Performance of solar and heat-pump water heaters in the New Zealand context

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New Zealand Electricity….

- 60 – 70% Hydroelectric
- 16% Gas (declining)
- Coal / geothermal

- But demand increasing at 2% per year
- Site depletion for more hydro-electric
- Gas fields (Maui) near depletion
- Kyoto Protocol limits use of abundant coal
- High risk of shortages during ‘dry winters’
- Wind constrained by transmission capacity, resource consenting

Demand side management

Energy efficient water heating…

- Residential electricity usage 1/3 of national
- Hot water 1/3 of residential

Technologies:

- Solar water heaters
- Hot water heat-pumps

BUT: How well do they work in the New Zealand Climate??

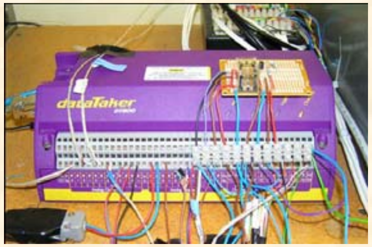
Our Work:

<u>Performance analysis of energy efficient water heaters.</u>

- Systems installed by manufacturer or agent.
- Installed as if purchased by consumer
- Systems tested by daily discharges, with datalogger controlling systems and recording data

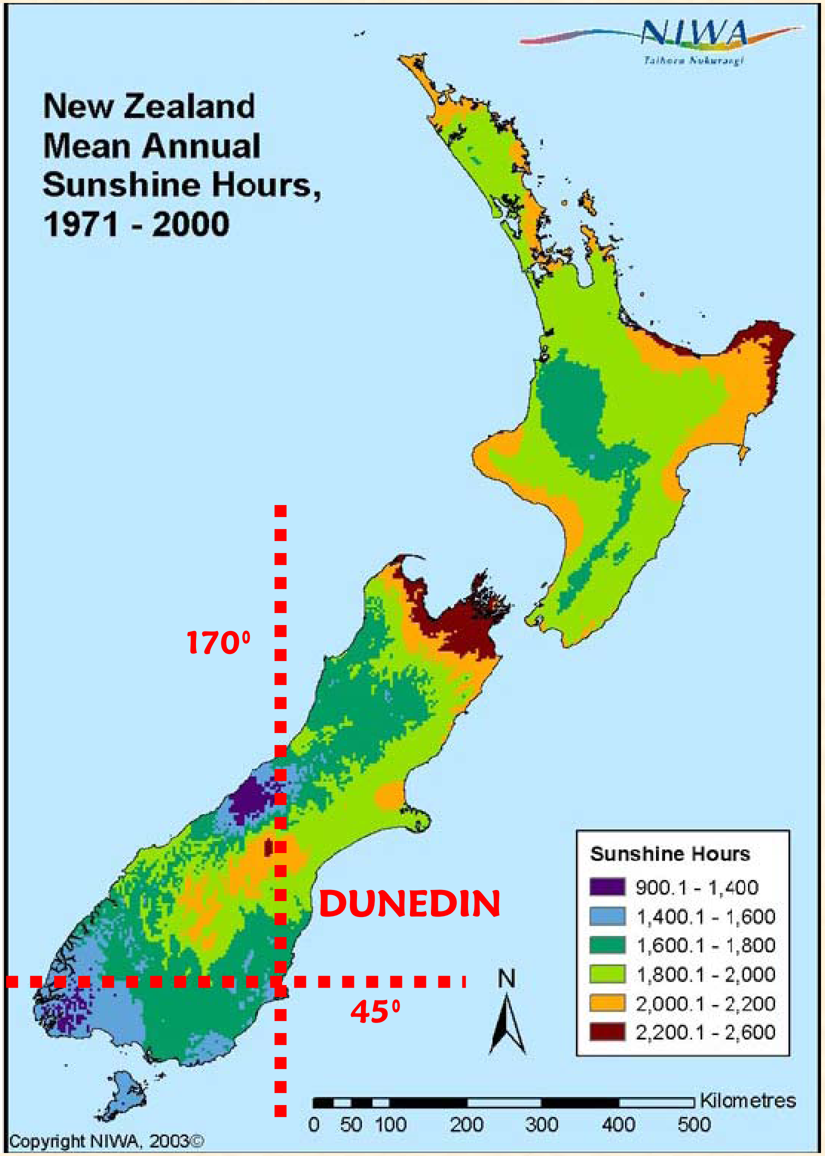
<u>Systems tested:</u>

1) Flat-panel thermosiphon solar system
2) Flat-panel pumped solar system
3) Evacuated tube solar system
4) Hot-water heat-pump system



Discharges: 37620 kJ/day at 8am (large)

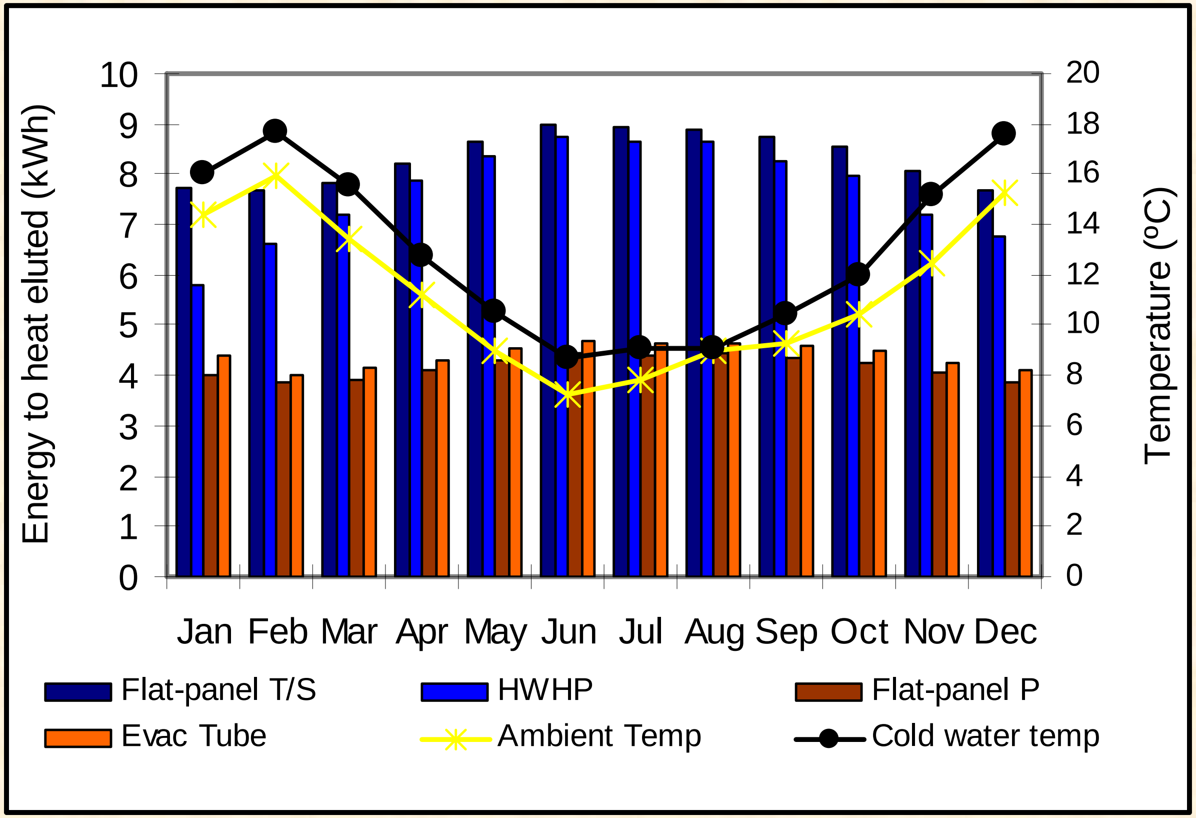
: 18810 kJ/day (small)



Dunedin:

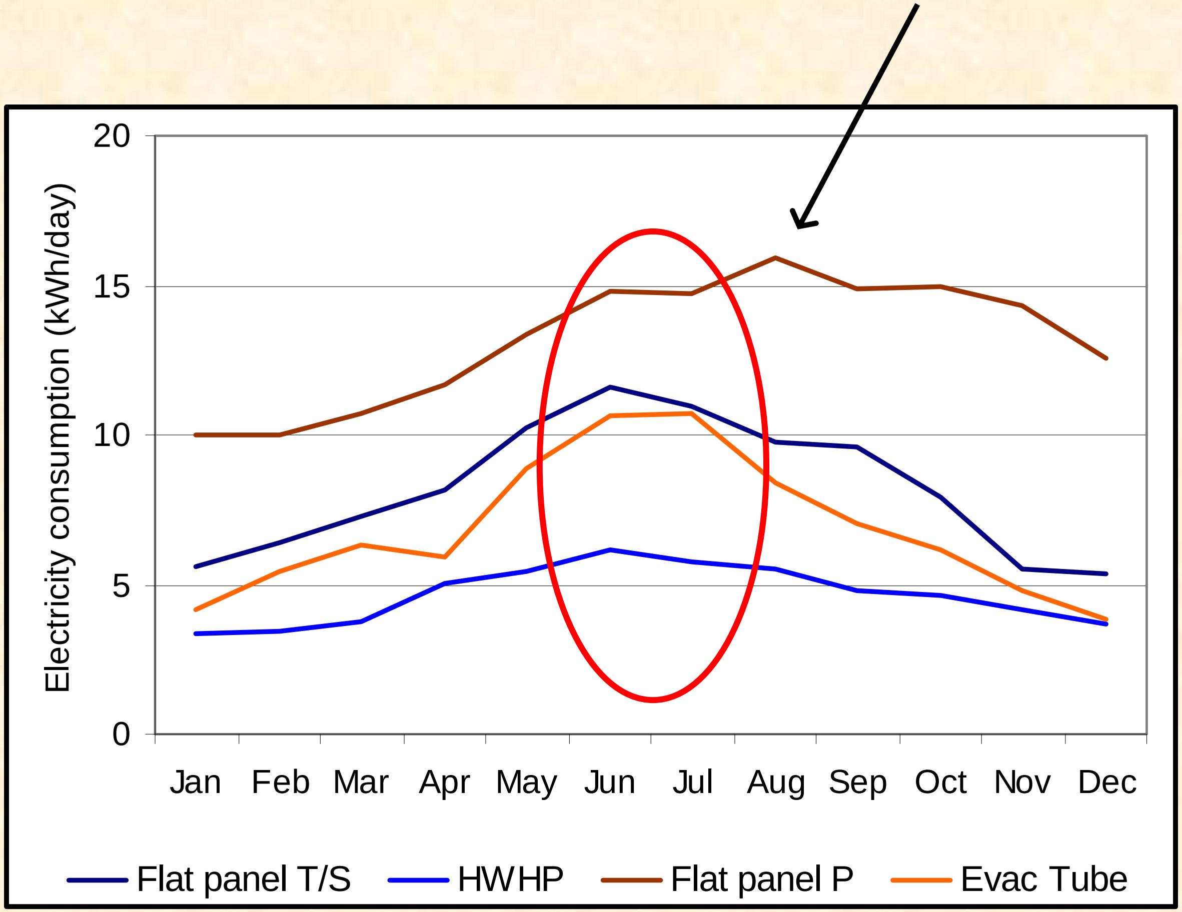
Av Temp: 11^{o}C
G_T: 3.16 kWh/m^2/day

Results – Jan to Dec 2005



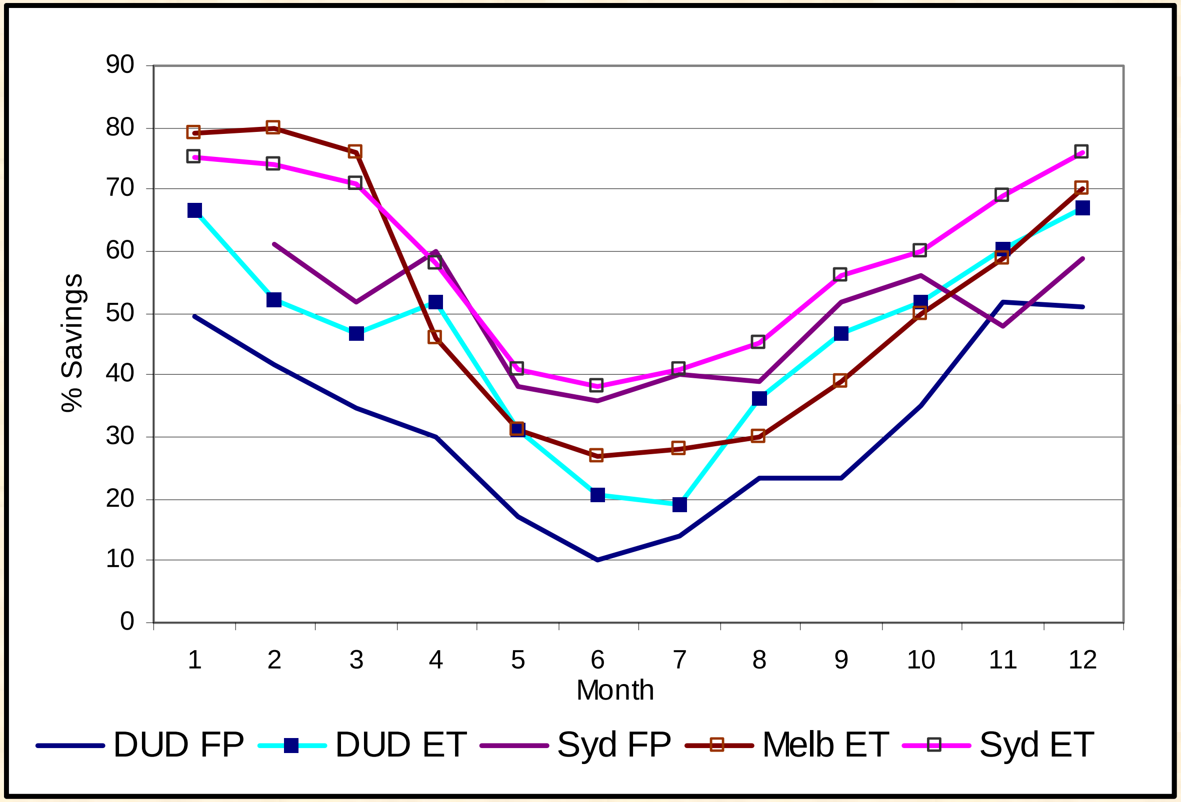
Daily load on the systems

Results – Jan to Dec 2005



Monthly electricity consumption - normalised

Results – Jan to Dec 2005



Compared with published results…

Results….

	COP	Savings*
Flat-panel thermosiphon:	1.02	31%
Evacuated tube:	1.30	46%
HW heat-pump:	1.65	58%
Flat-panel pumped:	0.64	-9%

* Standing loss at 30%

Results – lower than expected:

Thermosiphon system

- Installed too flat (17°) for Dunedin by supplier,
- Heat dissipation device installed,
- Some panel corrosion evident.

Pumped flat panel system

- Extensive failure of panel absorber due to overheating and moisture,
- Retrofit in design, with no control of auxiliary boost at bottom of cylinder,
- Poor transfer of heat between pumped circuit and cylinder through 5 way valve.

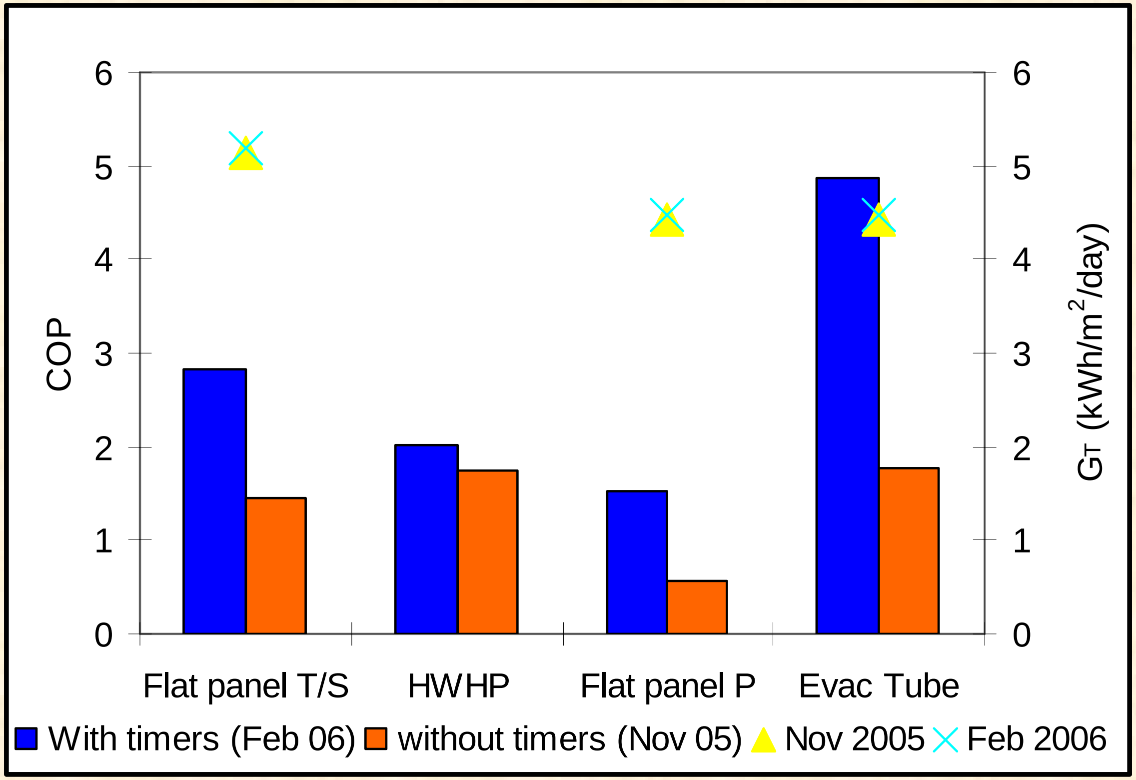
Hot water heat-pump

- Temperature too low (55°C) for legionella control,
- Potential for poor hot water service during very cold winter days.

Evacuated tube system

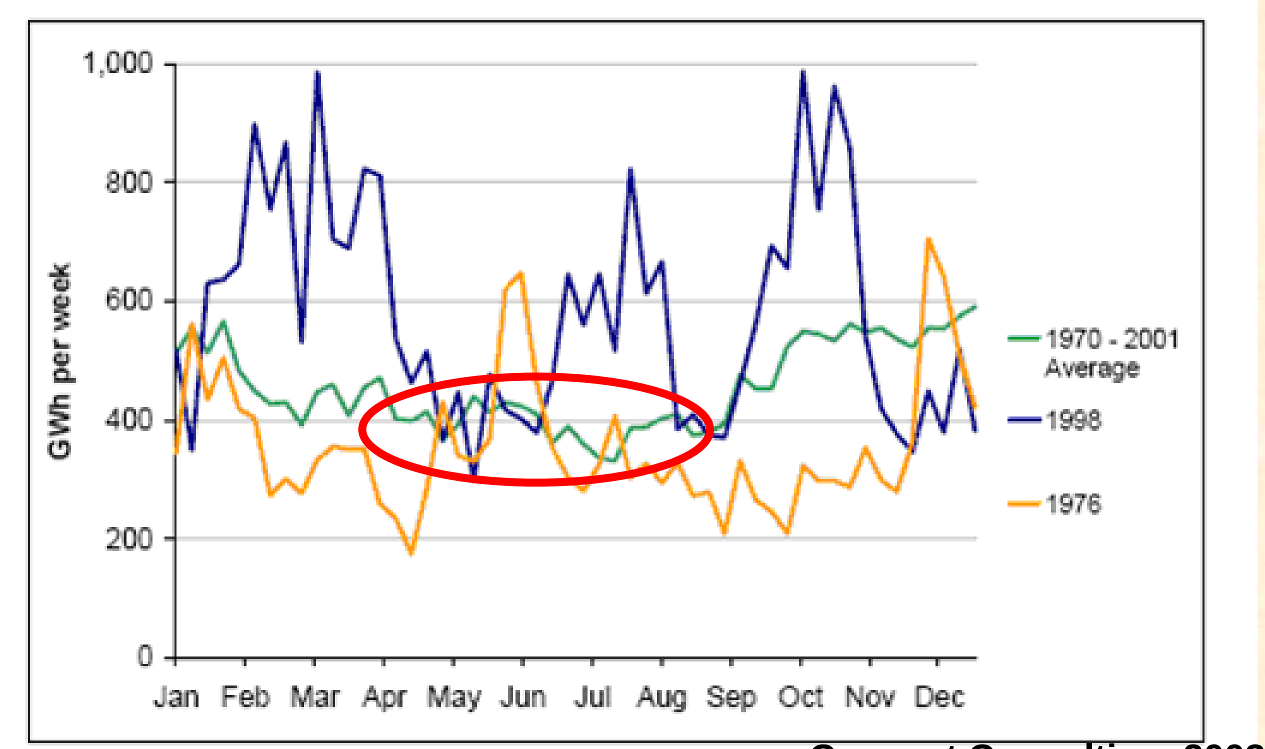
- system as tested too small for most NZ households.

Auxiliary boost control works!



	Feb'06	Feb'05	Nov'05
G_T	4.43	3.83	4.48
$Temp_{(av)}$	15	15.9	12.4

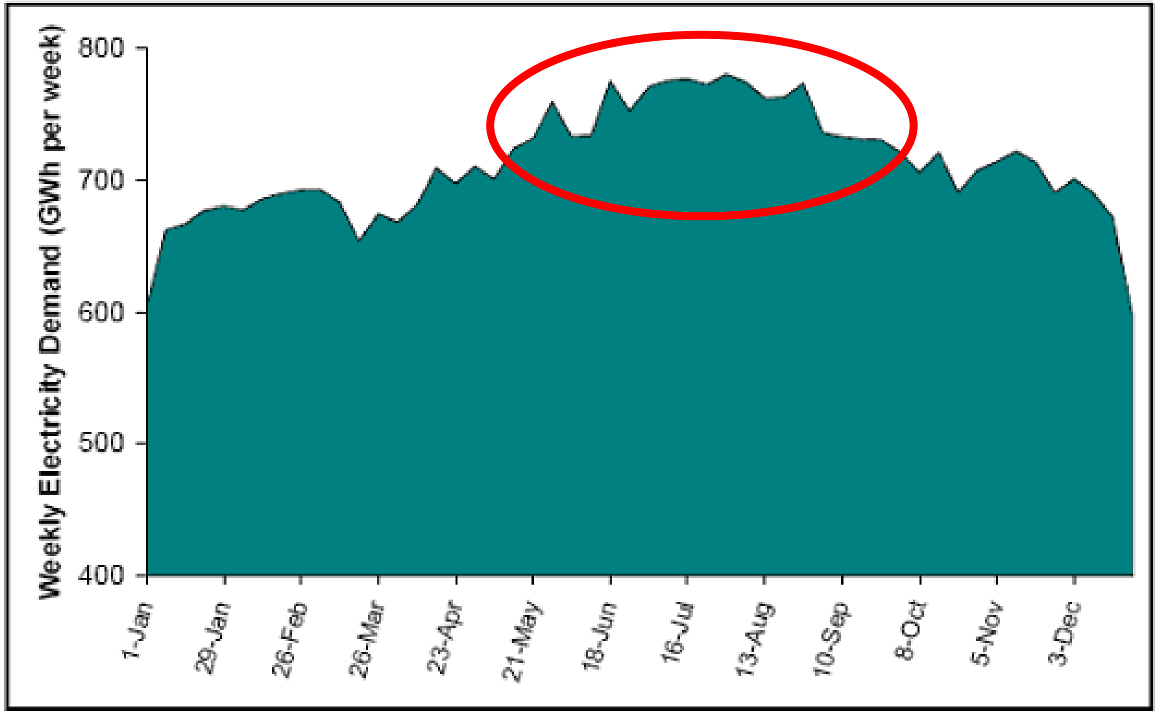
So what are the implications for NZ?



Concept Consulting, 2003

Inflows into the hydro-electric storage lakes

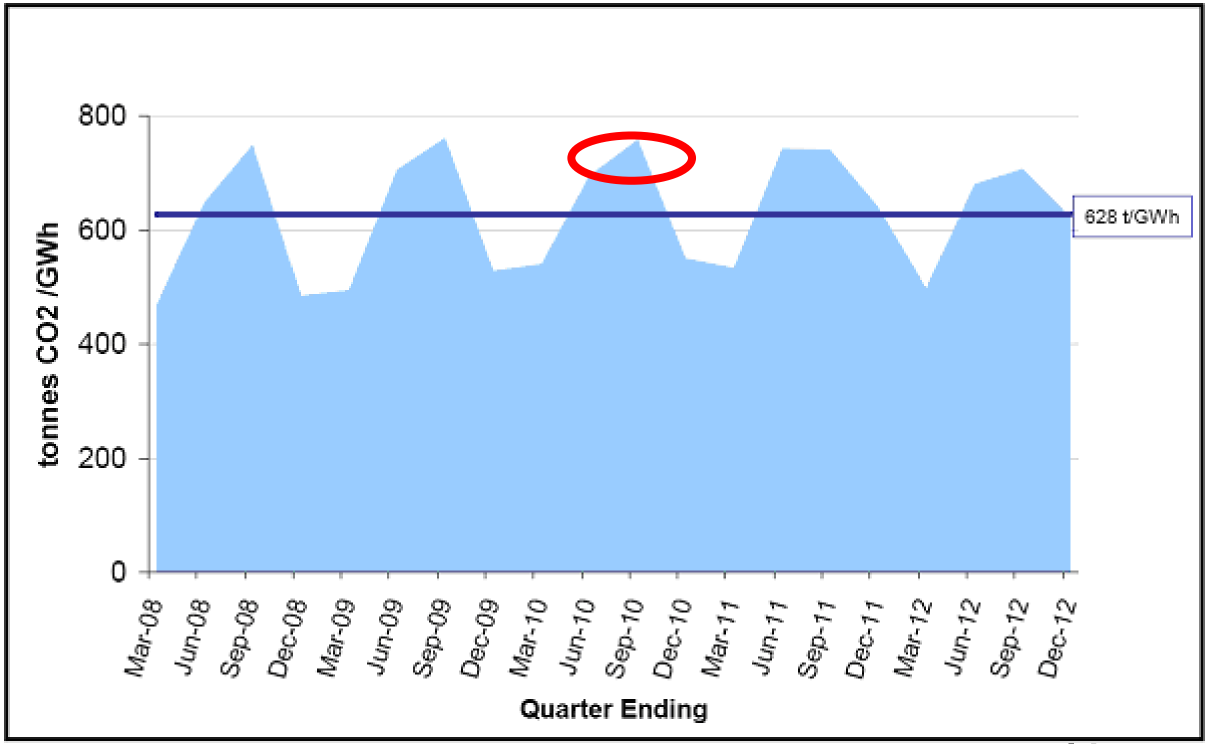
So what are the implications for NZ?



Concept Consulting, 2003

Seasonal weekly electricity demand.

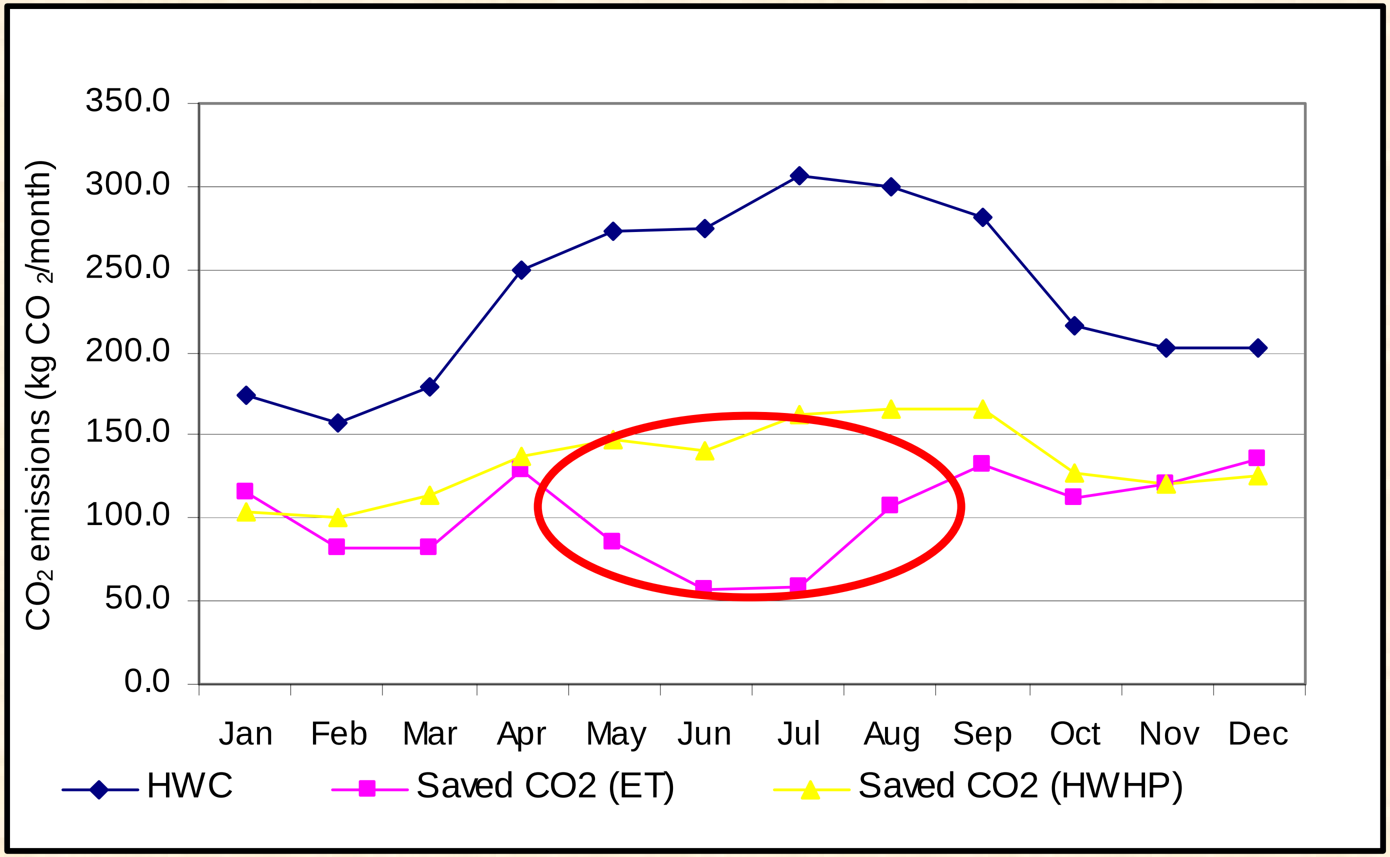
So what are the implications for NZ?



Concept Consulting, 2003

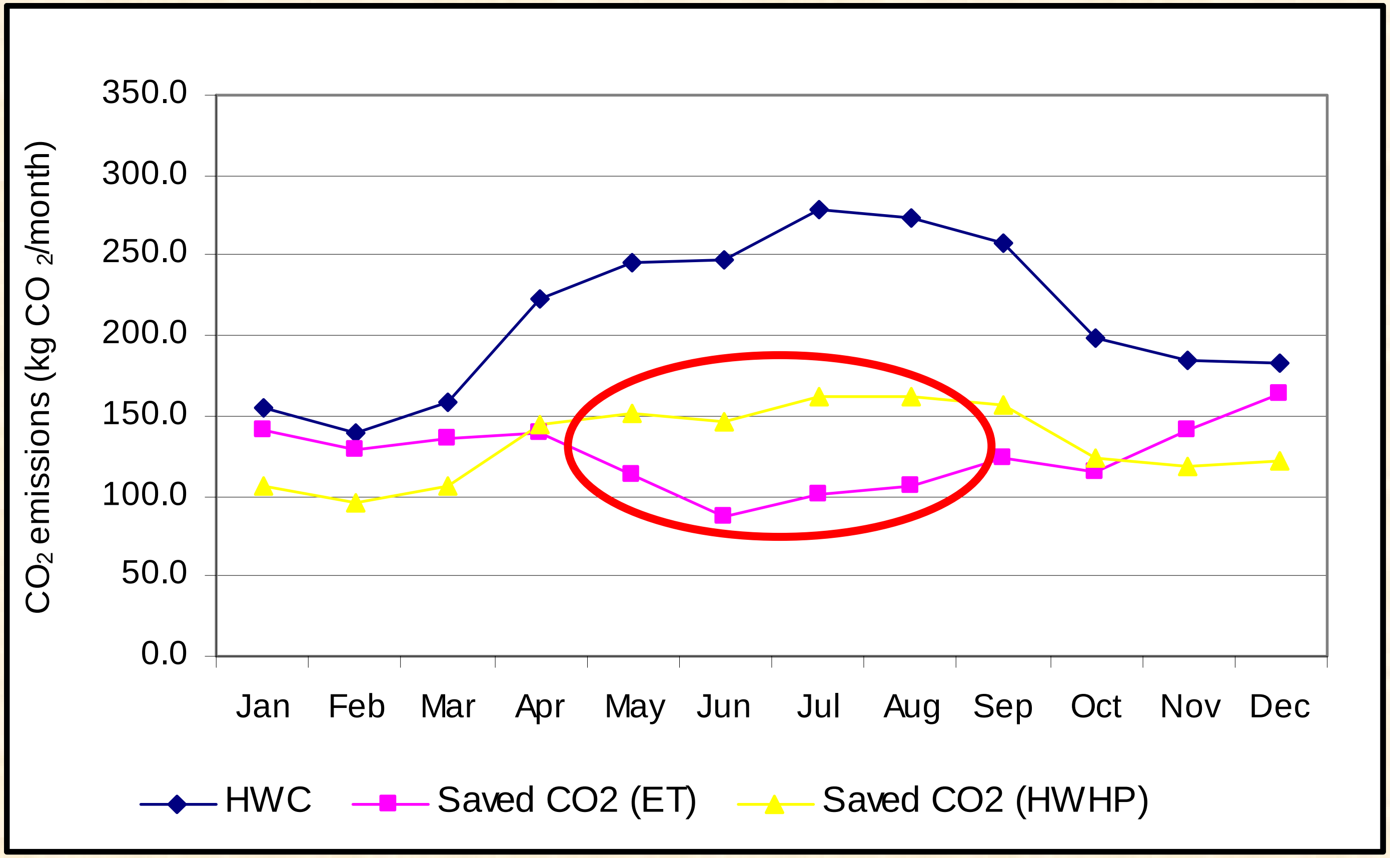
Quarterly GHG emission factor.

So what are the implications for NZ?



Avoided CO_2 - Dunedin

So what are the implications for NZ?



Avoided CO_2 – Auckland (est)

So what are the implications for NZ?

CO_2 emission reduction (kg CO_2 per year):

	Heat-pump	Evacuated tube
Dunedin:	1612	1220
Auckland:	1595 (est)	1493 (est)

- Electricity savings during winter leads to a greater CO_2 emission reduction benefit.
- Peak transmission loads are during winter. Heat-pumps have a much smaller peak load than solar systems.
- Supply insecurity is greatest during winter, especially during ‘dry winters’
- Electricity savings during winter are more desirable than during summer!!

Conclusions

- Energy efficient water heaters have an important role in reducing New Zealand's GHG emissions.
- Some systems are not working as well as they should.
- It is essential that auxiliary control strategies are used for good performance of solar systems in New Zealand.
- New Zealand is well suited to the use of heat-pumps. They have become mainstream for space heating, and offer at present a distinct advantage in terms of seasonal electricity consumption profile over solar systems
- This may change if installers overcome their resistance to the use of auxiliary controllers (eg timers), and begin to market their use to purchasers.

…..2007

AS/NZS 4234:

- Previously AS/4234 and adapted to the NZ situation,
- Simulation based Standard,
- Based on TRNSYS™ software,
- Allows for solar systems to be modelled,
- Has led to emphasis on:
  - improved cylinder design,
  - better performing panels,
  - reduced cylinder storage loss, and
  - the use of boost element controllers

…..2007

Improved system performance:

- Many packaged solar systems now achieve:
  - COP: 2.5 (AKL), 1.7 (DUD)
  - % savings: 65-70 (AKL), 50-55 (DUD)
  - Some are higher, but tend to be oversized
- Absorber surface greatly influences system performance,
- Retrofit systems still performing poorly,
- Little difference between Evacuated tube and ‘Tinox’ type flat panel systems,
- Design of cylinder still critical to performance.

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EECA's solar water heating program

- System performance is central to the availability of Govt subsidies
- Strong incentive for suppliers to improve their systems' performance in a cost effective way
- Whilst many systems now perform very well, they are not necessarily cost effective.