **Fuel Costs**
  - Steam Methane Reforming
  - Onshore Wind and Electrolysis
  - Mature industry assumptions
- **Externalities**
- **Oil Supply Insecurity**

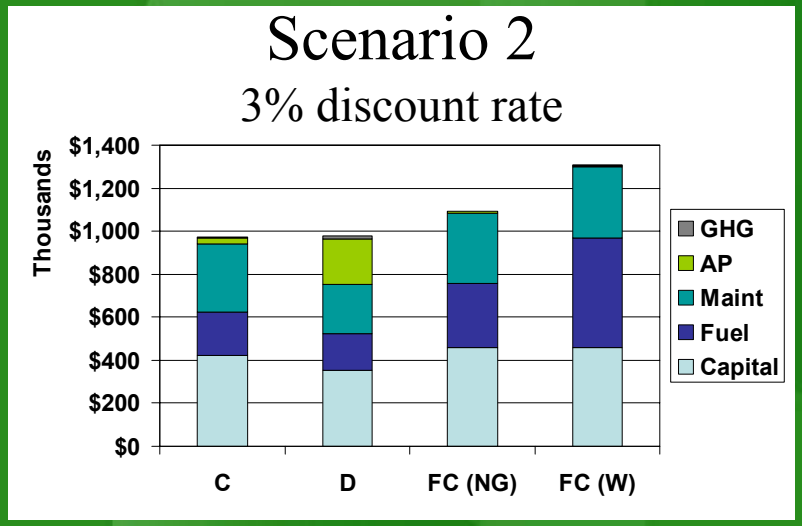
Scenarios

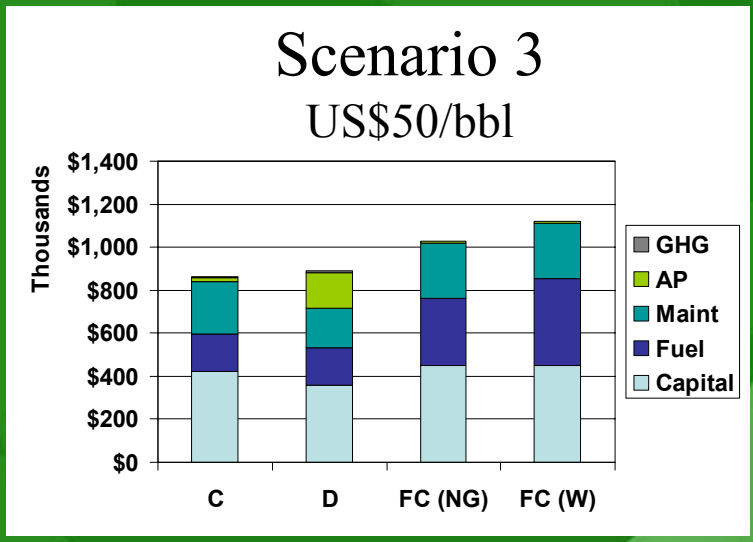
- **Base Case**
- **Scenario 1**
  - Diesel and CNG costs increase by 3% per annum
- **Scenario 2**
  - Discount rate of 3%
- **Scenario 3**
  - Oil price of US$50/bbl
- **Scenario 4**
  - Break even fuel costs

Results


Base Case
7% discount rate
Thousands
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
C
D
FC (NG)
FC (W)
GHG
AP
Maint
Fuel
Capital


Scenario 1
3% escalation
Thousands
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
C
D
FC (NG)
FC (W)
GHG
AP
Maint
Fuel
Capital


Scenario 2
3% discount rate
Thousands
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
C
D
FC (NG)
FC (W)
GHG
AP
Maint
Fuel
Capital


Scenario 3
US$50/bbl
Thousands
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
C
D
FC (NG)
FC (W)
GHG
AP
Maint
Fuel
Capital

Conclusions

- 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

Back up slides

Fuel Costs

	Future fuel/elec	Fuel	Other prod.	Transport	Refuelling	Future supply
	resource price	cost ($/GJ)	costs ($/GJ)	cost ($/GJ)	($/GJ)	cost ($/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
H2 (gas) CO2 seq.	$3-5/GJ	3.8-6.3	1.2-2.7	2	5-7	12-18
H2 (coal) CO2 seq.	$1-2/GJ	1.3-2.7	4.7-6.3	2	5-7	13-18
H2 (biomass)	$2-5/GJ	2.9-7.1	5-6	2-5	5-7	14-25
H2 (wind-onshore)	3-4c/kWh	9.8-13.1	5	2-5	5-7	22-30
H2 (wind-offshore)	4-5.5c/kWh	13.1-18.0	5	2-5	5-7	27-37
H2 (solar thermal)	6-8c/kWh	19.6-26.1	5	2-5	5-7	32-42
H2 (PV)	12-20c/kWh	39.2-65.4	5	2-5	5-7	52-82
H2 (nuclear)	2.5-3.5c/kWh	8.2-11.4	5	2	5-7	20-27
H2 (HTGR cogen.)	n.a.	n.a.	8-23	2	5-7	15-32
Source: IEA (2003)						