

# Andrew Rushworth Managing Director

Zero Emission Vehicles

2017



Zero Emission Vehicles

Kāpiti Coast  
DISTRICT COUNCIL

ENVIRO 500i

NEGATIVE  
DISCONNECT  
WARNING



OTAKI

# Batteries - Energy

- Energy density
  - Diesel energy density 35.8MJL
  - Lithium Batteries (0.6)0.9-2.3MJL
  - Diesel is between 15 & 60 times the energy density
  - Immediate gains of ~ 3 times with improved vehicle and battery pack design
- Does not account for
  - Motor, Exhaust, Post combustion, Driveline.....
  - Alternative electric vehicle designs
  - Refuelling options
  - Efficiency

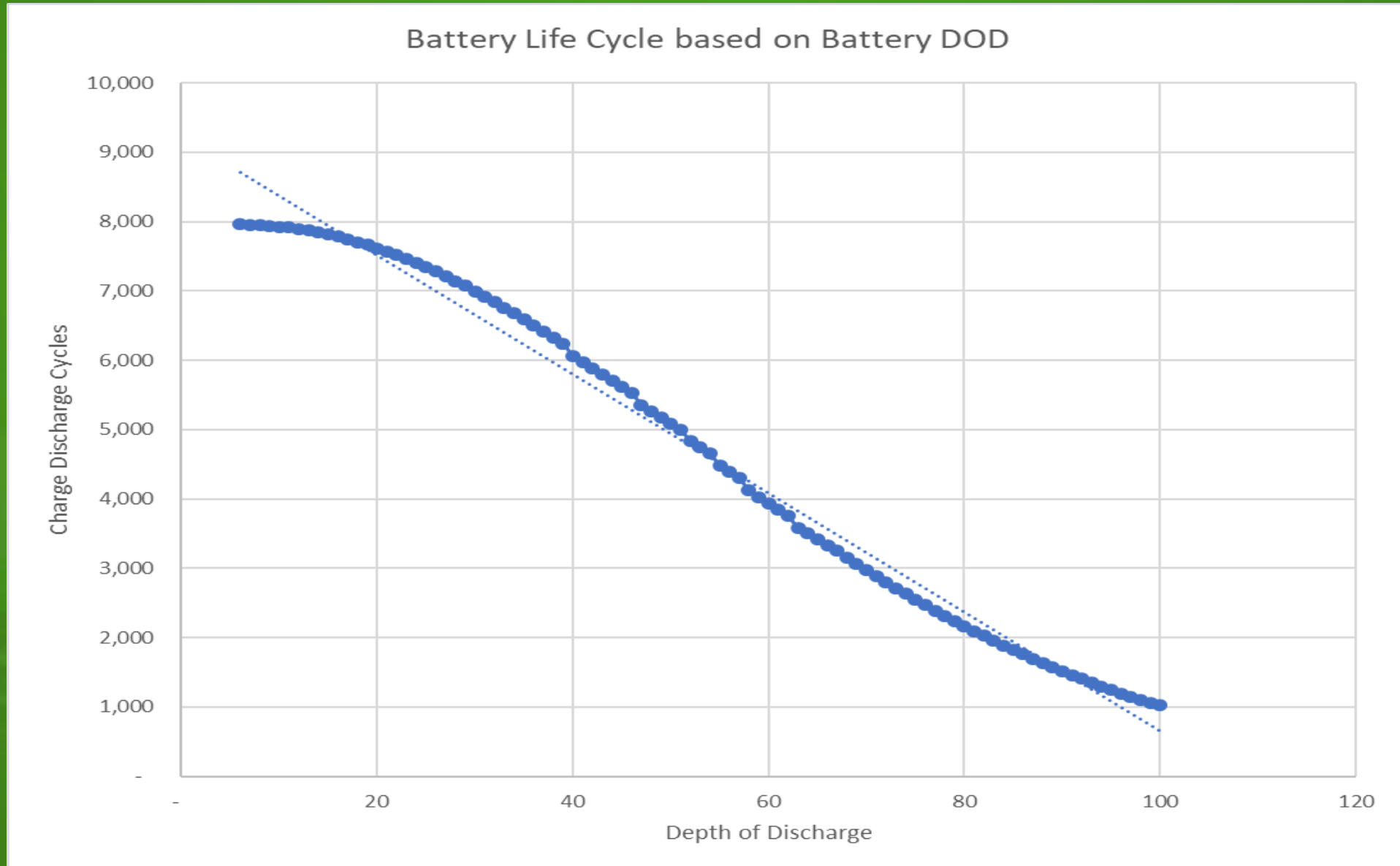
## Batteries - Weight

- At 2 km per litre diesel & range of 600 km
- 350 litres of diesel @ 290 kg
- Plus ICE & electric drive difference ~ 2,000 kg
- Equivalent battery of 507kWh
- Range of 150 km
- Weighs 4,600 kg
- Electric weight penalty of 2,300 kg

## Batteries - Life

- Between 2,000 – 3,000 cycles to 80% DOD to 80% capacity
- Chemistries up to 10,000 cycles
- One cycle per day, 5 days per week = 7.5 years
- Double shifted, 7 days per week ~ 1 – 2 years
- Life affected by usage
- Up to 27% life improvement possible

# Batteries - Life



# Batteries - Safety

- Electric Shock
  - Pack voltages from 350VDC to 700VDC
  - Very “Eager” energy source
  - Requires a different attitude
- Fire
  - Fire hazard increases with energy density
  - Thermal runaway
  - 507 kWh battery fire = 35 litres diesel fire
  - Nerve agents i.e. Sarin
- Chemical Burns
  - Electrolyte 6-7% of cell
  - With water – forms hydrofluoric acid

# Traction

- Two trends
  - Larger (more torque, lower RPM)
    - integration ease, poor scalability
  - Smaller (less torque, higher RPM)
    - integration complexity, good scalability
- Degrades under load
- Elegant design depends on drive train
- Elegant design depends on vehicle control



# EV Generations

- Generation One
  - Conversions of existing ICE vehicles
    - Complex to undertake
    - Compromised performance
    - Expensive
- Generation Two
  - Electric from new using ICE principals
    - Comparatively simple to build
    - Good performance
    - Significant cost improvement
    - Tightly bound to traditional automotive solutions
- Generation Three
  - Paradigm change
    - Rethink the business model
    - Technology leveraged solutions
    - Market and solution segmentation
    - Uncoupled from traditional automotive solutions









- Powered truck/tractor with powered “trailer(s)”
- 660 kW through 6 axles
- Super Singles
- 8 tonne axle loading
- 7,500 Nm per wheel
- Balanced system