



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