

Low Emission Buses

A Transport Operators Perspective

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Transit Systems and Tower Transit

- 3129 Buses
- 6744 Employees
- 344 Million Customers



Types of Electric Buses

TROLLEY E-BUS

- ☐ Electric drive
- ☐ Direct electric
- ☐ Powered directly by grid
- ☐ Overhead power lines



OPPORTUNITY E-BUS

- ☐ Electric Drive
- ☐ Small battery
- ☐ Grid charging along the road
- ☐ Charging stations



OVERNIGHT E-BUS

- ☐ Electric drive
- ☐ Large battery
- ☐ Grid charging at depot
- ☐ No route infrastructure



FUEL CELL E-BUS

- ☐ Electric drive
- ☐ Small battery & fuel cell engine
- ☐ Hydrogen refilling at depot
- ☐ No route infrastructure



Hydrogen Fuel Cell Buses

Our experience in London

London

- Central London since 2013.
- 10 hydrogen fuel cell buses.
- Operate 17 hours per day, 7 days per week.
- Commuter and tourist route.
- Drop in replacement for diesel bus.
- Operations, maintenance and fueling undertaken by Tower Transit.

More than 1.5 million kms driven, 135,000 kgs Hydrogen consumed, over 1,600 tonnes of CO2 avoided and over 600,000 litres of diesel saved



Technical Specifications

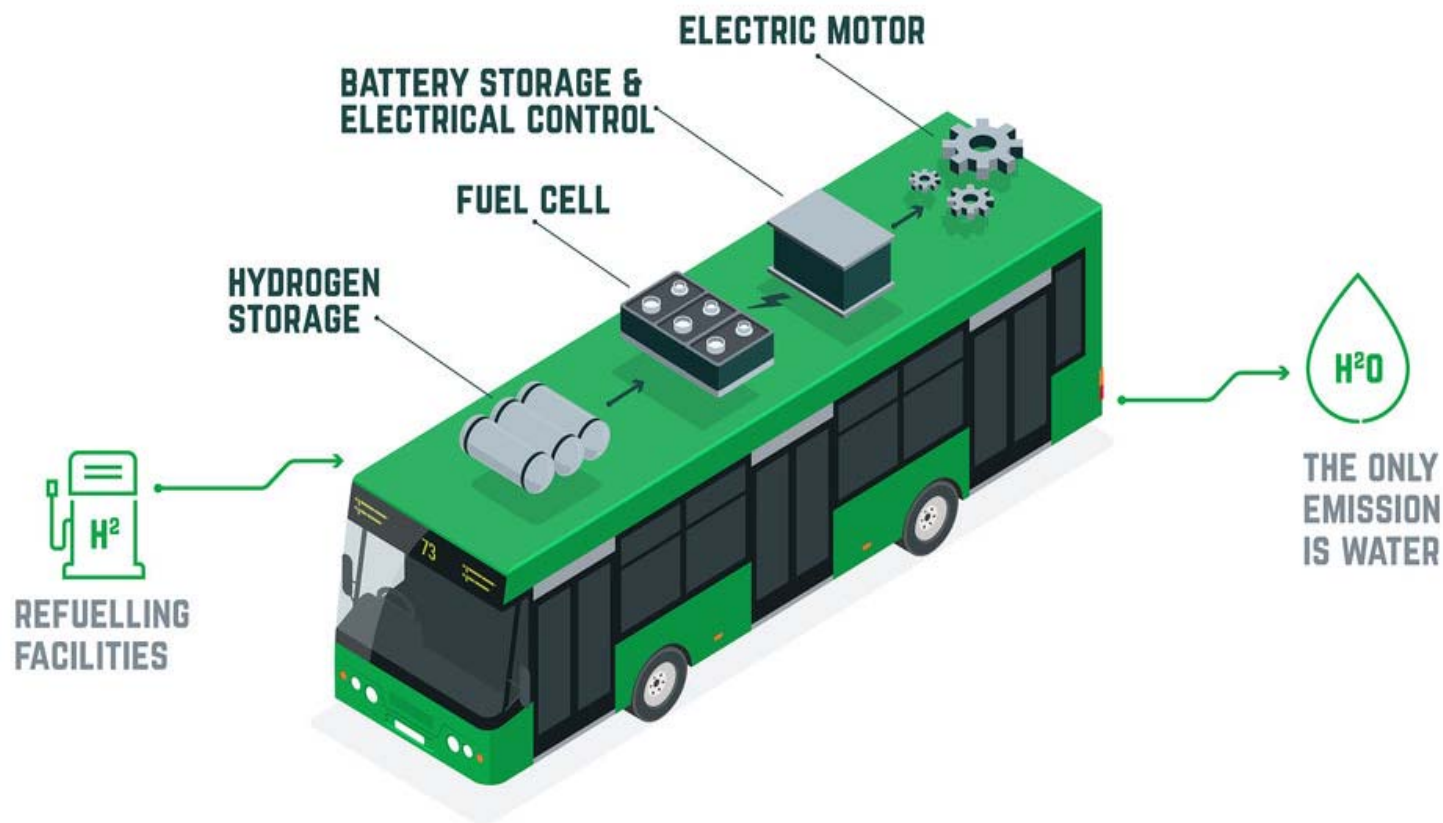
- Ballard fuel cell achieved over 36,000 hours before rebuild.
- 32kg hydrogen at 350bar.
- Length - 11.895m
- Width - 2.520m
- 34 seat + 10 stand (one wheelchair position).





London Maintenance Depot

- Bespoke maintenance facility which includes 2 workshop bays.
- All maintenance undertaken in depot.
- Safety systems include detection and venting.
- No prime contractor support.
- Ballard provide remote support.



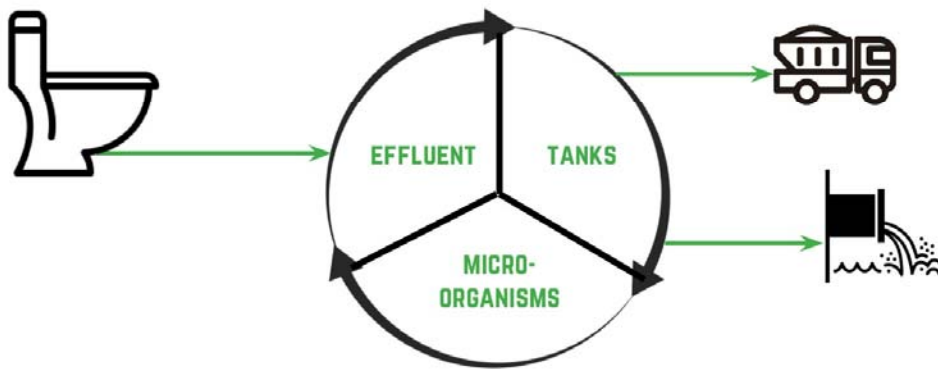
Hydrogen Buses VS Hydrogen Cars

- Buses are back to base which reduces capital investment.
- 1,000s of people travel on them each week.
- 100,000s of people see them each week.
- High level of community interface.

A hypothetical ...

Case Study

Waste Water Treatment
Company wanted to reduce
their environmental impact
and reduce operating costs.

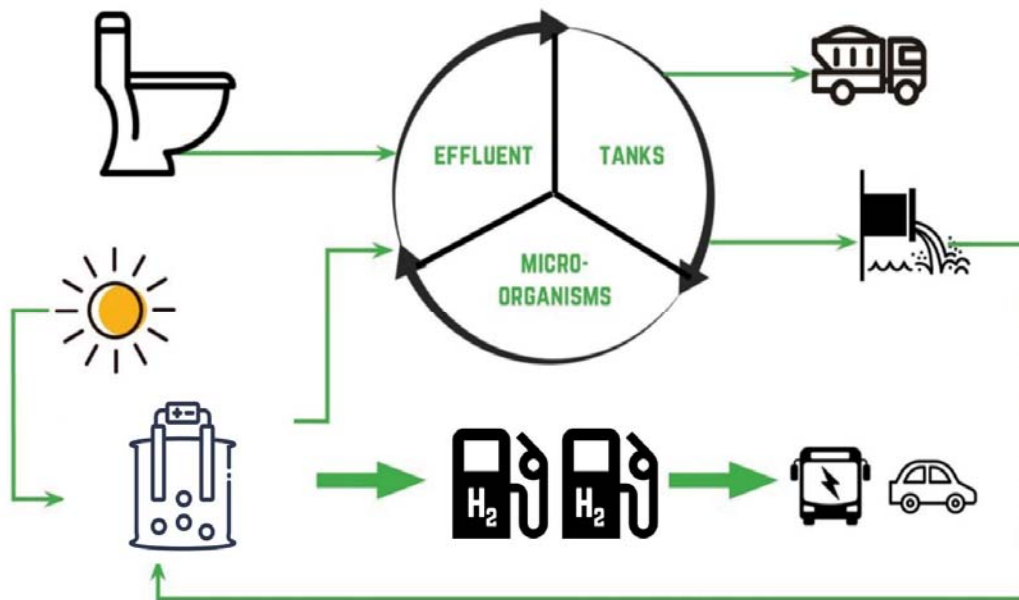


Current Process

- Most effort is used at the commencement of the process.
- Low intensity with most work being done by micro-organisms.
- Large amount of electricity used to pump air into the material.
- Landfill waste
- Water entering rivers.

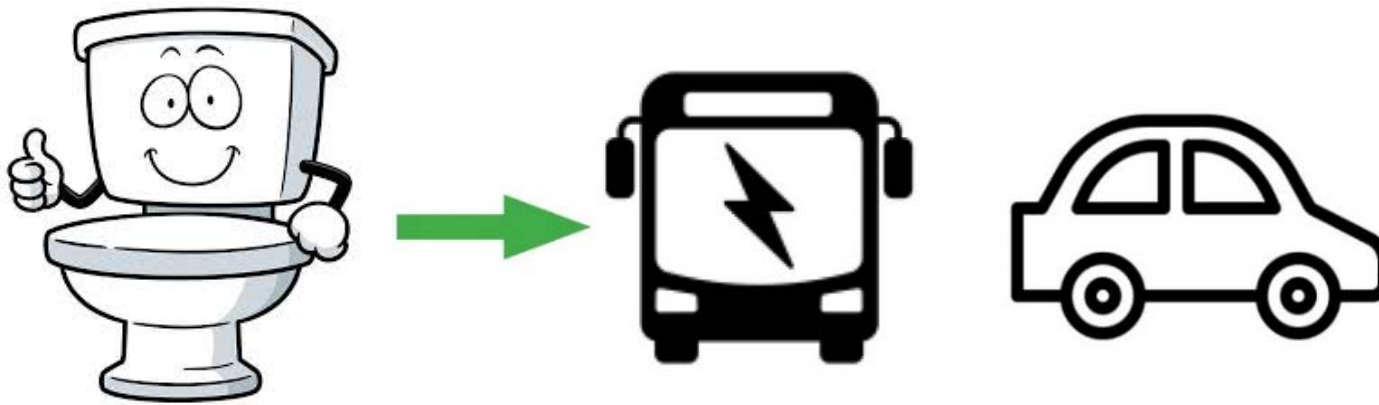
Case Study

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Which then led to an idea ...

- Source “green electrons” from an on-site Solar System.
- Reduce grid demand.
- Further treat out-put water to be re-used to feed the Hydrogen Electrolyser.
- Extract water from the “dry waste” which reduces land fill contribution.



The effort you put into this process, could put a bus on the road.

Electric Buses Sydney

Deployment

- Four battery electric buses with depot charging.
- 50,000km each bus per year.
- Operates general route services.
- Capable of travelling over 300 km and 16 hours between charging.
- Provides real-time data.



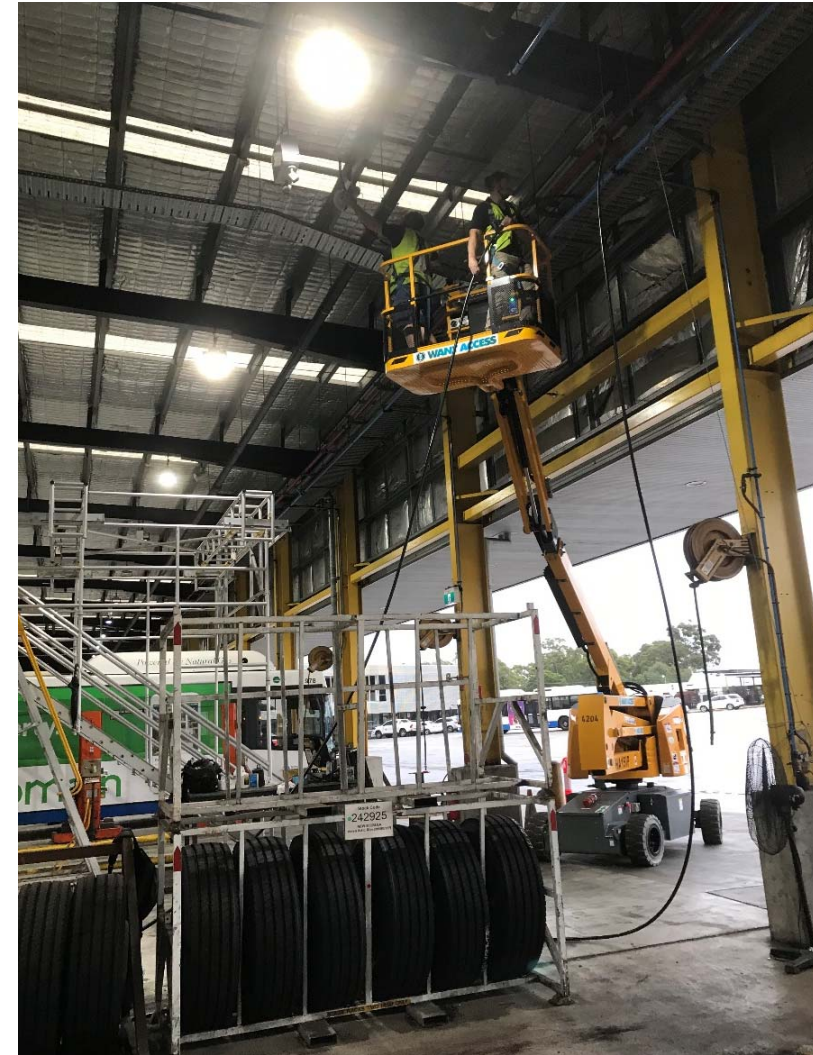


Safety

- Drivers selected based on driving history and customer service.
- Transit Systems mechanics trained in-house by bus manufacturers and supported locally.
- Response agencies inspected buses prior to entering service.

Infrastructure Upgrades

- Four charging locations;
- sub-station upgrade;
- distribution board upgrade; and
- cabling.



CASE STUDY:

Renewable Energy Options

- PV array on depot roof area.
- Battery storage system.



Comparison

Similarities

- Both vehicle types are “Electric Buses”.
- Both have zero tailpipe emissions.
- Both require additional skills training for drivers and mechanics.



Hydrogen Fuel Cell

- Drop-in replacement for diesel and CNG buses.
- No additional fleet requirements, or operational constraints.
- Similar refueling times to Diesel and CNG.
- Workshop adaptation required for hydrogen – similar to CNG Safety Systems.
- Limited redundancy if there is a supply issue.





Battery Electric

- Well suited to local bus deployment requiring up to 250 klms between charges.
- Battery performance is improving and may not have reached full potential.
- Additional Buses may be required to meet PVR.
- Relatively long charging times of 2-5 hours.
- Grid issues for large scale electric bus charging deployment.
- Depot upgrade could be costly for Depot Charging.
- Limited redundancy if there is an extended electricity outage.

Thank You

