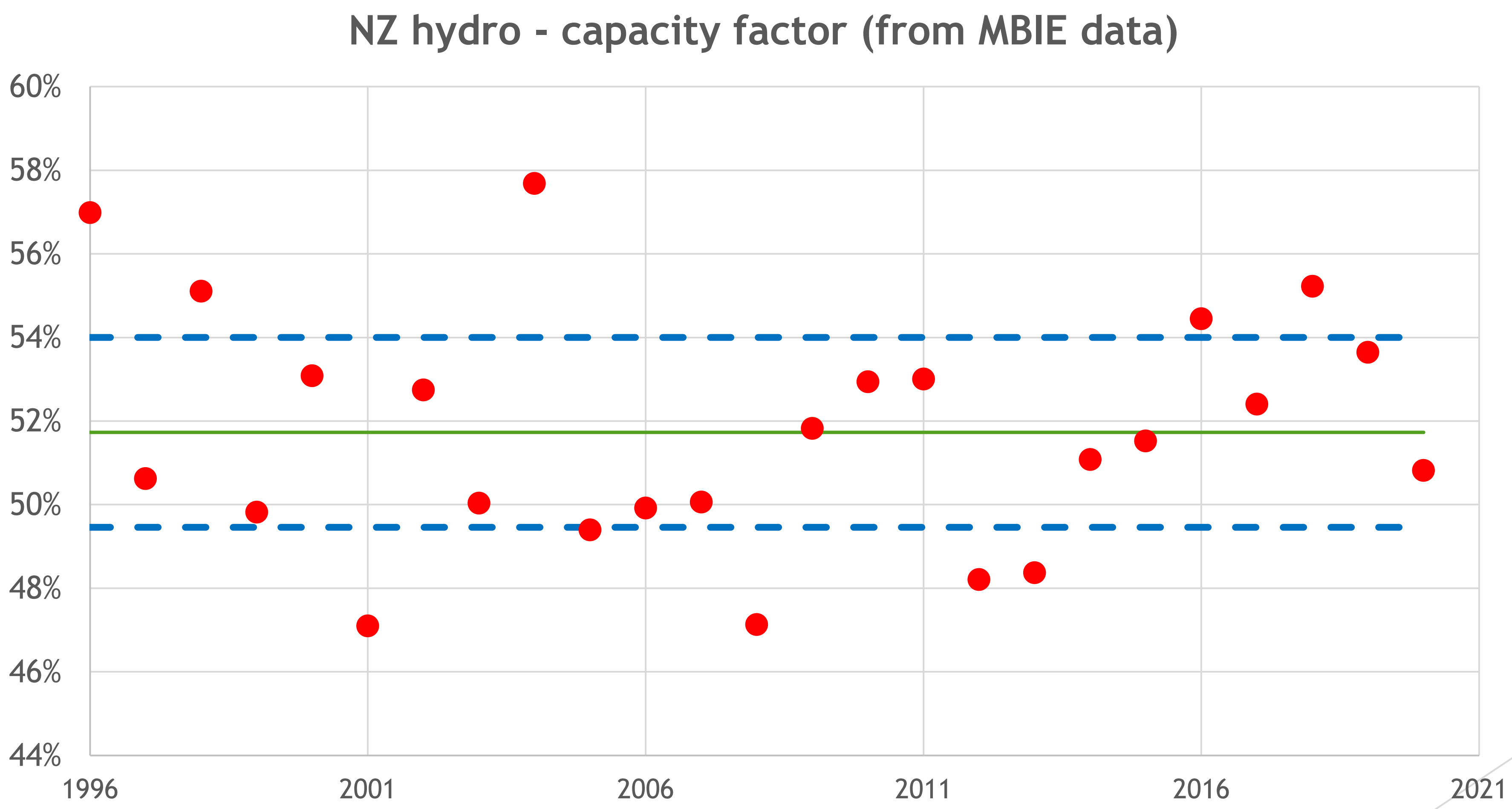
SEF SEMINAR

at 6.00 p.m. 23rd June 2021
at The Sustainability Trust and on Zoom

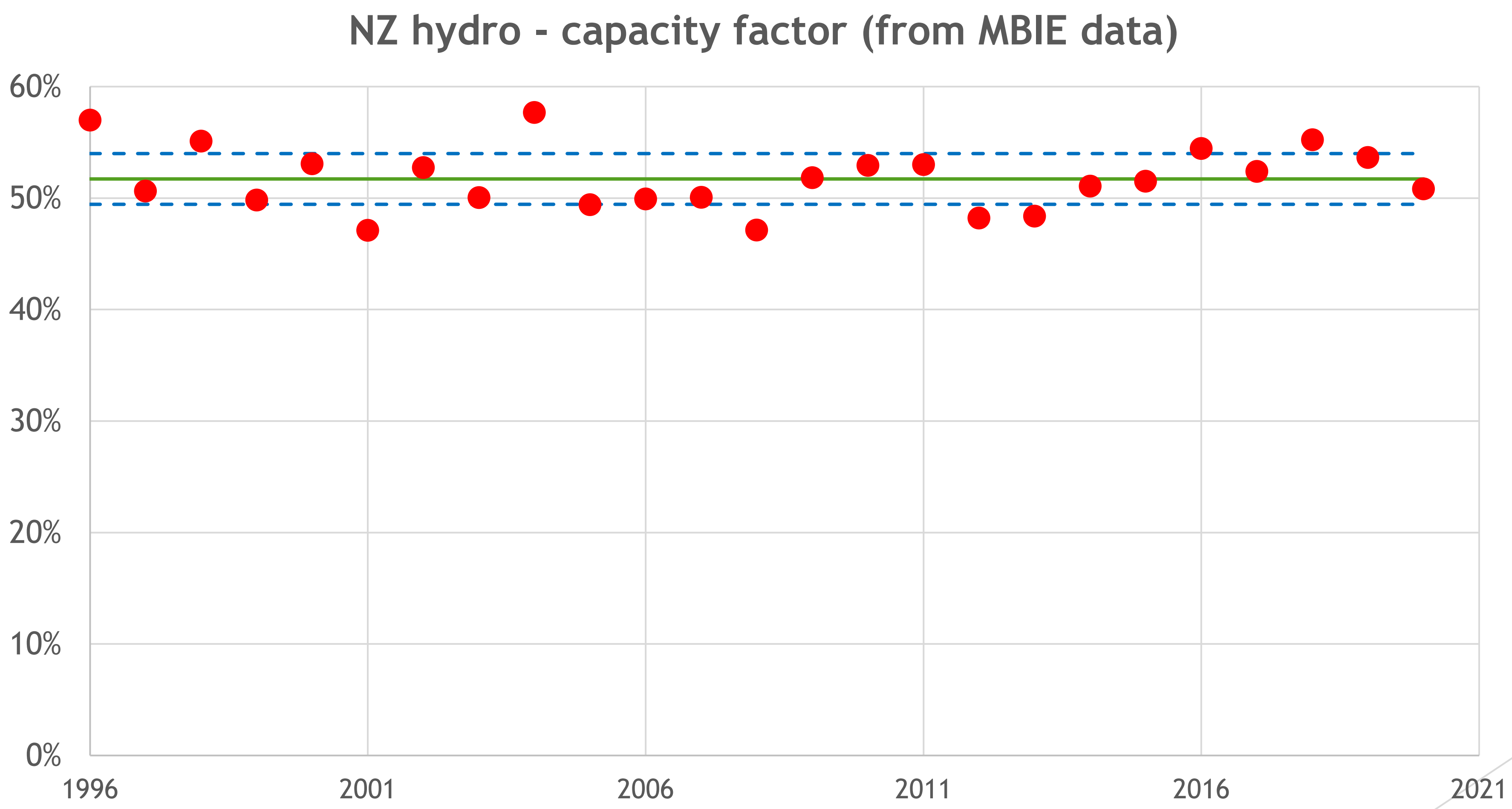
Discussion of topics raised in EW84

- **The dry year myth**
- **A Security of Supply Service for Huntly power station**
- **Torrefied Wood fuel for Huntly power station**
- **The Lake Onslow concept is fatally flawed**
- **Hydrogen planes won't get off the ground**
- **EV's are a costly way to reduce CO_2 emissions**

The Dry Year Myth



The Dry Year Myth

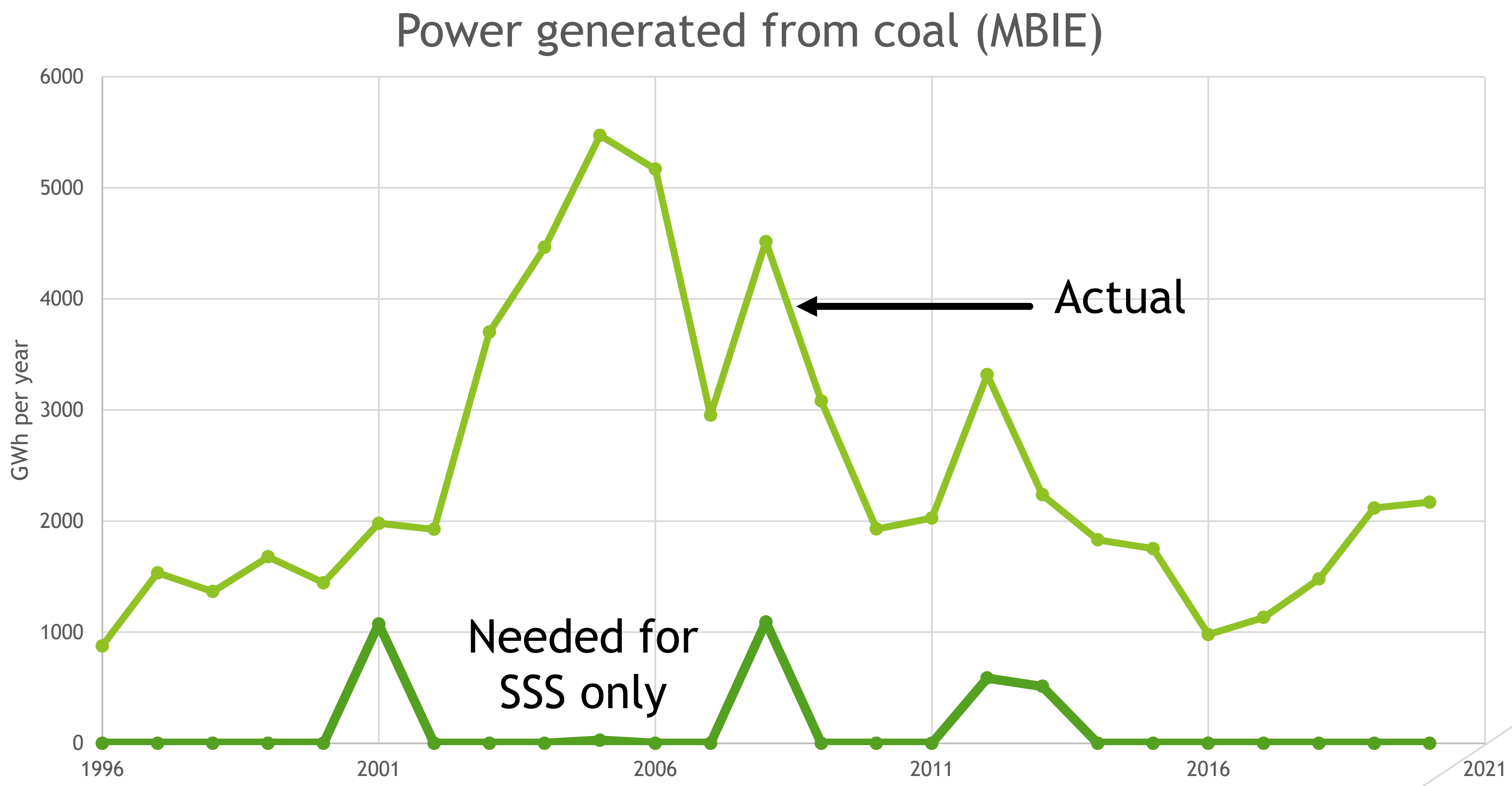


The “dry year” myth

- Every year in NZ is a wet year, but some are wetter than others
- The installed hydro electric generation capacity is 5400 MW in NZ
- The hydro generation in NZ is on average 51.7% of installed capacity
- The normal operating annual output of hydro generation is 49.5% to 54% of installed capacity on average.
- Over the last 25 years the lowest annual hydro generation was 47.1% on installed capacity in 2001 and 2008
- The generation of 2.4% of installed capacity **(i.e. 1,100 GWh)** would be sufficient to bring the hydro generation up from the minimum output in a low rainfall year up into the normal operating range.
- MBIE says that 5,000 GWh is needed to deal with a dry year

- Comments and discussion?

A Security of Supply Service for Huntly

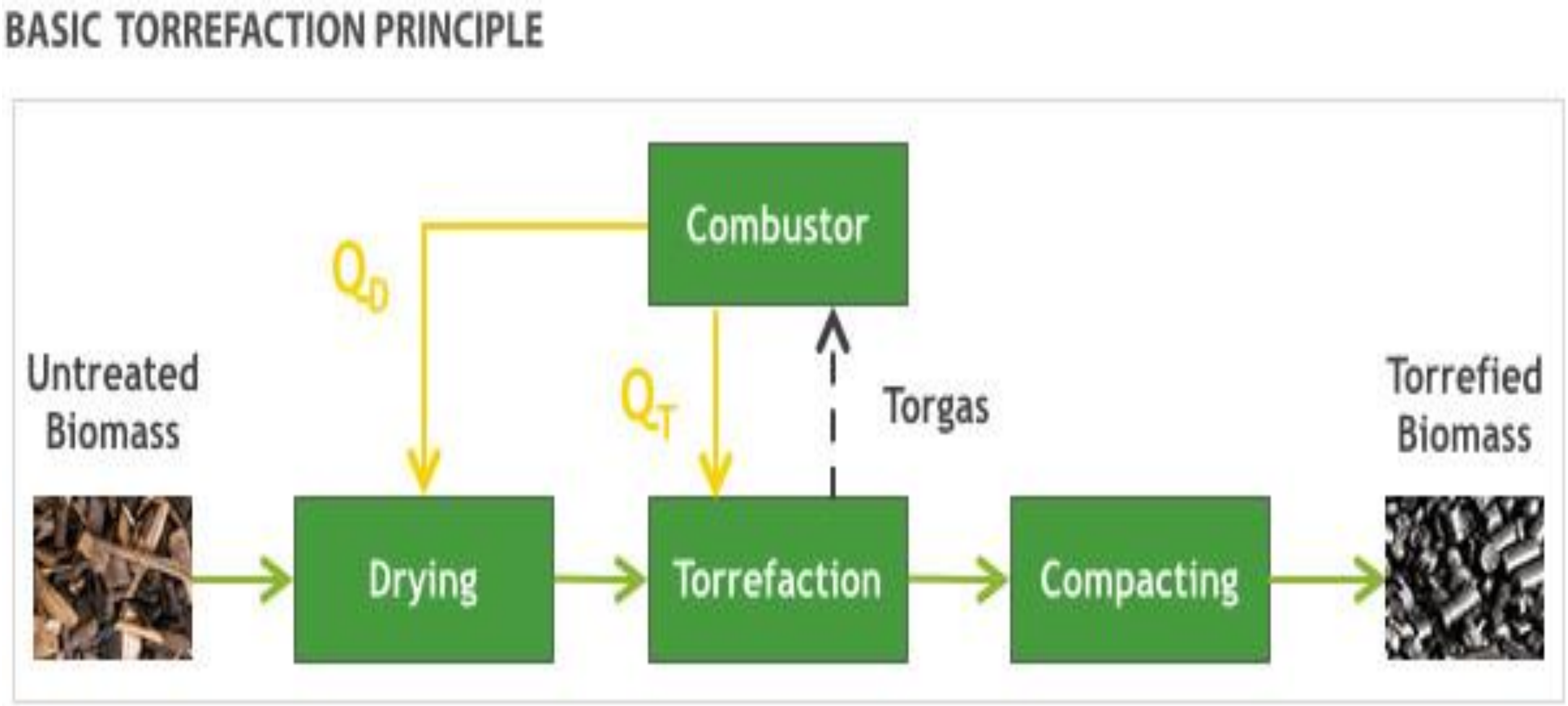


A Security of Supply Service for Huntly

- 1,100 GWh of back-up electricity generation is needed to provide a Security of Supply Service (SSS) in a low rainfall year or to accommodate a major equipment failure
- 1,100 GWh would be generated by 2 x 250 MW units at Huntly power station operating 24/7 for 3 months. (or 3 units for 2 months)
- If Huntly had been operated in SSS mode only for the last 25 years, then 95% of the CO_2 emission from coal fired power generation would have been avoided
- SSS mode would need to be funded like insurance with a levy
- Plant funded for SSS mode operation would be barred from the competitive electricity market and only operate in prescribed circumstances

- Comments and discussion?

Power station fuel made from wood



Huntly power station run on wood fuel ?

- Torrefied wood has a similar calorific value to sub-bituminous coal
- Torrefied wood has a bulk density 70% of that of coal
- Huntly power station has a multi-fuel capability torun on natiral; gas or pulverised coal
- Could units at Huntly be adapted to run on powdered torrefied wood?
- 1,100 GWh of electricity generation would require 11 PJ of wood fuel (i.e. 500,000 tonnes)
- That quantity of torrefied wood fuel would require 20 silos 75 m high and 25 m diameter on 2 hectares for storage.

- Comments and discussion?

Lake Onslow in Central Otago

Lake Onslow from the southwest

Photo – S Goldthorpe

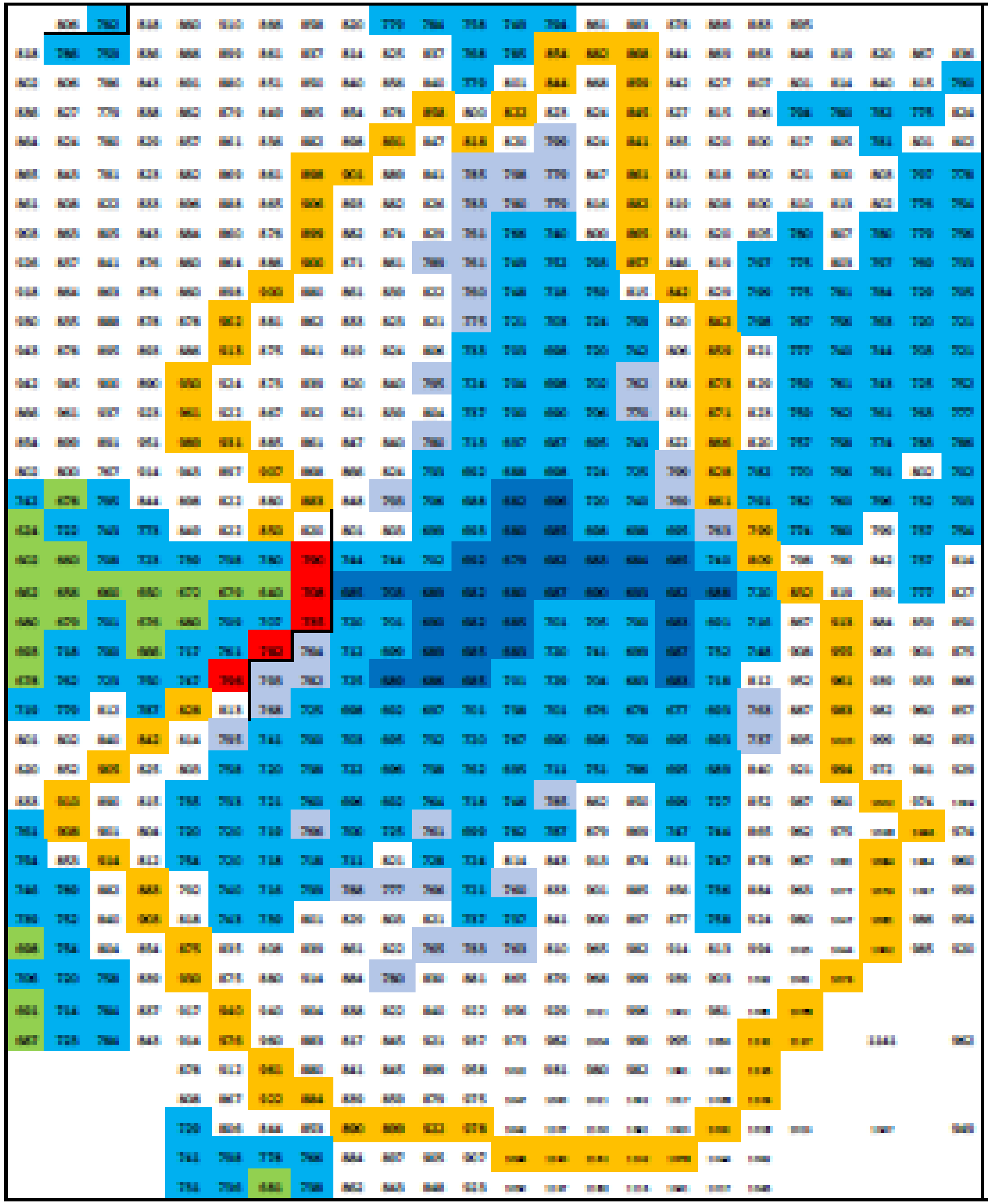
Dam at the top of the Teviot River

Photo – Pioneer Energy

Lake Onslow pumped hydro concept

Prof Earl Bardsley's scheme

- Original scheme in 2005
  - Raise level from 700 m to 800 m
  - 15 km tunnel to Clutha River near Teviot at 90 m elevation
  - Would need a 3 km long dam
- Revised scheme in 2020
  - Raise lake level to 760 m
  - 24 km tunnel to Lake Roxburgh at 135 m elevation - - - - - - -
  - Would need a 1.5 km long dam



Box model of Lake Onslow elevations

Existing lake 12 km^2
760 m lake 68 km^2
800 m lake 84 km^2
Catchment 200 km^2

3 km Dam for 800 m elevation lake

Upper Taieri River catchment to the east is beyond a low ridge

The Lake Onslow scheme is fatally flawed

- Reduced scope of the scheme is still 4-5 times greater than is needed to address the “dry year” problem
- The 1.5 m long earth dam would be the second longest dam in the world after the Three Gorges concrete dam in China
- Increased water losses due to seepage and evaporation would necessitate continual pumping of water to maintain the elevated lake level in the low rainfall region of Central Otago
- Round trip electrical efficiency would be about 60%. The electricity price differential between years is inadequate to earn any income.
- Filling Lake Onslow over 6 months could create an electricity shortage in New Zealand bigger than the “dry year” problem.

- Comments and discussion?

Hydrogen fuelled plane concept
for 200 passengers

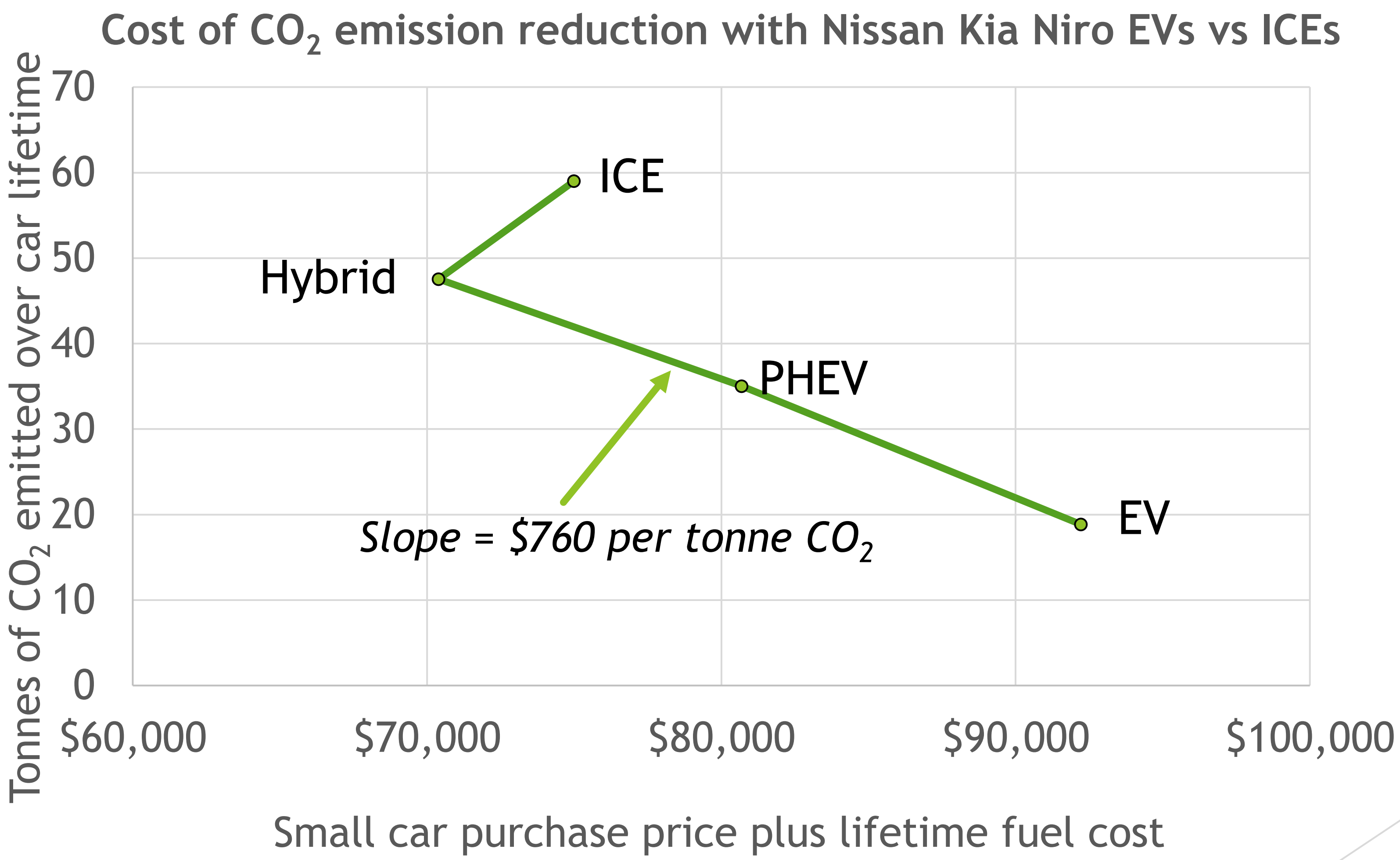
Airbus vision for zero emissions plane by 2035

Hydrogen containment is heavy

- A liquid hydrogen storage container typically weighs about 16 times the weight of hydrogen that it contains
- USDOE development goal is to reduced hydrogen containment weight down to 10 times the weight of the hydrogen contained.
- A tank of jet fuel typically weighs 30% of the plane take-off weight
- About 20% of jet fuel is consumed by take-off, climbing and descent.
- A tank of hydrogen would contain 5 times less energy than an equivalent tank of jet fuel
- Therefore, a hydrogen fuelled aircraft would consume all the fuel just to take-off, climb and descend.

- Comments and discussion?

EVs for CO_2 emission reduction



Kia Niro case study

	ICE	HYBRID	PHEV	EV
Purchase price	\$35,000	\$40,000	\$56,000	\$78,000
Fuel consumption per 100 km	5 l petrol	3.8 l petrol	1.3 l petrol + 10.5 kWh elec	14.3 kWh elec.
Lifetime fuel cost	\$40,000	\$30,400	\$24,700	\$14.200
Tonnes CO_2 emitted	59.0	47.5	35.0	18.8

Comparing the hybrid with the EV, the CO_2 emission reduction is 28.7 tonnes and the additional cost is \$21,800. Therefore, the cost of CO_2 emission avoidance is \$760 per tonne of CO_2, which depends on reference assumptions.

Hybrid vs EV	Reference Assumption	Alternative assumption	Revised \$/tonne CO_2
New capital cost subsidy	none	\$8625 - \$1170 per l/100km	606
Retail electricity price	25 c/kWh	15 c/kWh	563
EV electricity consumption	7 km/kWh	8 km/kWh	693
Power generation emissions	0.5 $kgCO_2/kWh$	0.2 $kgCO_2/kWh$	595
Marginal ICE maintenance	none	\$1/100 km	630

Reducing transport CO_2 emissions via EVs

The Kia Niro case study indicates that

- The lifetime fuel cost savings of a petrol hybrid are greater than the extra capital cost of the hybrid version. The associated CO_2 emission reductions are without cost.
- The PHEV is intermediate between the hybrid and the full-EV.
- The comparison of the hybrid and the EV indicates a very high cost of CO_2 emission avoidance.
- A rise in carbon charge to $250 per tonne of CO_2 by 2050 will not incentivise the switch to EVs by consumers for any of the conditions evaluated.
- The new EV subsidy scheme does not change that conclusion

- Comments and discussion?