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HYDROGEN IS THE UK'S LEAPFROG OPPORTUNITY IN THE RACE TO ZERO EMISSIONS

Viritech's Cleantech Call to Action for Hydrogen

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Forward

by Jay Nagley, Automotive expert and authority on R&D for electric vehicles and connected/automated vehicles.

Hydrogen is an essential piece of the Zero Emissions puzzle. For example, it is the only zero emission energy source that can replace diesel engines in large vehicles: in a 40-tonne truck, the weight of the batteries would render the payload completely impractical.

The UK is pioneering vital new hydrogen technologies and we have a real opportunity to leapfrog the competition to become the world leader in green hydrogen in the Automotive, Aerospace, Marine and Distributed Power industries.

To reverse climate change we need to embrace hydrogen and its associated technologies – it's not going to be batteries or hydrogen, it's going to be both...

Introduction

Viritech's Cleantech Call to Action: Hydrogen Is a Vital Part of the Solution

At Viritech we are passionate cleantech engineers. In the last 70 years the world has experienced remarkable economic growth, but at the cost of threatening our climate and our future.

The time for debate has passed and vigorous, committed, sustained action from all of us is required. We must now embrace hydrogen as a core part of the strategy to save the planet. This paper sets out our Call to Action for putting hydrogen at the centre of an unprecedented revolution in the transportation and energy industries.

Lithium-ion batteries have taken an initial lead in this challenge, but the technology depends on mining and refining scarce resources, which is itself an environmental issue. While part of the solution, batteries are not sufficiently scalable to meet the global demand for energy storage.

Batteries also suffer from a fundamental weakness, known as mass-compounding – meaning, to go further, faster or carry a heavier load, the battery has to be made bigger, which then adds to the weight, which means yet bigger batteries, and so on.

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About Viritech

Viritech is leading the world in development of integrated hydrogen powertrains, harnessing the strengths of fuel cells, advanced battery technology, and revolutionary vehicle control systems to deliver world class solutions to the Automotive, Aerospace, Marine and Distributed Power industries.

Started in 2020 by Timothy Lyons, a former banker and serial entrepreneur, and Matt Faulks, a former Formula 1 engineer and specialist vehicle entrepreneur, Viritech's guiding mission is to contribute to the global effort to save the planet.

Recognising that batteries alone could not solve the decarbonisation problem facing industry, they set out to tackle the challenge of harnessing hydrogen, nature's battery, to generate abundant and affordable clean power.

Viritech is based at MIRA Technology Park, Europe's leading mobility R&D location for developing the latest automotive technology.

Through our technical partnership with Horiba-MIRA, Viritech has access to 40 major engineering facilities, over 700 engineers, and an engineering eco-system stretching across the UK Midlands, meaning no engineering project is beyond our capacity.

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#1. We're Having the Wrong Clean Energy Argument

There has been an ongoing and misguided controversy over whether batteries are better or worse than hydrogen fuel cells (e.g., Elon Musk's famous description of "fool cells"). The fact is both technologies will be a vital part of our green future – it's not either, or, it's both...

Batteries are a known technology and are made in large quantities but have a big disadvantage in terms of weight per KW of power. Fuel cells are a newer technology, they are still made in small quantities but are much lighter – their weight per KW is broadly comparable with a similarly powerful internal combustion engine.

Hence, if the required battery pack is not too heavy (anything from a power-tool to a city car) then batteries make complete sense. Conversely, if the task is to drive a 40-tonne truck for 500 miles, then batteries are a non-starter.

It's not batteries or hydrogen, it's both

Cleaner *than batteries,* ***Lighter*** *than oil, hydrogen is a crucial part of the solution*

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#2. Hydrogen is Batteries' Big Brother

To see why it's a 'both' argument, consider the energy density of a current lithium-ion battery. One litre of diesel contains 10 KWH of energy. To provide the same energy as a 200-litre tank of fuel would require 2000 KWH of batteries. In truth, an electric vehicle uses energy more efficiently than a diesel one, so the battery pack does not need to be that large. Still, an articulated truck would need an 800KWH battery pack to achieve a modest 500-mile range. That would weigh approximately 4.5 tonnes which means the payload of the 40-tonne truck would shrink from 26 tonnes to 21.5 tonnes. To put it another way, it would mean 20% more trucks on the road to deliver the same amount of goods.

If we want to decarbonise large vehicles, fuel cells are currently the only option. Exactly where that boundary lies is still to be determined – large trucks are definitely beyond any foreseeable battery technology, and even a 2.7 tonne petrol SUV may well be too large for pure battery power – an electrified luxury SUV could end up as technically an HGV, with a weight of over 3.5 tonnes. Therefore, the issue is not whether hydrogen fuel cell vehicles are coming, it is how they are going to arrive.

If we want to decarbonise large vehicles, fuel cells are currently the only option.

#3. Green Hydrogen Is a By-Product of Renewable Energy

What is needed is so-called “green hydrogen” which is produced by using renewable energy to electrolyse water which separates the hydrogen from the oxygen.

In the short term this will be challenging (only 2% of current hydrogen production is green) and more expensive. But the good news is electricity grids around the world are on an unstoppable path to becoming greener, due to the rapidly falling cost of electricity produced by renewable energy, meaning we will reach a point when green hydrogen can be made with grid electricity. And intriguingly, in a sort of (green) virtuous circle, green hydrogen will actually help the economics of renewable energy.

Currently, renewable energy production is rarely in the “Goldilocks zone”, where production is just right. For example, if there is no wind during periods of peak electricity demand, the grid needs to source energy from other fuels. Conversely, when the wind blows strongly in the middle of the night, when demand is low, the grid cannot absorb all the electricity being produced. Hence the counterintuitive phenomenon of seeing wind turbines stationary when one would expect them to be running at full power, meaning we are actually wasting free electricity...

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#4.
The Green Hydrogen Virtuous Cycle Already Exists

Hydrogen can address the problem of not capturing all the 'free' energy, as surplus electricity can be used to generate the hydrogen. Indeed, this is already happening in the Orkney Islands, a location with no shortage of wind.

Finding that in periods of low grid demand its local wind turbines were being switched off, the Orkney community decided to invest in hydrogen production facilities so the otherwise wasted wind energy could be used to make and store *green hydrogen*, in effect capturing and storing the energy of the wind.

As a result, the Orkney Islands now have an abundance of *green hydrogen* capable of providing household electricity, recharging both hydrogen fuel cell and battery electric cars, and powering the local ferry. They are even planning to use hydrogen to fuel the passenger and cargo aircraft which serve the islands.

The Orkney Islands now have an abundance of green hydrogen capable of providing household electricity, recharging both hydrogen fuel cell and battery electric cars, and powering the local ferry.

With governments around the world now committing vast resources to the hydrogen economy, the Hydrogen Council is forecasting that by 2050, hydrogen will power:

More than 400 million
passenger cars worldwide

Provide 18% of the
world's total energy needs...

Up to 20 million
trucks and 5 million buses

And create 30 million
jobs globally

Source

Hydrogen Council & McKinsey & Company, 'Hydrogen Insights 2021' - **www.bit.ly/3707kEO**

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#5.
The UK Must Seize the Opportunity to Leapfrog and Lead the World

So, confident about the future availability of green hydrogen, the UK can also become a world-leading clean technology hub if it embraces the opportunity to lead the world in the development of hydrogen technologies.

For example, the UK has a strong early position in hydrogen, with leading R&D in both electrolysis and fuel cell stacks, world-leading vehicle control systems, light-weight energy storage and advanced hydrogen storage technology emerging.

Alarmingly though, based on recent history, the UK is in danger of repeating the pattern of pioneering a new technology and then allowing other countries to put it into production.

- *The lithium-ion battery was invented at Oxford University but productionised in Japan.*

- *Germany and France each have a budget of €7 billion for hydrogen development. So far, the UK government has allocated £250 million for hydrogen.*

We Need a Clear Hydrogen Roadmap Now

If the UK is going to compete, it urgently needs a roadmap of how hydrogen is going to be produced and consumed in the UK. The government has a stated mission in its **Transport Decarbonisation Plan** of putting the UK at the forefront of the design, manufacture and use of zero emission vehicles.

But bizarrely, hydrogen is actually excluded from use in the government's **Renewable Transport Fuel Obligation** on the grounds that electricity used to generate green hydrogen could be used for other energy generation.

To be eligible for the RTFO scheme, a hydrogen supplier must build its own dedicated wind turbine. What other green technology faces being excluded from government support?

The government must prioritise resources on commercially focussed and deliverable engineering without further delay, playing to the UK's rich engineering heritage and resources. The COVID ventilator project, which relied on the world-leading engineering talent in the UK F1 community, is a clear demonstration of what can be achieved when resources are corralled effectively.

We must break paradigm of losing home grown IP

The UK is in danger of repeating the pattern of pioneering technology only to see it scaled-up elsewhere. For example, the lithium-ion battery was invented at Oxford University, but productionised in Japan.

Germany and France each have a budget of €7 billion for hydrogen development. So far, the UK government has allocated £250 million for hydrogen.

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Early-Stage Technology Needs Better and Immediate Access to Funding

Despite the leading role of the City of London in world financial markets, the UK does not supply capital efficiently to early-stage businesses which are the source of most disruptive initiatives/technologies – it is incredibly challenging to fund early-stage businesses.

Similarly, the Grant Funding system would benefit from streamlining and a greater focus on delivering products to market. The government promised "up to £1 billion" for the **Automotive Transformation Fund** in 2020 to help convert the UK automotive industry to EV production. To date only £400 million of new money has been made available, and once the amount needed to support battery gigafactories was ring-fenced, there was little remaining for any other technology.

Is the UK Government mistakenly excluding a Key Clean Technology?

Bizarrely, hydrogen is actually excluded from use in the government's Renewable Transport Fuel Obligation on the grounds that electricity used to generate green hydrogen could be used for other energy generation. To be eligible for the RTFO scheme, a hydrogen supplier must build its own dedicated wind turbine s. What other green technology faces being excluded from government support?

#6.
Hydrogen Solutions are Readily Scalable Across Industries

One of the great benefits of the technologies associated with electrification is their scalability. Whereas the engine and gearbox of a passenger car are not capable of being used to power an HGV, mobile electrification technologies are far more scalable – e.g., the battery packs designed for the Nissan Leaf are also used to power electric off-highway construction vehicles.

This means that hydrogen powertrains are easily scaled and deployed across the Automotive, Aerospace and Marine industries, as well as being applied in Agriculture, Construction and Distributed Power Generation.

The other benefit of hydrogen fuel cell powertrains is that they are complementary to battery electric powertrains as everything downstream of the fuel cell or battery is virtually identical – the motor, transmission and drive system are the same. All these components have no interest in how the electricity was generated – they are simply processing electric power.

Again, fuel cells and batteries are complementary technologies.

By developing world leading expertise in combining these technologies, the UK can create a wide range of hydrogen product solutions for global markets.

The UK must not miss this opportunity...

Viritech Apricale Hydrogen Powertrain

01. Thermal System

02. H2 Storage Tank

03. Electric Motor & Inverter

04. Battery Store

05. Fuel Cell Stack

06. DC/DC Converter

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Hydrogen Key Points

- The Hydrogen Council estimates a future hydrogen and equipment market worth $2.5 trillion globally by 2050, supporting 30 million new jobs.
- In the UK, this development has the potential to unlock £18bn in GVA by 2035 and support 75,000 additional jobs in the UK.
- Five years prior to 2035, the EU is targeting the production of 10 million tonnes of green hydrogen.
- Given its leadership position in wind power generation, the UK is well positioned to take a European lead in upstream green hydrogen production.
- Downstream amongst a variety of applications, hydrogen is forecast to power 28% or 400 million passenger cars by 2050 as well as 20 million trucks and 5 million buses globally.
- For transport applications, hydrogen has a higher energy density per weight than batteries and therefore forms part of a combined solution to decarbonise road, rail, air and sea transport.
- Transport currently accounts for one fifth of global carbon emissions, but 30% of this total emissions output arises from hard-to-abate heavy road freight, 11% from aviation and 10% from shipping.
- Hydrogen is suited to heavy freight applications; batteries suffer from mass compounding – or in other words, more heavy batteries are needed to move heavy freight loads which limits their application beyond light transport.
- Hydrogen investment is ramping; McKinsey & Company estimate global project investment is now topping $500b and over 30 countries have funded hydrogen strategies.

Sources:

McKinsey & Co

https://mck.co/2V64LhL

The Hydrogen Council

https://bit.ly/3zx0HnZ

https://bit.ly/3rA8Erj

The Hydrogen Taskforce

https://bit.ly/3x8ksCp

International Energy Agency/Our World in Data

https://bit.ly/2UIJxa2

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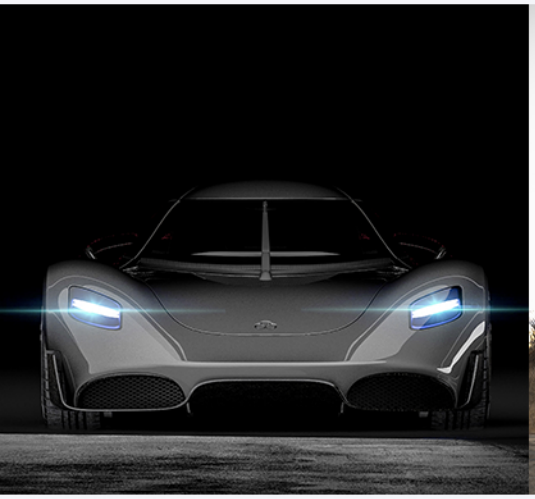
Conclusion

Oil seemed to be the low-hanging fruit of transport: cheap, energy-dense and light but as we have discovered, it came at a terrible price.

No one energy source is going to replace all the applications of petrol, diesel and kerosene – simply wishing batteries could do everything will not make it happen. Instead, we have to analyse which solution, or combination of solutions, is best for which application. In applications where the vehicles are large, and overall weight is limited (e.g., trucks or even large cars, or in aerospace and marine) hydrogen is the only viable solution.

While batteries are the key growth industry of the early 2020s, hydrogen powertrains will be the key growth industry of the late 2020s.

The UK has a unique opportunity to surf the hydrogen wave and build a vital new industry. We must not repeat the traditional UK pattern of spotting a wave in the far distance, being the first to head towards it, and then giving up just as everyone else notices it.



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