



Energy systems analysis including hydrogen

Dr Jonathan Leaver
Vice-Chair IEA H2 TCP



UniSyD – Multi-regional energy economic model

- ❖ Partial equilibrium system-dynamics model with a high level of resource and technology specificity.
- 64 Sectors, 11,000 lines of code, over 30 publications
- Models of New Zealand, Iceland, Japan, Scandinavia
- <http://www.unisyd.org/>

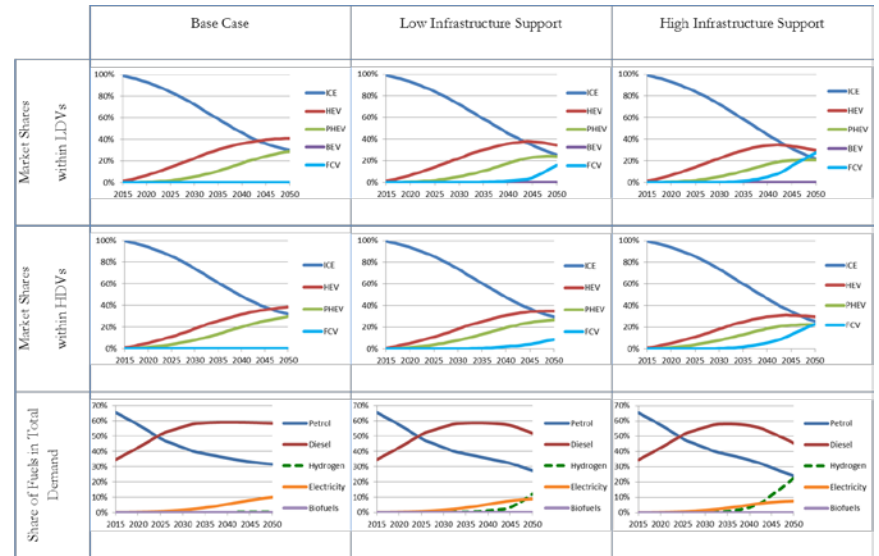
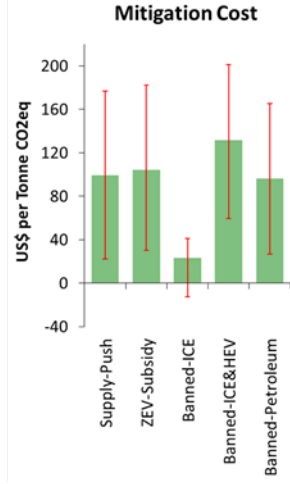
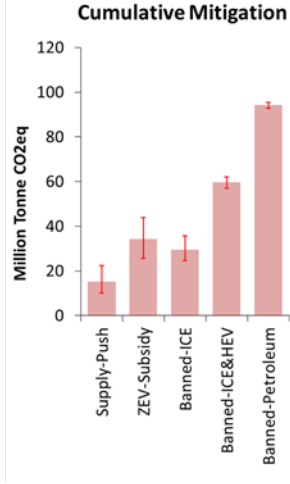
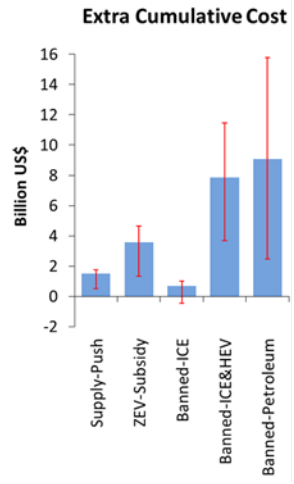
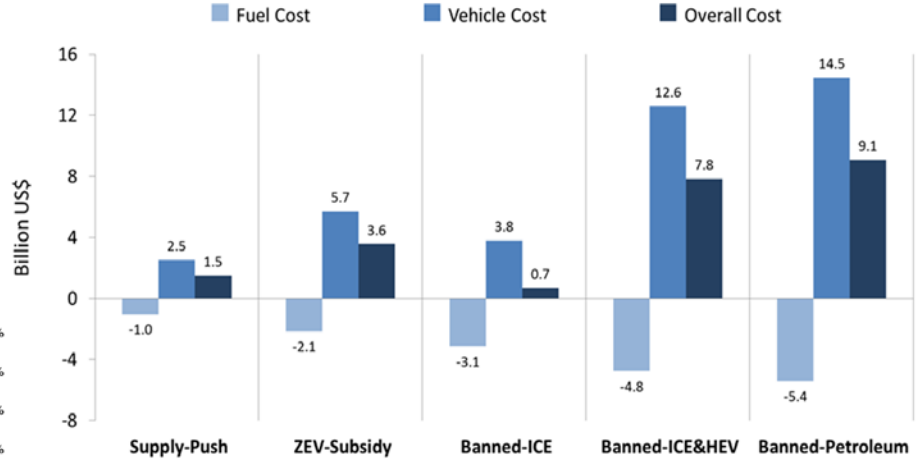
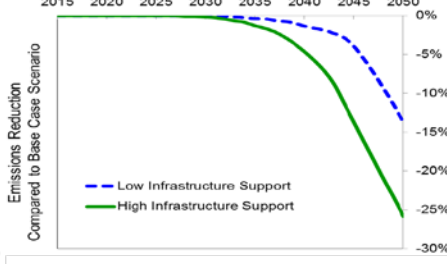
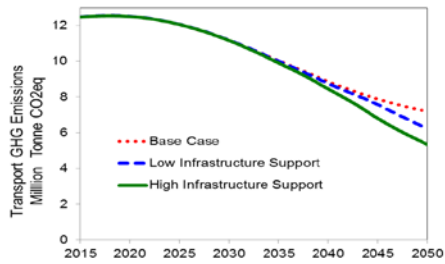
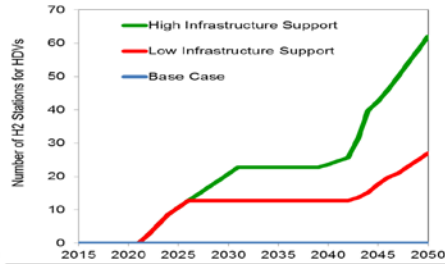
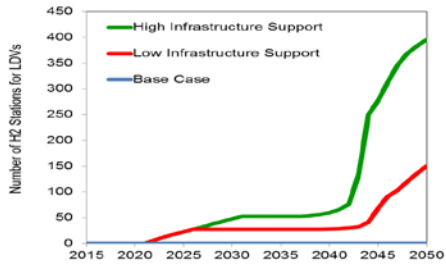
Models NZ's Energy-Economic System

- Simulates in biweekly time steps.
- 2 islands with 13 NZ regions

Primary Sectors

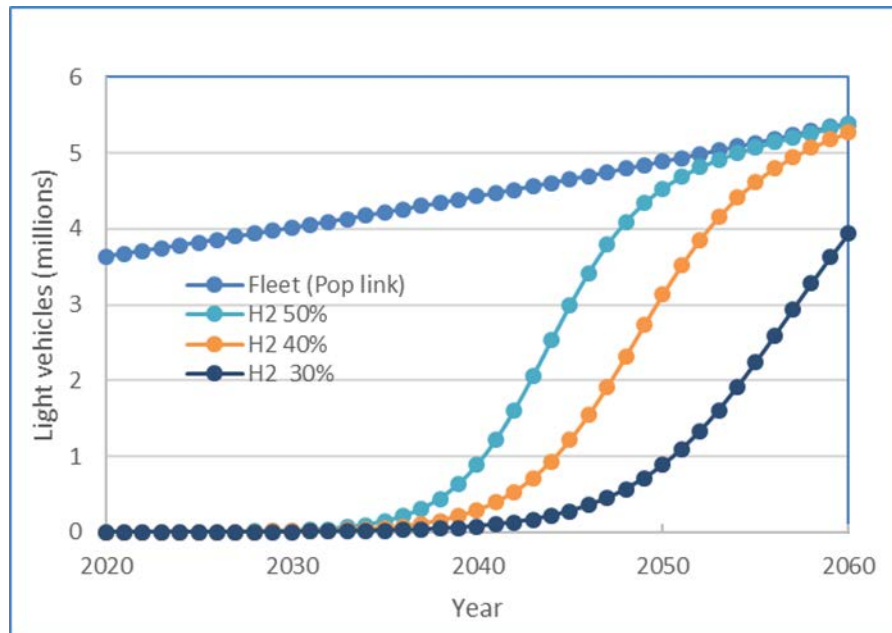
- Electricity Market
- Hydrogen Market
- Biofuel market
- Vehicle Fleet Market

UniSyD Sample Results



UniTrac - Multiple owner vehicle systems analysis

- Economic comparison of light HFCVs against CVs for successive owners
- Net present value analysis of capital cost, fuel and maintenance, interest and depreciation for multiple owners.

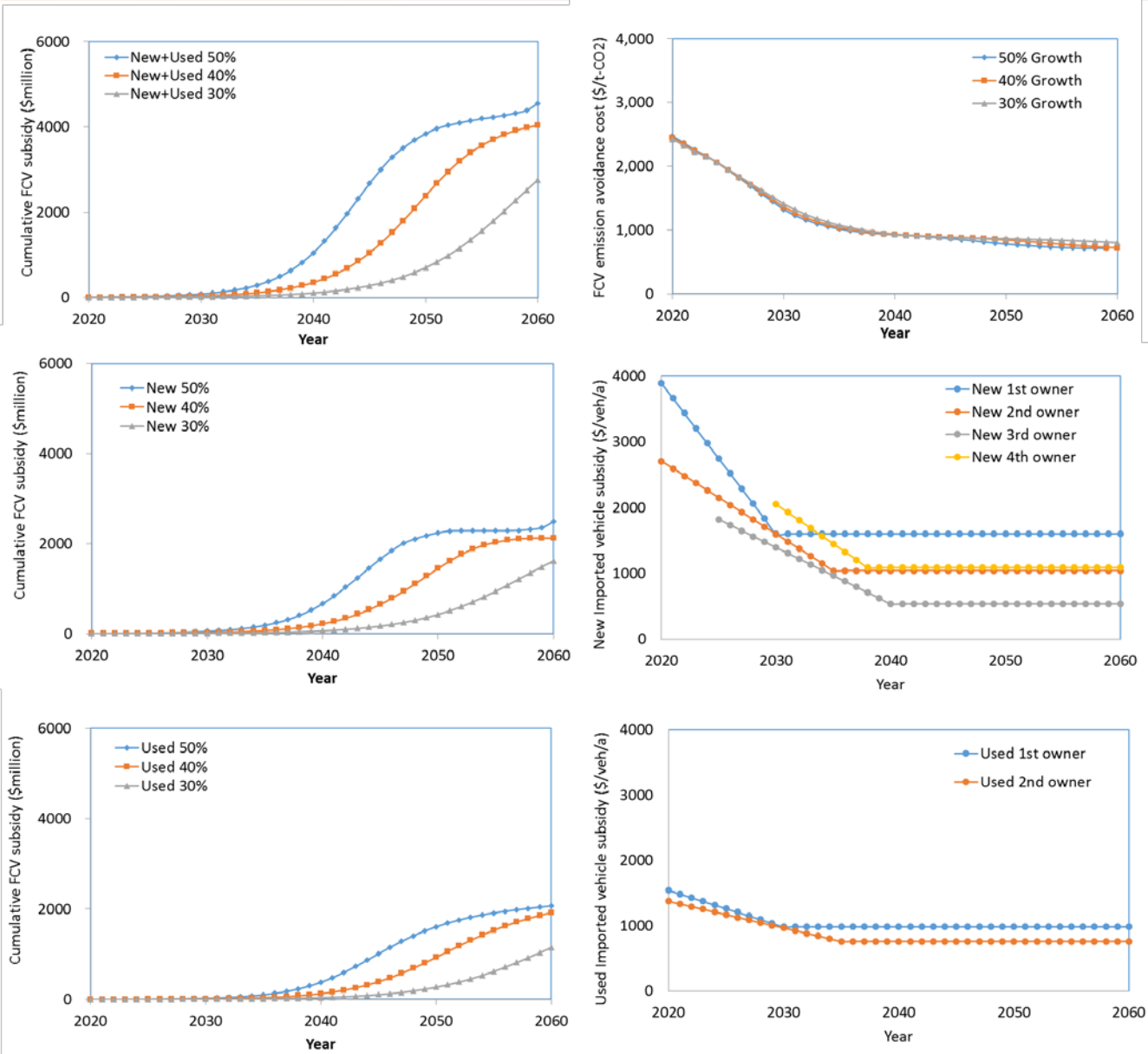


FCV Analysis

Key Variables

Ave annual travel distance (km)	11393
Ave fuel economy of new CVs (km/L)	14.93
Ave fuel economy of used CVs (km/L)	11.76
Ave fuel economy of FCVs (km/kg)	100
Annual main & service costs of CV-FCV (US\$) *	148
Annual FCV price depreciation	16.40%
Annual CV price depreciation	12.20%
Discount rate for new vehicles (NPV)	2.50%
Discount rate for used vehicles (NPV)	8.50%
Gasoline price (US\$/L) *	0.77
Electricity Price (US\$/kWh) *	0.1
Hydrogen Price (US\$/kg) *	12
Electrolyser electricity (kWh/kg)	44
(*) US/NZ ex rate average over 5 yrs 2012-16	0.741
Gasoline CO2 emissions (kg/L)	2.36
Electricity CO2 emissions (kg-CO2/kWh)	0.138
Annual reduction in electricity CO2 emissions	7.18%
Annual Fuel Expense (US\$) w/o taxes	
New CV	588
Used CV	746
Fuel cell size kW (Mirai)	114
Fuel cell cost in 2015 US\$/kW	345
Fuel cell cost in 2030 US\$/kW	49
FCV capital cost in 2030	\$23,815
FCV capital cost reduction rate (2015-2030)	0.057

UniTrac Sample Results



Future interest

UniSyD

- Addition of industrial and agricultural sectors
- Addition of shipping and rail in the transport sector.

UniTrac

- Addition of multiple ownership heavy vehicle fleets

Contributions of the following colleagues are gratefully acknowledged:

- Dr Ehsan Shafiei – University of Iceland (UniSyD)
- Prof. Akihiro Watabe – University of Kanagawa (UniTrac)

Thank you