Presentation

INTERNATIONAL TRUCK, TRAILER & EQUIPMENT CONFERENCE

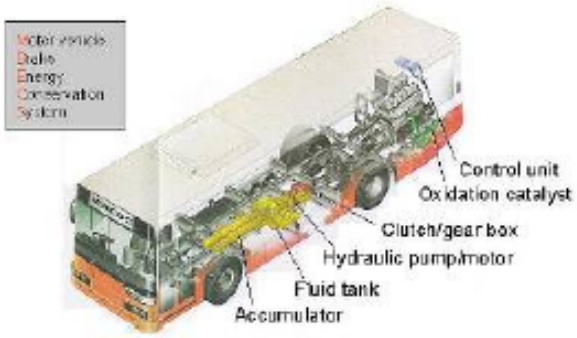
By Kevin Johnston of Fuso

Hybrid Truck Technology Over The Next 5 Years

Fuso Hybrid Qualifications

Electric bus

1973



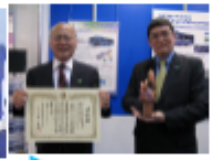
Accumulator system hybrid bus MBECS

1994 → 1999

Canter HEV (Concept vehicle)

1995

2009 Energy Conservation Grand Prize
Energy Conservation Center Chairman's Prize



Hybrid city bus

AERO STAR ECO HYBRID

2004 →

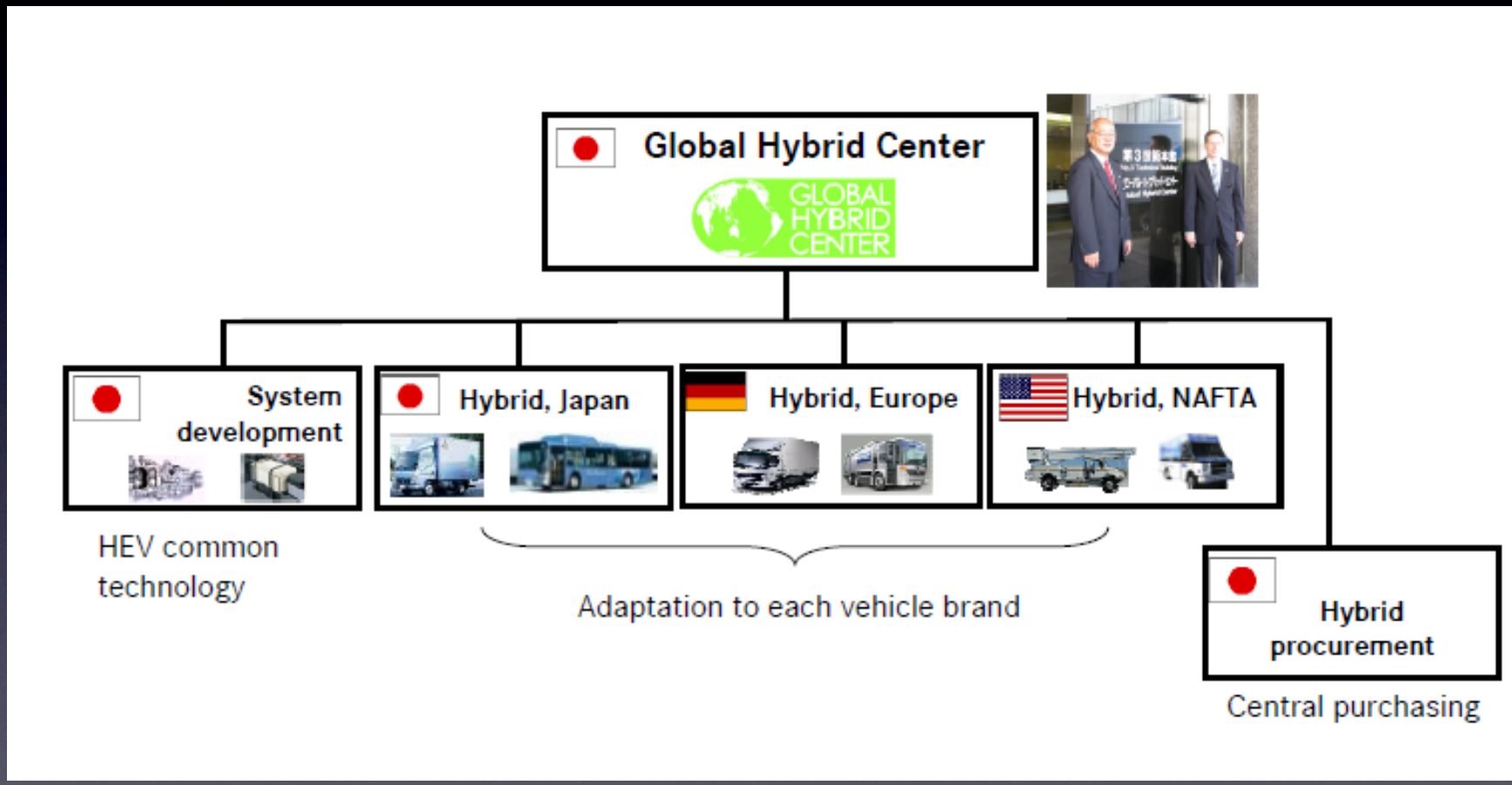
Canter TF hybrid

Hybrid LDT

CANTER ECO HYBRID

2006 → 2012 →

Fuso Hybrid Qualifications



My Hybrid Qualifications

- Mechanical Engineer
- 15 years in commercial vehicle industry
- Personal interest in environmental issues & new technologies
- 4 years with Fuso

- Australian Hybrid model launch
  - First country outside Japan to sell

- Australian Hybrid data collection program
  - Input feed into 2012 hybrid model

My Hybrid Qualifications

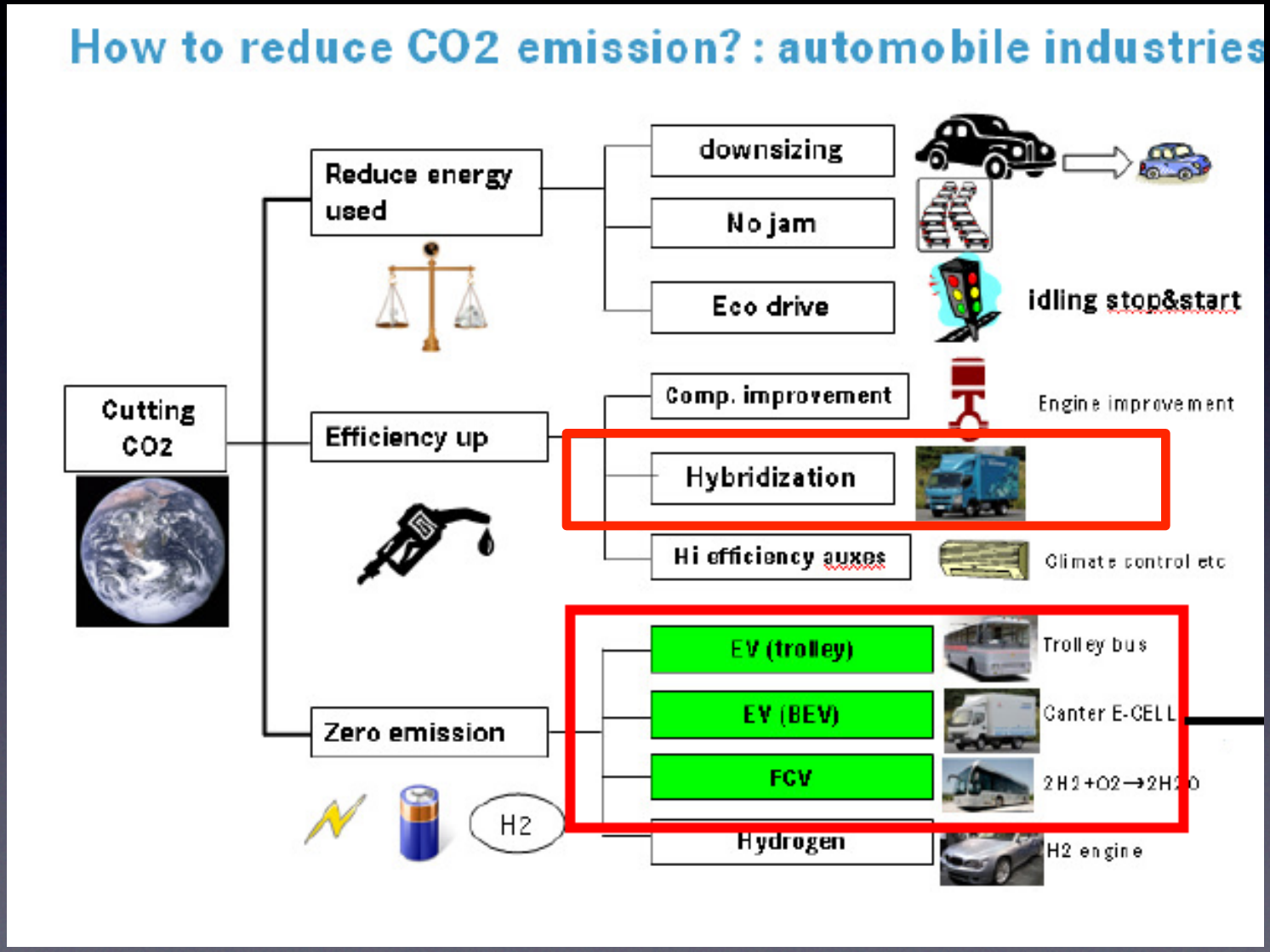
- Preparations for 2012 model hybrid for Oz
  - Assembled show truck yesterday for stand

- At press launch of heavy hybrid concept vehicle

- Bought Eco D concept vehicle to OZ for Brisbane truck show




Emission Reductions

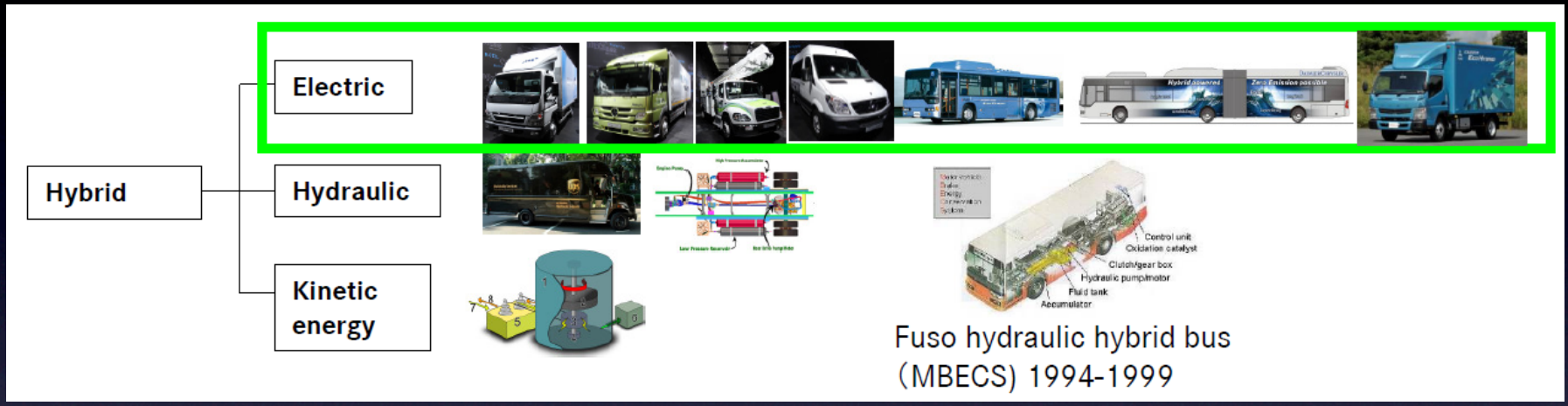


Efficiency Improvements

- Engine development
  - Mature technology
  - Fuel economy is a trade off with emissions
- Transmission development
  - Significant gains foreseeable
- Drive-train
  - Ratio's, tyres – fluids – quite mature
- Idle stop start
  - Significant gains still foreseeable

- Improving mature technologies
  - Big effort
  - Small return

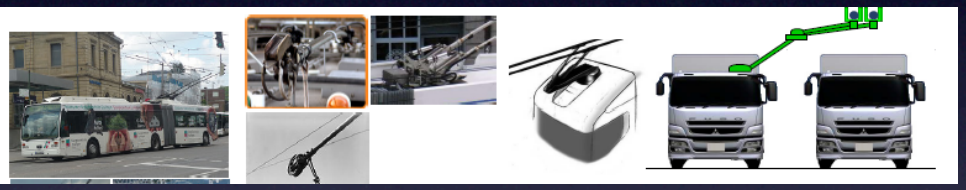
Hybrid Types



- Fuso has stopped working on hydraulic hybrids
  - Some development in the US
- Kinetic Energy Recovery System
  - KERS in F1
  - Mechanical or mechanical / electrical (capacitor type)
- Electric hybrids
  - Most common hybrid
  - Fuso believe most truck potential

Zero Emissions Vehicles

- BEV = battery electric vehicle
  - External energy
  - Energy storage is key

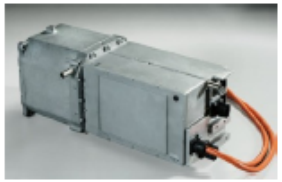


- Electric vehicle
  - Without storage system

- Hydrogen
- Fuel Cell
  - Not energy storage
  - Energy generating systems

Electric Truck – Battery Storage

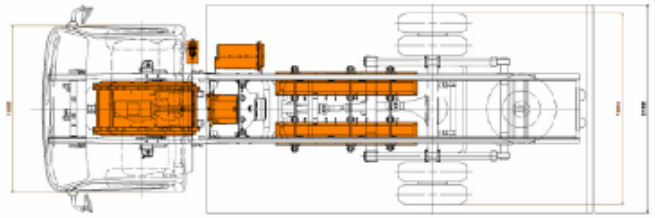
- Fuso “E-cell” prototype
- Very expensive & short range



Motor & inverter

X 23

Li-ion battery



No clutch, no transmission, no shifting

E-motor:

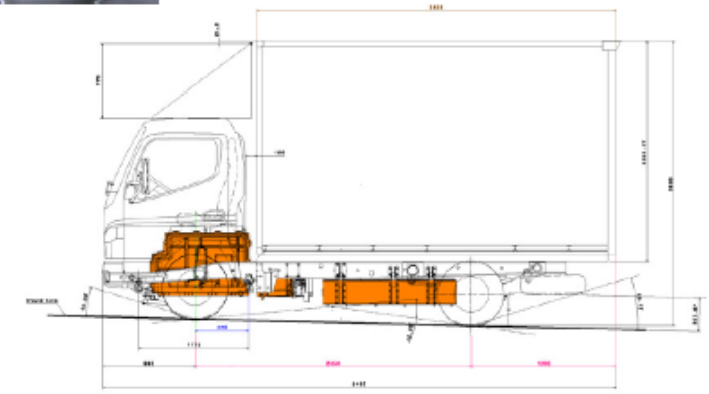
- 70kW peak, 55kW constant
- 300Nm peak, 250Nm constant

Battery:

- Li-Ion, approx. 300V 40kWh 23 in series

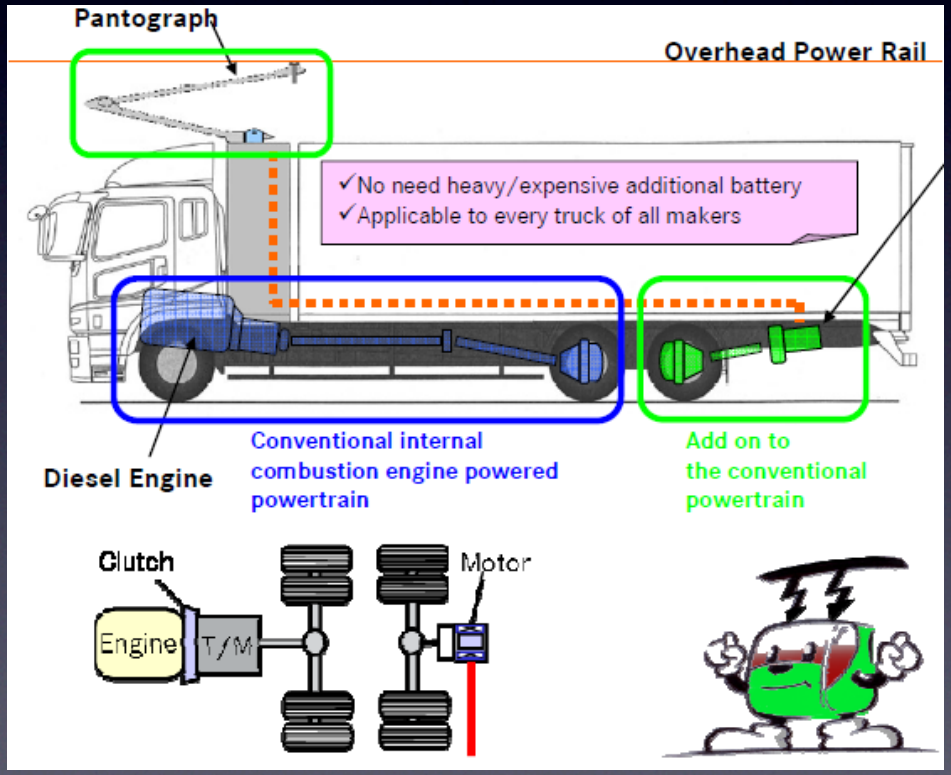
Vehicle:

- V_{max}: > 80 km/h
- Range: ca. 120 km
- Payload: ca. 1.34 t
- Charging time: ca. 6 hours (@380V)
- Weight penalty ca. 250kg

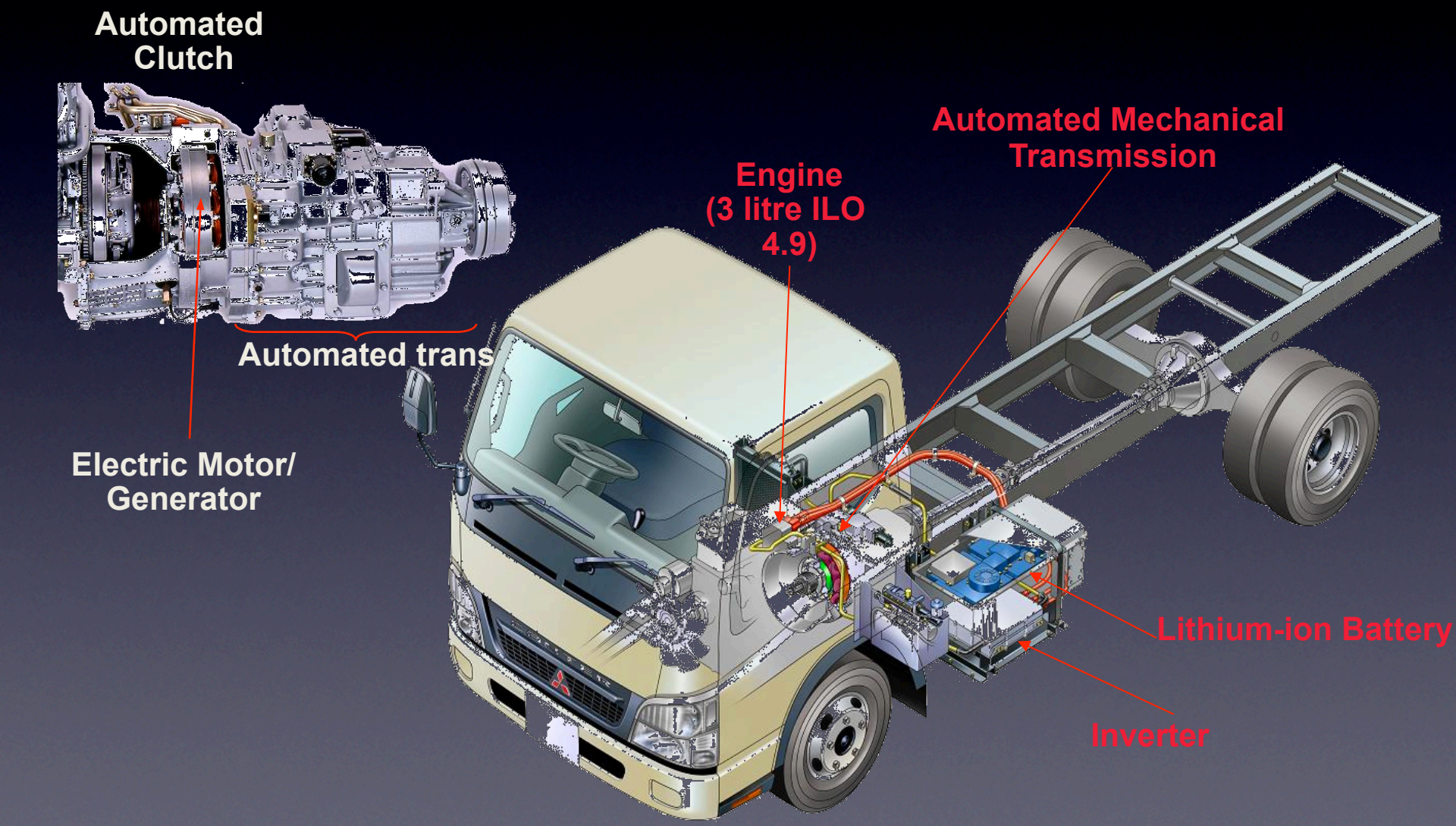


Phase 1

Electric Truck – Direct Energy

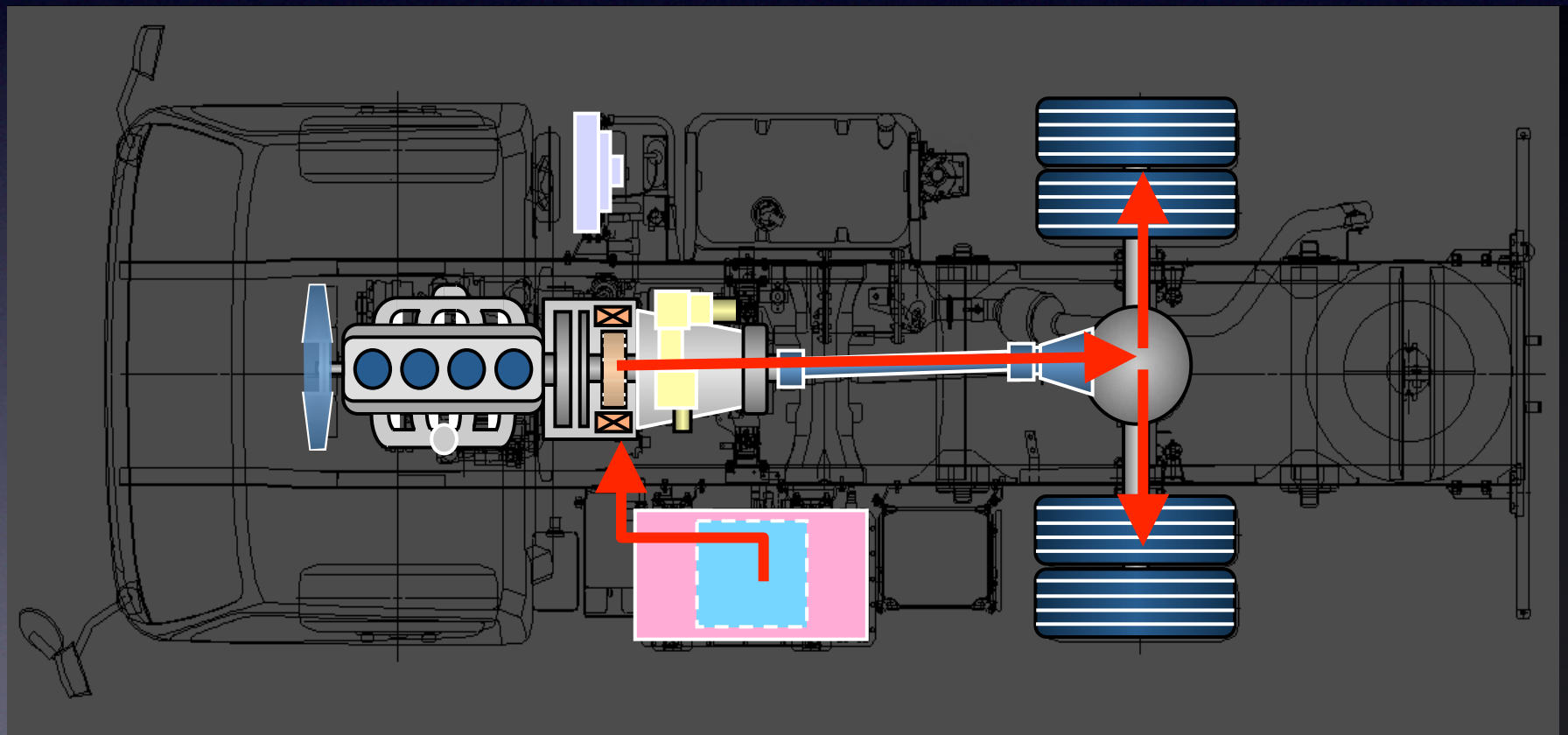


Fuso Hybrid - Australian Spec



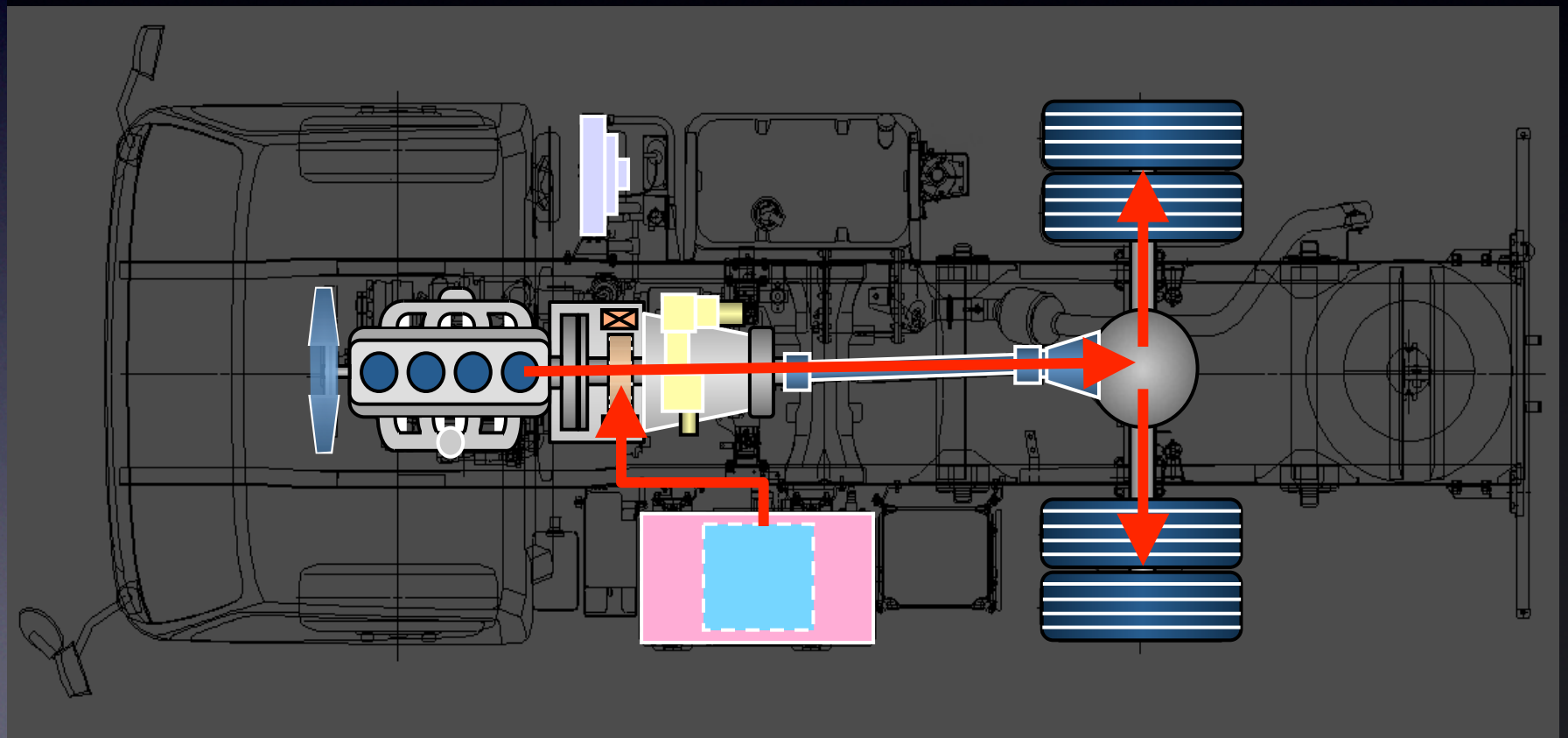
Taking Off

- Clutch not engaged
- Takes off by electric motor only
- Noise & emission reduced
- Clutch life improved



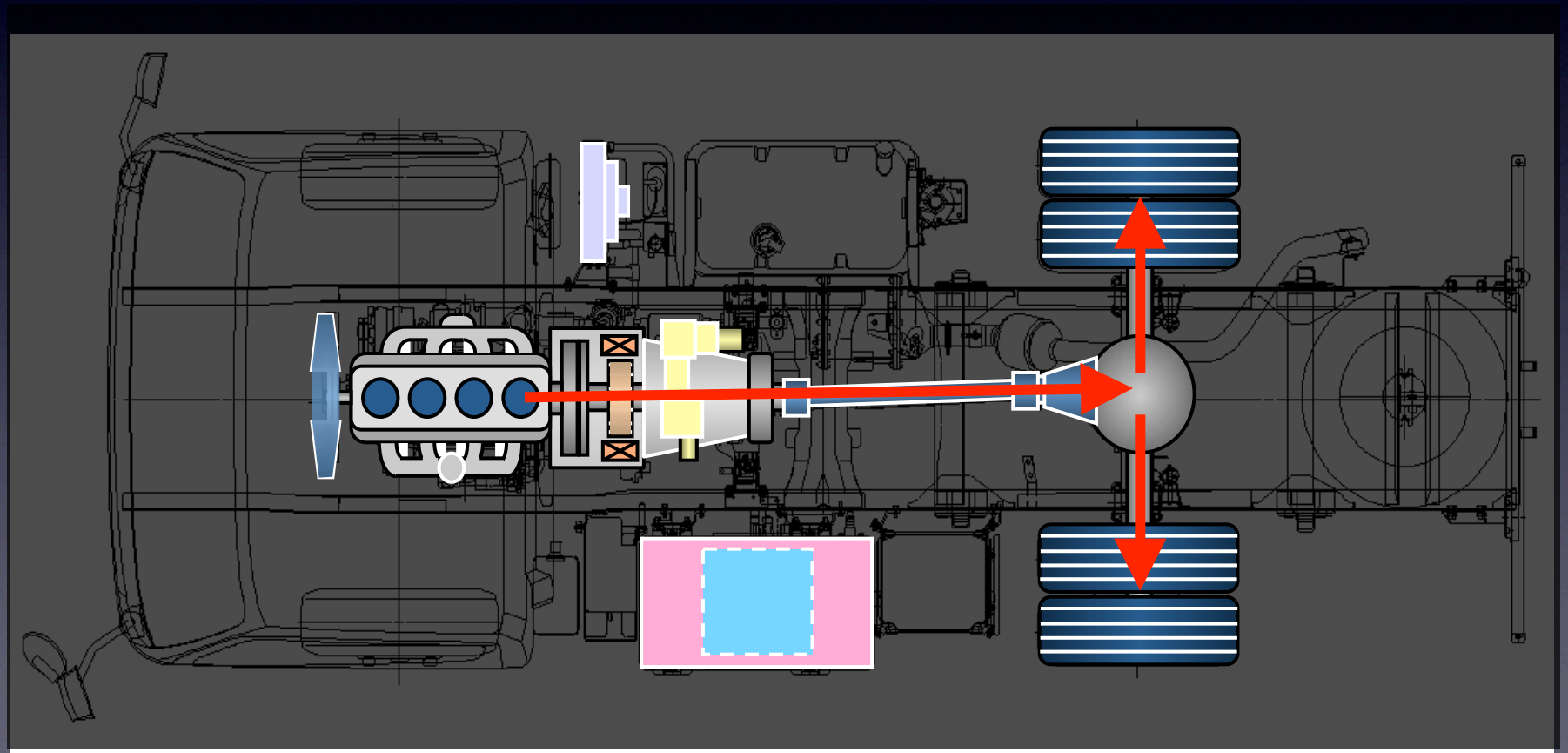
Accelerating

- At low/medium engine speed the electric motor assists the engine



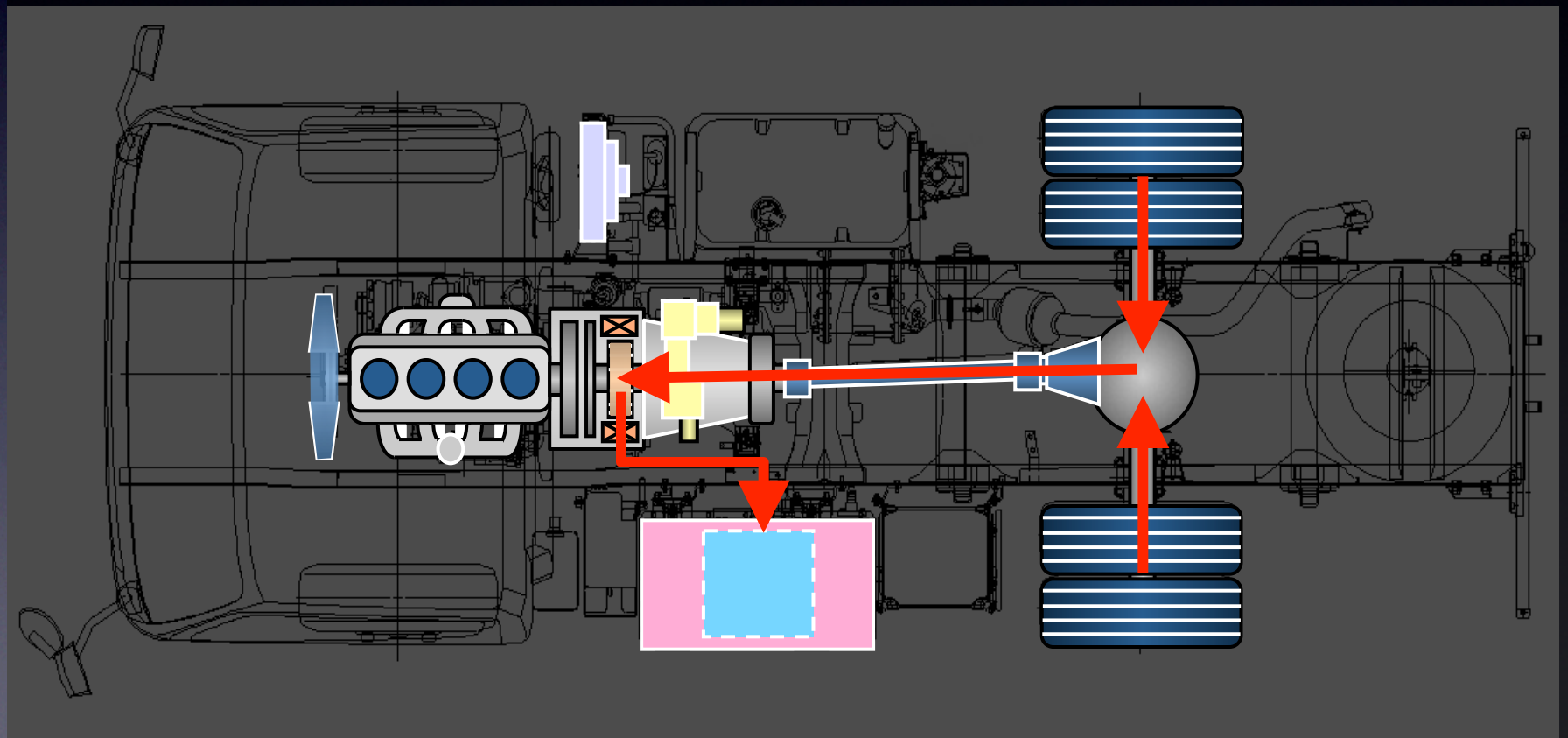
Cruising

- Engine drives the vehicle as per a conventional vehicle



Regenerative Braking

- Electric motor/generator functions as a generator to slow vehicle
- Generator converts brake energy into electricity & stores it in the battery
- Improves life of brake components



Hybrid Australian Data

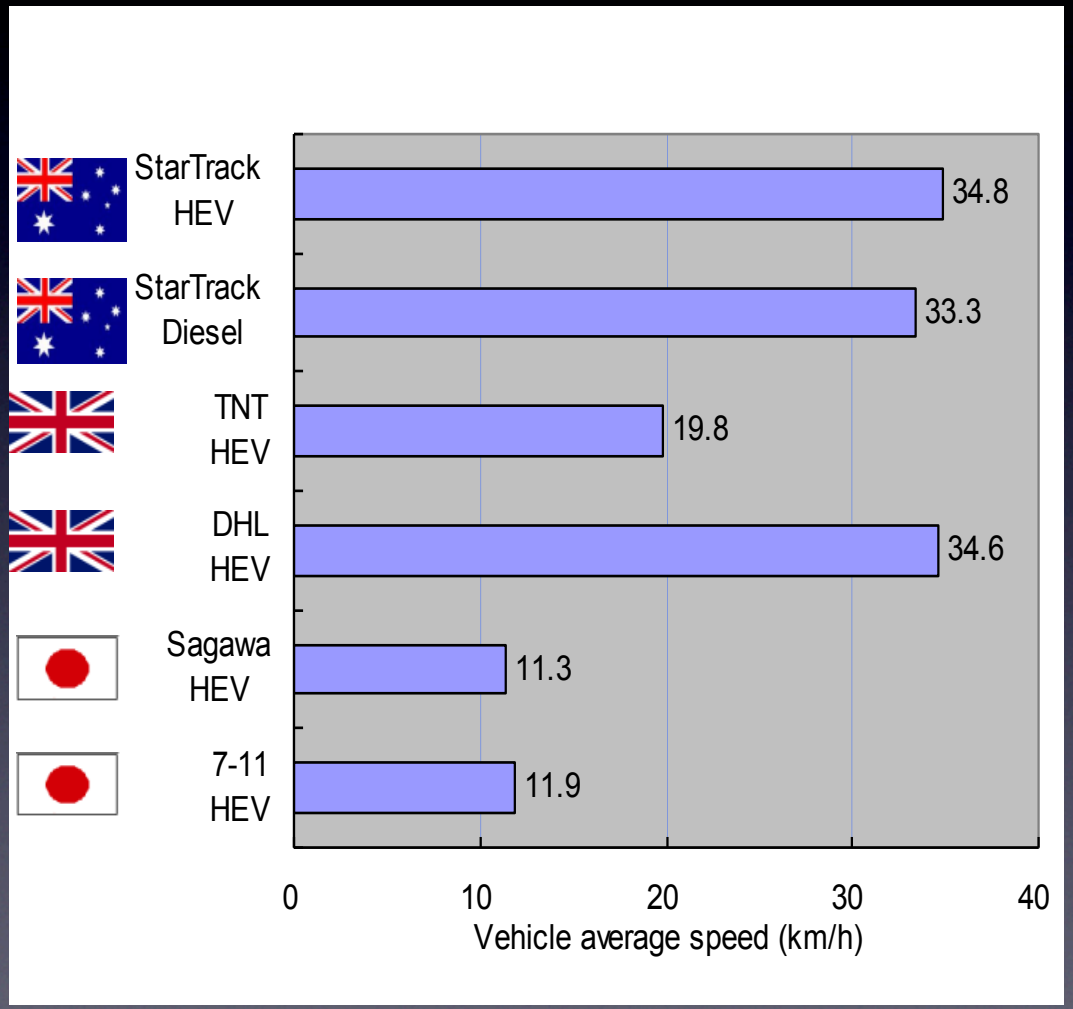
- **The Test:**
- Fuso Canter Diesel Compared to Fuso Canter Hybrid
- Application: Star Track Parcel Delivery in Sydney

- **The Results (after 15,000 Km)**
- Consistent fuel savings above 30%
- Saving greater when average speed lower
- Average speed 35 Km/hr

Hybrid As Business Investment

- Ideal case:
  - Extra hybrid cost
  - Paid for within 3 years
  - Based on fuel savings
- Depends on
  - Brake frequency, duration and demand
  - Fuel cost
  - Battery life
  - battery cost

How Does Australia Compare?



Fuso Hybrid Progress

- Fuso Hybrid launched in 2006
    - Reliable truck
    - Hybrid achieved plan savings
    - So the technology works
    - But…price too high for 3 year payback

- Battery cost approx 50% extra vs. diesel vehicle cost
    - So battery must last for the life of the vehicle
    - Testing showed battery life more than ok

Fuso Hybrid Progress

- Main improvements in 2012 model hybrid
- More cost effective battery
  - Lower spec
  - Different process
    - Pouch instead of cell

- High Volume inverter used
  - Common with cars
  - 12 Volt

Hybrid As Business Investment

- 2012 hybrid model
  - Hybrid component price reduction around 50%
- 3 year payback goal
  - Again depends on
    - Application
    - Diesel price
    - Vehicle utilisation
  - Based on Star Track application data
  - 4 year payback is possible