



Innovation  
Networks

# Off-Highway Workshop

7th of June 2021

## Summary of discussions

This document presents a summary of the discussions that took place as part of KTN's joint **Hydrogen Economy and Cross-Sector Battery Systems Innovation Networks workshop** on 'Off-highway Solutions'. The workshop brought together a diverse group of participants from industry, Government and academia from 3 end-use sectors (Construction, Agriculture and Defence) and solution providers (battery and hydrogen innovators) for a highly interactive session.

Please note that the feedback has been summarised and anonymised. You can find the list of the participating organisations below.



# Technical Challenges

The technical challenges that were raised from participants were split across 4 main themes; infrastructure needs, vehicle design, battery innovation and hydrogen innovation.

## Infrastructure needs:

- A widespread electric vehicle (EV) charging / hydrogen (H2) refuelling network.
- Local / onsite energy generation for remote agriculture / construction or defence locations.
- Short refuelling times for heavily used vehicles.

## Vehicle Design:

- The need for, and the availability of modular drop in systems.
- 'Safe' thermal runaway. i.e. do not vent into passenger compartment.
- Space within existing platforms (military vehicles etc.) is already limited - retro-fit might be difficult.

## Battery Innovation:

- Further research is required for next generation battery technology: solid state, lithium metal anodes, etc.
- High energy batteries that are stable.
- Solutions for green fleet (deployed military platforms) have to work in extreme environments.
- Need for international supply chain - not only based in China.

## Hydrogen Innovation:

- Next generation hydrogen storage mechanisms (i.e. liquid hydrogen / metal hydride)
- Concerns over robustness of hydrogen supplies / tanks
- Safe and easy transportation to point of deployment
- Hydrogen purity

# Non-technical Challenges

Across the three sectors, 5 key non-technical challenges were identified and the narrative on these appeared to be largely similar.

## Manufacturing:

- Scaling up quickly to meet demand.
- Lead times associated with heavy duty vehicles.
- Siloed industry; very large, or very small manufacturers.
- Machines made to global requirements with the UK being a relatively small market.
- Validating new technologies to enable approved supply ASAP.
- Confidence in Hydrogen - is it certain before we invest?

## Safety:

- High investment assets often demand a retrofit solution making 'designed in' safety hard.
- Perception - the need to demyth safety concerns and provide education on the true risks.
- Fire; temperatures and effect of Lithium battery fire vs petrol. Are structures protected against conventional fires safe against lithium battery 'fires'?

## Legislation, policy and standards:

- How to get regulations assigned ahead of advances in new technology?
- The need to produce global products that align with global standards, quickly.
- Lots of long term policy, but very little early or intermediate planning - making large investment decisions hard for individual organisations
- Lithium ion transport regulations

## Sustainability credentials:

- How do we obtain standardised comparisons to truly assess the most sustainable options?

## Costs and business models:

- Prioritising total cost and lifetime cost rather than initial purchase cost.
- Investment cycles are long, so if we don't invest at a particular point we could be waiting 15 years before renewing some assets.
- Simple cost savings - hard to justify certain equipment unless it demonstrates a saving and likewise, hard to win tenders with such options.
- Procurement and introduction of innovation in existing contracts remains a challenge - procurement processes often not designed to take account of whole life and sustainable benefits.

# Innovation Activity

## Activity relevant to all off-highway sectors:

- Mobile off grid EV charging developments.
- hybrid hydrogen heavy goods vehicles (HGV), hydrogen generators, electric small / medium plant.
- Fast charging.

## Agriculture:

- [New Holland Hydrogen tractors](#).
- [John Deere Autonomous tractors](#).
- Harper Adams work on automated small scale machines, unfortunately diesel for now, but with a view to move to any power source.
- Performance Projects fully [autonomous electric tractor](#).

## Construction:

- [JCB Hydrogen hybrid excavator](#).
- Construction - Hydrogen fuel-cell generators / renewable energy solution.
- Hydrogen HGV dual fuel system.
- Mid size quarrying equipment is available.

## Defence:

- [RAF Astra programme](#) is looking at some of this.
- Team Defence Information (TDI) / KTN Sustainability Strategy.
- Discussions with US Army on hybrid electric vehicles (HEVs).
- [Technology Demonstrator 6 \(TD6\)](#) - derisking demonstrators.

# Gaps

Across the 3 sectors the gaps were largely common as summarised below:

## Hydrogen:

- New materials for H2 storage and catalysts for fuel cells
- Hydrogen aggregators for small H2 producers (farms for example)
- Hydrogen power pack to work in multiple locations
- Cheaper hydrogen
- Hydrogen modular systems for heavy equipment
- Off the shelf hydrogen storage solutions

### Batteries:

- Lighter weight batteries required (particularly for Agri to avoid soil compaction).
- Energy density of batteries.
- Portable charging equipment.
- Speed of Charging.
- Battery modular system required for heavy equipment.

### Other:

- Incentives for Fuels and OEMs.
- Clear industry roadmaps.
- Vehicle supply for demonstrators.
- Cumulative use and demand required to promote the infrastructure needs.
- Objective Total Cost of Ownership (TCO) calculator.
- A trailblazer required.

## Participating organisations

- KTN
- Teesside University
- PUNCH Flybrid
- DSTL
- APC
- Mat Allen C Eng
- NC Engineering
- John Deere
- Tarmac
- Teddington Group
- Terex
- AVL
- SCS Railways
- CPI
- NanoSUN
- Coleg Cambria
- Performance Projects
- University of Nottingham
- QinetiQ
- Danecca
- HS2
- Ceon