

# The Hydrogen Society

2019



JM Johnson Matthey  
Empowering science, accelerating the future

ITM POWER  
Energy Storage | Clean Fuel

SCIENCE  
MUSEUM  
GROUP

ARVAL  
BNP PARIBAS GROUP

riversimple

Intelligent Energy

ATC-P

EasyCabin  
EcoSmart ZERO

TOYOTA  
MATERIAL HANDLING

FUEL CELL  
SYSTEMS

arcola  
energy

elementenergy

UK H<sub>2</sub> Mobility



green  
tomato  
cars

ENERGY OBSERVER

TOYOTA

## EVENT LOCATIONS:

- Media Hotel: Vintry and Mercer  
19-20 Garlick Hill, London EC4V 2AU
- Johnson Matthey Fuel Cells  
Lydiard Fields, Great Western Way, Swindon SN5 8AT
- Science Museum Wroughton  
Red Barn Gate, Wroughton, Swindon SN4 9LT
- Hilton Hotel Heathrow T4  
Terminal 4, Longford, Hounslow TW6 3AF

N 51°30'40"  
W 000°05'38"

N 51°32'52"  
W 001°51'19"

N 51°30'38"  
W 001°48'45"

N 51°27'32"  
W 000°26'27"

## EMERGENCIES:

In case of emergency, please call:

<b>Emergency services</b>	999
<b>Iñaki Benito, E4B Events</b>	+34 619 407 827
<b>Denise Clifford, Toyota Events Team</b>	+44 7539 000 431
<b>An Dua, Toyota Motor Europe</b>	+32 474 80 14 90

## SPEED LIMITS:

We kindly ask you to observe the speed limits.  
Unless specified differently, speed limits are:

- Urban: 30 mph
- Country road: 60 mph
- Motorway: 70 mph

## ROUTES:

The car's Navigation System has been programmed to guide you on the suggested test route by means of intermediate destinations. Please do not change the destinations settings. Our support staff is happy to change the route upon request.

The navigation will guide you to Johnson Matthey and Science Museum Wroughton where our staff will meet you and take the car. From Science Museum you will be shuttled to London Hotel.

## AM ROUTE (DRIVER SWAP)

Hilton Hotel Heathrow T4 > Johnson Matthey (2h – 148Km)

## PM ROUTE:

Johnson Matthey > Science Museum Wroughton (10' – 8,3Km)



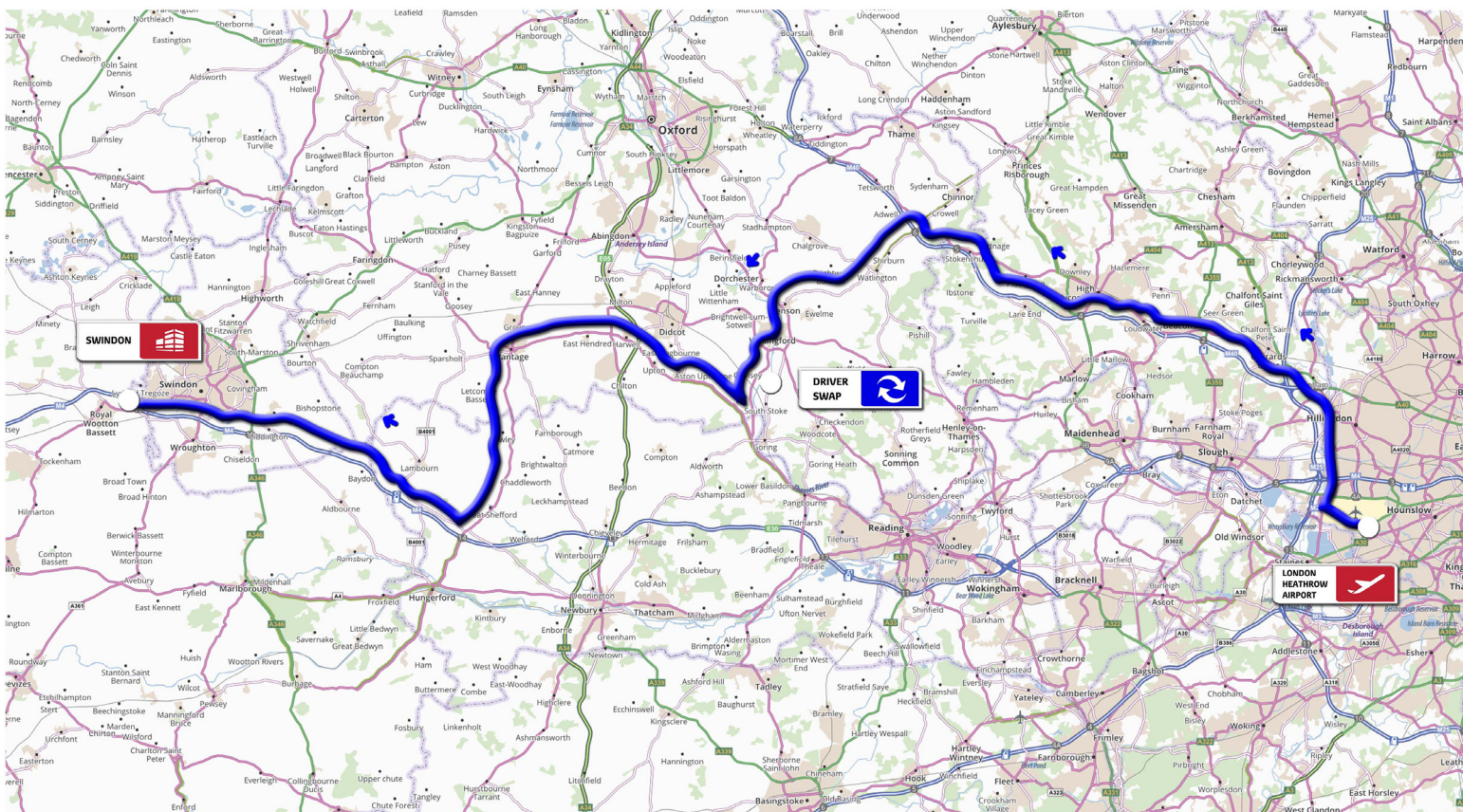
# HYDROGEN SOCIETY EXPERIENCE

London, Great Britain

October 2019

## TEST DRIVE

London Heathrow T4 Airport > Swindon .....148Km (2h)





Notes:

Lined area for notes, consisting of multiple horizontal dotted lines.

## USEFULL INFORMATION



### To select a destination



- Select NAV on the screen or MAP / NAV
- Select 'My destinations'. 'Stored' destinations will be displayed
- Select required destination (You may have to scroll up or down). Route will be calculated
- Select 'Go'



*If map is not displayed on the screen press the MAP/NAV button or the return icon on the screen*

### To suspend guidance

- Select Options icon on the screen (below NAV)
- Select 'Stop Guidance'

# IMPORTANT RECOMMENDATION

## FOR YOUR MIRAI TRIP



Always keep an eye on your remaining range...



Try to keep your fuel consumption below than 1.2 kg/100 km.



... and compare it with the distance still to go.

Always try to keep a margin of 40 to 60 kilometres. This can be very useful if you get lost during the travel or in case of an issue with the H2 fuel station.

# JOHNSON MATTHEY

JOHNSON MATTHEY'S VISION IS FOR A WORLD THAT'S CLEANER AND HEALTHIER. AS A GLOBAL LEADER IN SUSTAINABLE TECHNOLOGIES, WE USE OUR CUTTING EDGE SCIENCE TO CREATE SOLUTIONS WITH OUR CUSTOMERS THAT MAKE A REAL DIFFERENCE TO THE WORLD AROUND US.

We have an impressive heritage in the development of fuel cell technologies. In the 1960s, we supplied catalysts for the fuel cells in the Apollo and Gemini space missions. In the 90s our scientists turned their attention to developing catalysts and components with high performance and low cost, making fuel cells a real option for energy generation.

## **HYDROGEN POWERED FUEL CELLS**

Hydrogen powered fuel cells are a great way to reduce the carbon in transportation and elsewhere. Hydrogen can have a much higher energy density than batteries and refuelling with hydrogen takes a similar timeframe to filling current fuel tanks. Fuel cells also match the needs of cars covering large distances.

JM develops the platinum containing catalysts and membranes which make up the membrane electrode assembly (MEA). Within this component, which is at the heart of a fuel cell, hydrogen and oxygen react together electrochemically - producing water, electricity and heat.

Because hydrogen is an extremely flexible energy option, many countries are exploring how it can help their broader decarbonisation efforts. Hydrogen has great potential to drive substantial reductions in the carbon emissions associated with domestic heating, enable the decarbonisation of high temperature industrial processes and provide flexible, dispatchable power generation.

To achieve all of this, the world is going to need more low carbon hydrogen; it is imperative that



cost effective low carbon hydrogen is produced at scale. There are different ways to produce hydrogen. Today, most is produced by steam methane reforming (SMR) where natural gas at high temperature is converted to hydrogen and CO<sub>2</sub>. JM has developed a new, class leading process to produce low carbon hydrogen (LCH) from methane using a process technology called a gas heated reformer. This yields more hydrogen and is more energy efficient than existing SMR technologies. And JM's process is easier and cheaper to decarbonise through CCS, a technique which captures the CO<sub>2</sub> produced along with the hydrogen and subsequently stores it.

As a leader in science that makes the world cleaner and healthier, our commitment to developing leading hydrogen technologies as enablers for the future energy mix is long-standing. It is based on decades of R&D and commercialisation of new technologies plus a thorough understanding of their applications, which gives us confidence in hydrogen's viability and competitiveness and our fuel cell technology, where hydrogen is converted electrochemically to clean power, is an important enabler in the journey to zero emission transport and pollution free roads.



# ITM POWER

## WORLD LEADER IN PEM ELECTROLYSER TECHNOLOGY

ITM POWER PLC DESIGNS AND MANUFACTURES INTEGRATED HYDROGEN ENERGY SYSTEMS BASED ON PROTON EXCHANGE MEMBRANE (PEM) TECHNOLOGY AND HAS A PRODUCT OFFERING THAT IS SCALABLE ABOVE 100MW IN SIZE. OF PARTICULAR IMPORTANCE IS THE ABILITY TO RESPOND RAPIDLY AND TO GENERATE HYDROGEN AT A PRESSURE, FLOW RATE AND PURITY APPROPRIATE TO ITS APPLICATION.

ITM Power Plc is a globally recognised expert in hydrogen technologies with the overarching principle to take excess energy from the power network, convert it into hydrogen and use it in one of three broad applications – Power to Gas, Renewable Chemistry and Clean Fuels. We believe that all of these markets will grow significantly over the next few years based on the increasing drive for improved air quality worldwide, the growth of renewables in the energy mix and the need to decarbonise industrial processes.

### FEATURES

- Rapid Response
- Modular design
- Full integration
- High purity hydrogen
- Remote control monitoring



# SCIENCE MUSEUM GROUP

THE SCIENCE MUSEUM GROUP IS THE WORLD'S LEADING ALLIANCE OF SCIENCE MUSEUMS, EXCITING AND INSPIRING OVER 5 MILLION VISITORS IN PERSON AND OVER 10 MILLION ONLINE EVERY YEAR.

Over the course of the next four years, the Science Museum Group will take on our most ambitious project in a generation: to transform the way we care for the world's most important science and technology collection and revolutionise how people from across the globe connect with it. This includes building a new home for over 300,000 objects in our collection - the National Collections Centre - which will become a leading hub of innovation where advances in technology and sustainability can be inspired by our objects and the surroundings, including one of the UK's largest solar farms.

The first step in creating the National Collections Centre is the construction of our new 60,000sqm collections management facility. This sector-leading building will be publicly accessible, setting new standards for collection care and enabling us to more easily display the collection across our museums and beyond.

We will also create a visitor experience at the National Collections Centre to enable schoolchildren, community groups, enthusiasts and researchers to get closer to their scientific heritage. By providing new STEM public engagement programmes, we will bring science to life for more people than ever before and further contribute to the local society.

As we move the objects to their new home, we are ensuring each one is photographed and meticulously catalogued using innovative

technology that allows them to be digitised at unprecedented speed - creating the most extensive online scientific collection in the world. Our collection illustrates the profound impact of technology on our everyday lives and captures iconic moments in popular culture. By revealing more of the collection online than ever before, we can engage new and existing audiences with incredible stories of human ingenuity and the impact of science on all our lives.

Alongside this important new facility, we will develop facilities across the site for research and development collaboration. Our focus on autonomous and EV vehicle testing, renewable energy and data management will transform the wider estate into a contemporary innovation park that draws on our collections for inspiration.

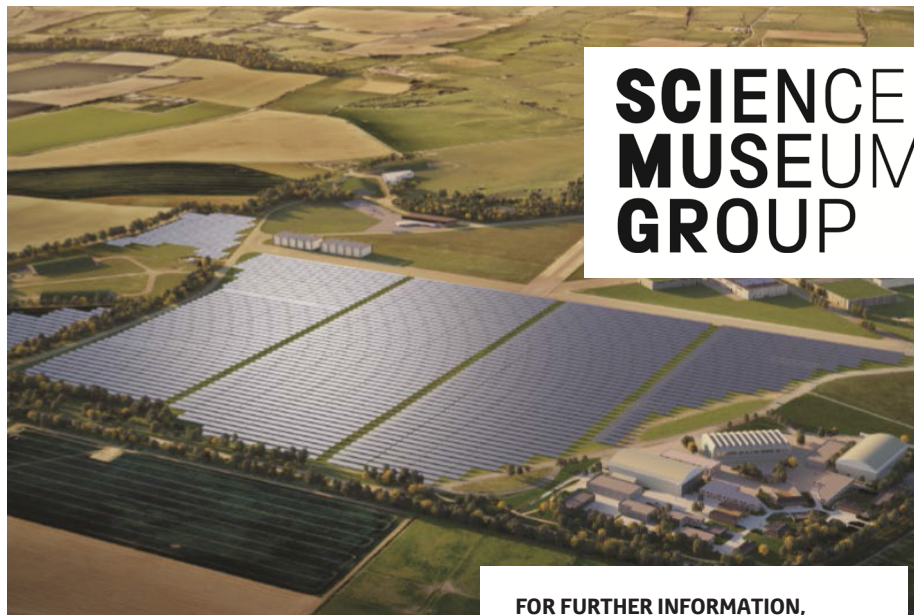


We are very proud of our long and rich history of showcasing the technological innovation of Toyota as part of our international collection through our daily operation of the Toyoda Type 'G' automatic loom on permanent display in the Science Museum's Making the Modern World gallery, to the Toyota Mirai's that are in use at the National Collection Centre and three Toyota robots that have been traveling around the world in our highly acclaimed Robots exhibition, instilling wonder and awe amongst visitors.

For those people who feel that science, technology, engineering or mathematics is abstract or irrelevant to them, our collection demonstrates its real-world applications and engages audiences with STEM in unexpected new ways.

We are looking for external expertise, support and funding to enable greater

public engagement with our collection, to develop the National Collections Centre's infrastructure and offer enhanced public access. By working together, we can preserve this globally significant collection for future generations and bring local and global audiences closer to it than ever before, to inspire the creative problem solvers of tomorrow.



# SCIENCE MUSEUM GROUP

## FOR FURTHER INFORMATION, PLEASE CONTACT:

*Matt Moore*  
*Head of National Collections Centre*  
[Matt.moore@sciencemuseum.ac.uk](mailto:Matt.moore@sciencemuseum.ac.uk)

*Emily Cameron*  
*Senior Development Manager*  
[Emily.cameron@sciencemuseum.ac.uk](mailto:Emily.cameron@sciencemuseum.ac.uk)

ARVAL UK, THE FLEET MANAGEMENT AND LEASING SPECIALIST, PART OF THE BNP PARIBAS GROUP, CAN CREDIBLY CLAIM TO BE DOING MORE THAN ANY OTHER COMPANY IN ITS SECTOR TO SUPPORT THE INTRODUCTION OF HYDROGEN CARS TO FLEETS.

Its expertise has been built through involvement in a Government-backed project called the Hydrogen Hub, which researches the viability of fuel cell technology for a range of domestic, commercial and transport applications in real world conditions.

Paul Marchment, Senior Business Manager at Arval UK, who oversees the company's hydrogen activities, explained: "Thanks to

the work we've done with the Hydrogen Hub, we have considerable know-how in running hydrogen cars, with nine now on hire with a range of fleet customers. Their experience of hydrogen – and ours – has been very positive."

As part of its activity in support of hydrogen in fleets, the company is holding five roadshows in major cities this year that are designed to reach fleet decision makers and other influencers. To date, more than 580 delegates have visited events in Swindon, Oxford and Leeds with Birmingham and London to follow.

Paul said: "In all the locations we are visiting, we are reaching audiences that can help to drive positive change – for example,

businesses, the public and local politicians. We want to show them hydrogen production vehicles that are being used today and explain how the technology works. Once people know more about the advantages of hydrogen, it is our belief that they will be much more likely to adopt and promote it."

Arval has also produced a range of hydrogen car resources for Year 10 and Year 11 school pupils directly linked to the GCSE Chemistry element of the National Curriculum. These have been created to provide a greater understanding of fuel cell technology and the role it plays across a range of real-world applications, and have so far been downloaded almost 1,000 times.



# RIVERSIMPLE

RIVERSIMPLE IS A CAR COMPANY DEDICATED “TO PURSUING, SYSTEMATICALLY, THE ELIMINATION OF THE ENVIRONMENTAL IMPACT OF PERSONAL TRANSPORT”.

From their headquarters in mid Wales, Riversimple are pioneering highly efficient hydrogen fuel cell cars. Their first car is the Rasa; composite-bodied, with a fuel cell of only 8.5kW, four in-wheel motors and a bank of supercapacitors, it has no need for batteries.

The Rasa does 0-60mph in 9.6 seconds, cruises at 60mph/100kph and has a range of 300 miles/ 480km. The whole car weighs just 630kg - it is light, agile and so efficient that it does the equivalent of c.250mpg (just over 1.1litres/100km).

Air quality is acknowledged to be a massive and urgent challenge, and we believe the Rasa is best in class. It emits nothing but pure water vapour and is designed to minimise the particulates from tyres and brakes with its low weight, skinny tyres and highly regenerative braking.

And a radical powertrain is just the starting point. Riversimple is probably the only car manufacturer in the world that hopes never to sell a car. They aim to offer customers these fun-to-drive vehicles as a complete and cost-transparent subscription service, with a single monthly fee that covers the car, the maintenance, insurance and all fuel. Why? Because the fastest way to meet today's environmental imperatives is to pioneer a new business model that makes efficiency

profitable without asking the customer to pay a premium for it.

Riversimple are currently building 20 cars for a Clean Mobility Trial with the general public in Monmouthshire and have secured a £1.25M grant from OLEV towards the build of the fleet. In parallel, they are exploring manufacturing sites in mid Wales – their intention is to manufacture in small plants producing 5,000 vehicles per annum, starting with the Rasa and a light commercial van before progressing to a family vehicle.





riversimple



# INTELLIGENT ENERGY

## HYDROGEN DRONE DEMONSTRATION

INTELLIGENT ENERGY IS A WORLD LEADING FUEL CELL ENGINEERING COMPANY FOCUSED ON THE DEVELOPMENT, MANUFACTURE AND COMMERCIALISATION OF ITS PROTON EXCHANGE MEMBRANE (PEM) FUEL CELL PRODUCTS WITH A REPUTATION FOR DELIVERING WORLD FIRSTS. THE COMPANY IS HEADQUARTERED IN LOUGHBOROUGH IN THE UK, WITH ADDITIONAL OFFICES AND REPRESENTATION IN THE JAPAN, US, INDIA, KOREA AND CHINA.

### **INTELLIGENT ENERGY'S FUEL CELLS**

Intelligent Energy's high-performance fuel cells have been designed for mass production with minimal component count resulting in high reliability and low system cost. We offer our customers a variety of fuel cell products, with outputs of up to 100kW.

### **OUR PRODUCTS**

Intelligent Energy has two proprietary platforms; air cooled and evaporatively-water cooled fuel cells, both providing clean power at class leading power densities.

Its air cooled technology is integrated into products for the commercial drone market and into diesel replacement products, helping

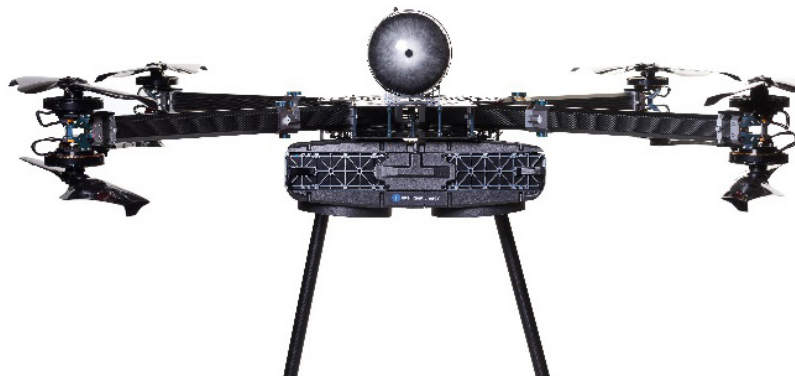
the construction industry transition to cleaner power solutions including portable power units, lighting towers and welfare cabins.

In addition, Intelligent Energy's next generation of evaporatively cooled technology is ideal for higher power applications such as automotive and aerospace.

### **CONTACT US**

To contact Intelligent Energy email [sales@intelligent-energy.com](mailto:sales@intelligent-energy.com) or telephone 01509 271271.

For more information visit:  
[www.intelligent-energy.com](http://www.intelligent-energy.com)



# TCP

## 〈TAYLER CONSTRUCTION PLANT LTD〉

TCP (TAYLOR CONSTRUCTION PLANT LTD) IS A LEADING INNOVATOR OF HYDROGEN FUEL CELL/BATTERY HYBRID PRODUCTS FOR CONSTRUCTION, RAIL AND HIGHWAY, AND EVENT INDUSTRIES. INCLUDED IN THE RANGE ARE LIGHTING TOWERS, CCTV UNITS AND POWER GENERATORS WHICH PRODUCE ZERO CARBON EMISSIONS (AT POINT OF DELIVERY), ARE VIRTUALLY SILENT IN OPERATION, AND ELIMINATE RISK OF FUEL SPILLS.

The Ecolite TH200 hydrogen fuel cell off-grid light tower has been developed in partnership with BOC, a Linde company. The product uses BOC's HYMERA® fuel cell which produces electricity from the reaction between hydrogen and atmospheric oxygen: the only emission is water vapour. The process is virtually silent enabling contractors

to comply with section 61 of the Control of Pollution Act.\*

TCP's Ecolite TH200 uses Prismatic Lens technology to prevent light pollution and unwanted glare. The system operates within the mesopic range on the spectrum and therefore produces light similar to lunar light instead of replicating white light like many other mobile and task lighting solutions.

Following the success of the Ecolite TH200, TCP launched the Ecolite CCTV hydrogen fuel cell tower which provides cost-effective temporary site security with remote monitoring and on-site recording. The company has also developed a clean air alternative to a 5KW diesel generator for off grid applications by combining two of its

recent product innovations together, The LGP 2500 Power Pack and the ECO GH2.

The LGP 2500 Power Pack provides a clean air alternative to a traditional diesel generator for off-grid applications. This product has zero emissions, is silent in operation and has a peak power output of 5kW. The battery has a long life and shows no power fade over its full capacity.

The ECO GH2 hydrogen DC power generator, developed in partnership with Intelligent Energy, has zero carbon emissions at point of delivery; the only emission is water vapour. The electro chemical reaction, combining hydrogen with oxygen from the air, is virtually silent. It is fuelled by hydrogen and uses a Fuel Cell Module to produce a DC generator capable of a maximum output of 1kW.



When combined these two products provide an environmentally friendly off-grid power resource. The ECO GH2 DC generator reliably backs up the LGP 2500 (2-3 hours) in the absence of mains power. Furthermore, the units when used together can be hybridised with Photovoltaic array (PV panels) to power equipment such as a welfare cabin.

### ABOUT TCP

TCP offers nationwide rental and sales from its headquarters in the historic Essex town of Maldon and its depots which are positioned across the UK. The company is committed to providing high-quality solutions that increase efficiency, promote environmentalism and boost safety. TCP is proud to be a member of Hydrogen London and The Scottish Hydrogen and Fuel Cell Association (SHFCA).

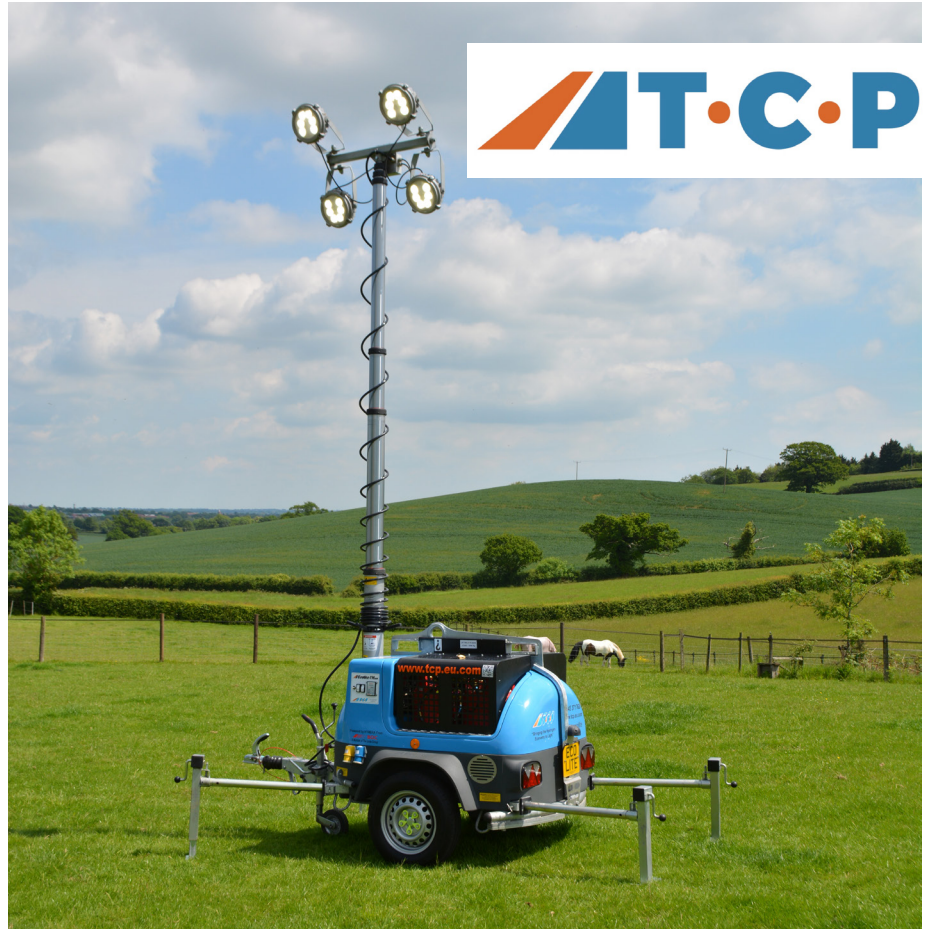
<https://www.tcp.eu.com>

<https://www.facebook.com/tcpecolite/>

<https://twitter.com/tcpecolite>

<https://www.linkedin.com/company/tcp-ltd>

\* Control of Pollution Act 1974 Section 61 3(b) - the steps proposed to be taken to minimise noise resulting from the works





# JC EASYCABIN / ECOSMART ZERO. THE FUTURE OF SITE WELFARE.

WELFARE UNITS ARE AN IMPORTANT PART OF ANY CONSTRUCTION SITE OR TEMPORARY OUTDOOR WORKPLACE WHERE NO MAINS-POWER & BUILDINGS ARE AVAILABLE TO USE. THEY PROVIDE SHELTER, HOT WATER, HEATING & TOILET FACILITIES TO WORKERS. MOST WELFARE UNITS USE A DIESEL GENERATOR TO POWER THE HEATING & HOT WATER ETC.

As a result of winning multiple Green Apple awards for our energy efficient diesel hybrid welfare units, we have been asked by many of our customers to develop site welfare solutions that produce zero emissions at point of use. As a result we have been busy designing, building and testing a new concept, ready for the demands of future CO2 reduction targets.

Ecosmart ZERO is the first viable welfare alternative for companies that are working

to reduce their carbon footprint and, more importantly, improve the environment for communities in the vicinity of operation.

The Ecosmart ZERO system (solar + backup hydrogen fuel cell), provides an opportunity to both reduce operating costs and increase environmental performance relative to the use of traditional diesel generator welfare. ZERO is near silent, and emits only pure water vapour.

Ecosmart ZERO has been designed to have the same user friendly operation as standard Ecosmart welfare unit. Power to run the heating, sockets, kettle and microwave comes instantly from the battery bank. The batteries are constantly fed by the solar panels and the backup hydrogen fuel cell.

- ZERO FUEL POTENTIAL - On summer days up to 100% of the power demands can be met from the solar panels.

- ZERO local carbon emissions - Only water vapour.
- ZERO noise - Very quiet with no vibrations.
- On-demand power & heat on any appliance in the cabin.
- Safe & easy to re-fuel - Hydrogen gas bottles.

AJC Trailers Limited has been manufacturing trailers in the UK for nearly 55 years. For the past fifteen years, the company has focused their activities on designing and producing a range of sustainable temporary accommodation units primarily for the rental, construction and associated industries, under the EasyCabin brand.



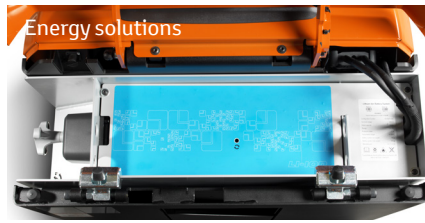
**AJC** EasyCabin EcoSmart **ZERO<sup>CO2</sup>**

**MORE INFO:**

<https://www.easycabin.co.uk/zero-co2-ecosmart-welfare.html>

Contact: [lisa.gillett@ajc-trailers.co.uk](mailto:lisa.gillett@ajc-trailers.co.uk) - 01582 486663

# TOYOTA MATERIAL HANDLING



## QUICK FACT

Toyota Material Handling Europe is part of Toyota Industries Corporation – the global number one in material handling, providing businesses of all sizes with a full range of material handling solutions. We offer counterbalanced and warehouse trucks, semi & fully automated solutions, energy solutions, fleet management and services all designed to maximise safety, productivity and efficiency in your operations.

All our products are built following the Toyota Production System to ensure in-built quality & reliability through their lifetime.




## OUR VISION

Zero Muda. No more waiting and waste through seamless flow of goods and data.

# TOYOTA

## MATERIAL HANDLING

A strong  
global  
network

FY19	TOYOTA INDUSTRIES CORPORATION	TOYOTA MATERIAL HANDLING GROUP	TOYOTA MATERIAL HANDLING EUROPE
 <b>Employees</b>	<b>64,600</b>	<b>45,600</b>	<b>11,600</b>
 <b>Turnover</b>	<b>17.2 bn EUR</b>	<b>12.4 bn EUR</b>	<b>2.5 bn EUR</b>
 <b>Structure</b>	<b>4</b> business units Material Handling, Logistics, Automotive, Textile Machinery	<b>5</b> regions Japan, Europe, North America, China, International	<b>30</b> operational entities



**106,000**  
factory shipment in FY19



**4 million**  
service visits per year



**+200**  
dealers and 15 distributors



**5** factories  
**21** sales and  
service companies



**+5,100**  
trained service technicians



**404,000**  
trucks on service agreement



**+300**  
suppliers



**4** support entities

# FUEL CELL SYSTEM

FUEL CELL SYSTEMS LTD (FCSL) DESIGN, SOURCE AND INTEGRATE BESPOKE FUEL CELL SOLUTIONS FOR CUSTOMERS. WE UNDERSTAND THE PRODUCTS AVAILABLE GLOBALLY AND RECOMMEND SOLUTIONS BASED ON OUR CUSTOMERS' POWER NEEDS. FOR MORE THAN 10 YEARS WE HAVE SPECIALISED IN PROVIDING RELIABLE OFF-GRID POWER FOR REMOTE APPLICATIONS IN THE UK AND FURTHER AFIELD FROM THE ARCTIC TO SOUTH GEORGIA.

Additionally, we offer a range of hydrogen vehicle refuelling products, to help address the current infrastructure gap, which is at least partly responsible for holding back the take up of hydrogen vehicles in the UK.

Our mobile hydrogen refuelling truck has been designed to help fill the gap between current static refuelling stations and locations with an interest in vehicle deployment but without available hydrogen. It has so far been used at exhibitions, ride and drive events and vehicle trials - including an 18 month trial of Suzuki fuel cell scooters for the Metropolitan Police and a current trial of a hydrogen powered train.

The Mini Hydrogen Dispenser from FCSL is designed to fit in the back of a breakdown recovery vehicle to offer an emergency fill for stranded vehicles - a "jerry can" for hydrogen vehicles. The product is also useful for anyone needing a backup fuel option onsite - such as hydrogen forklift trucks and dual-fuel vans. The first production unit has been incorporated into a prototype alternative refuel vehicle by the AA.

Email: [enquiries@fuelcellsystems.co.uk](mailto:enquiries@fuelcellsystems.co.uk)

Tel: 01488 507050

Website: [www.fuelcellsystems.co.uk](http://www.fuelcellsystems.co.uk)





# ARCOLA ENERGY <TBC>

## FUEL CELL AND H2 TECHNOLOGIES FOR ENERGY AND TRANSPORT

ARCOLA ENERGY IS A SYSTEMS-ENGINEERING COMPANY AND TIER 1 SUPPLIER TO VEHICLE MANUFACTURERS, SPECIALISING IN ZERO-EMISSION POWERTRAINS INTEGRATING HYDROGEN, FUEL CELLS, AND BATTERIES. WE FOCUS ON HEAVY VEHICLES SUCH AS BUSES, TRUCK AND TRAINS, AS THIS IS WHERE WE THINK HYDROGEN TECHNOLOGIES HAVE THE STRONGEST TECHNICAL AND BUSINESS CASE.

We aim to help vehicle manufacturers and operators with the transition from diesel to zero emission technology by providing our specialist expertise and supplying complete hydrogen, fuel cell and powertrain systems. Our leading client is leading UK bus manufacturer Alexander Dennis and we are working with them on the development of hydrogen fuel cell electric double deck bus. The first fleet of 35 will be on the road next year with 25 to be deployed in Liverpool City Region.

Arcola Energy is a young, innovative company, developing our specialist capability with a focus on quality, safety and compliance and designing the technology to meet the needs of reliability and robustness. We have a team of about 30 and are recruiting rapidly. We are internationally recognised as a leading business enabling hydrogen markets and our position as specialist Tier 1 gives us a unique perspective and approach to the developing market.

We have just launched our hydrogen powertrain product range, which we will supply to vehicle manufacturers such as Alexander Dennis. Our products range from complete fuel cell systems as range extenders or prime power to integrated and optimised fuel cell electric hybrid powertrain systems and whole vehicle drivetrain solutions. All use our specialist expertise in production of safe, fully compliant on-board hydrogen storage.

We see heavy-duty, busy vehicles such as trucks, buses and trains as the ideal early market for hydrogen powertrains. They are the hardest to do with current battery technology without trading-off payload carrying capacity against range. Hydrogen energy storage provides much greater energy by weight and so fuel cell electric vehicles can go further and carry more within vehicle weight limits. Back-to-base fleets of large vehicles with high hydrogen use also provide a strong business case for refuelling infrastructure.

We are in conversation and negotiation with several manufacturers in the UK, Europe and the Far East for development programmes in refuse collection vehicles, heavy-duty trucks, trains and construction plant.

- Contact: Richard Kemp-Harper, Strategy Director  
richard@arcolaenergy.com 07979151373



# ELEMENT ENERGY

ELEMENT ENERGY IS A DYNAMIC AND GROWING STRATEGIC ENERGY CONSULTANCY. WE SPECIALISE IN THE INTELLIGENT ANALYSIS OF LOW CARBON ENERGY.

At Element Energy, we are dedicated to understanding and helping to solve the challenge of climate change. We are a specialist energy consultancy, with an excellent reputation for rigorous and insightful analysis in the area of low carbon energy. We consult on both technical and strategic issues – our technical and engineering understanding of the real-world challenges support our strategic work and vice versa. We apply best-in-class financial, analytical and technical analysis to help our clients intelligently invest and create successful policies, strategies and

products. Element Energy work across all major low carbon energy sectors, including:

- Built Environment
- CCUS and Industrial Decarbonisation
- Energy Networks
- Hydrogen and Fuel Cells
- Low Carbon Transport
- Smart Energy Systems

We also coordinate many low carbon energy projects through our Project Management team.

The team at Element Energy have a strong industrial track record of deploying low carbon and renewable energy technologies and understanding the practical issues that they face. We have been involved in many of the first meaningful deployments of a number of low carbon energy technologies, for example the majority of the UK's hydrogen refuelling stations and the associated bus and car deployments.

Our clients include government departments, local government, NGOs, FTSE100 companies, technology startups and cleantech SMEs throughout the United Kingdom, Europe and worldwide..



## Ben Madden (Director – Element Energy)

Ben Madden is a director at Element Energy. He founded the company and helped it grow into a leading low carbon energy consultancies, consulting on topics such as energy storage, management of electrical grids, improving building energy efficiency and low carbon transport. Ben now runs Element's hydrogen activities, in which Element is seen a European leader in both strategic analysis (including projects such as the H2Mobility initiatives in the UK and France and work for BEIS on hydrogen for heat) and in developing major deployment projects such as the hydrogen bus deployments in London and Aberdeen. Recently Ben has been involved in bringing together large pan-European deployment projects for passengers cars and stations (H2ME) and for buses (JIVE).





# UK H<sub>2</sub> MOBILITY

THE UKH2MOBILITY GROUPING WAS ESTABLISHED IN 2012 AS A COLLABORATION OF UK INDUSTRY LEADERS AND UK GOVERNMENT DEPARTMENTS. ITS PURPOSE WAS TO EVALUATE THE BENEFITS OF FUEL CELL ELECTRIC VEHICLES (FCEVS) TO THE UK AND PREPARE FOR THE INTRODUCTION OF VEHICLES IN ORDER TO MAKE HYDROGEN-FUELLED TRANSPORT A UK REALITY.

UKH<sub>2</sub>Mobility participants from industry included car OEMs (Toyota, Honda, Daimler, Nissan, Tata Motors and Hyundai); hydrogen providers (BOC-Linde, Air Liquide, Air Products, ITM Power); technology providers (Johnson Matthey, Intelligent Energy) and the energy company SSE. Government involvement came from OLEV, BEIS, and DECC. Transport Scotland, Welsh Government and the Greater London Authority were Observer Partners.

Supported by McKinsey and focusing on passenger vehicles only, the UKH<sub>2</sub>Mobility project undertook fundamental and detailed analysis that established the first FCEV roadmap. It quantified the key benefits of

FCEVs achieved via reduction of carbon emissions, air quality improvements and energy security enhancements. It identified market dynamics for FCEV introduction and forecast future fleet numbers from initial vehicle supply in early adoption locations and then growing to a fleet of 1.6 million FCEVs on UK roads by 2030. It identified the number of hydrogen refuelling stations (HRS) needed for FCEV fleet coverage, with an initial network of 65 HRS in targeted areas by 2020, then leading to 1,150 HRS for national coverage by 2030. It also assessed hydrogen production methods and the economics of delivering hydrogen at a cost competitive level with diesel, yet with 60% - 75% lower CO<sub>2</sub> emissions levels.

## PARTICIPANTS OF THE UKH<sub>2</sub>MOBILITY ASSESSMENT PHASE, 2013



DAIMLER



UK H<sub>2</sub> Mobility

Industry ambition, investment and Government support for FCEV vehicle deployment and HRS introduction has seen progress made on the UKH<sub>2</sub>Mobility roadmap – but now along with a broadening of hydrogen vehicle applications. Most of the early demand for hydrogen is recognised will come from buses and medium to heavy duty vehicles, complemented by trains and trucks as hydrogen vehicle technologies mature. These vehicles will typically be refuelled by depot-based HRS facilities.

The wider HRS network will continue to be developed with the passenger car in mind, to ensure the UK achieves nationwide coverage as quickly as possible and hence is ready

for the significant expansion in the rate of deployment of passenger car FCEVs expected during the 2020s.

The UKH<sub>2</sub>Mobility grouping maintains and updates a roadmap detailing how the UK can build a hydrogen refuelling infrastructure to support the introduction of FCEVs. The initial focus is on an infrastructure to serve metropolitan areas and fleets of vehicles whose operation is “captive” to these regions (taxis, municipal vehicles, buses). The UK now has some 20 publicly accessible HRS stations operating or under construction. The next phase progresses to deployment of further station in cities, with the beginning of stations on the major routes which link the

large cities, before nationwide coverage is to be implemented by 2030.

With a widening of the hydrogen vehicle coverage the industrial partners in UKH<sub>2</sub>Mobility currently includes car OEMs (Toyota, Honda, Daimler and Hyundai); rail OEMs (ALSTOM); hydrogen providers (BOC-Linde, Air Products, ITM Power, INOVYN); technology providers (Anglo American and fuel cell company Intelligent Energy) and fuel retailers (Shell). OLEV and BEIS, along with Transport Scotland, Welsh Government and the Greater London Authority, are now Observer Partners

THE GLOBAL ENERGY SYSTEM IS CHANGING. A PLANET DESTINED FOR MORE PEOPLE AND RISING LIVING STANDARDS WILL NEED MORE ENERGY, BUT AT THE SAME TIME THE WORLD MUST FIND WAYS TO REDUCE CARBON EMISSIONS AND TACKLE CLIMATE CHANGE.

Shell is playing a part in the transition towards a low-carbon energy future and our ambition is to cut the Net Carbon Footprint of the energy products that we sell by around half by 2050. Our New Energies business, set up in 2016, supports this ambition and we plan to invest, on average, \$1-2 billion a year in New Energies until 2020.

Shell's New Energies business focuses on two main areas: power and new fuels for transport. As part of this, Shell is participating in several initiatives to encourage the adoption of hydrogen.

In Germany, Shell is part of a joint venture called H2 Mobility to develop a nationwide network of hydrogen refuelling stations. In the UK, in 2017, Shell became the first

branded fuel retailer to sell hydrogen at one of its retail sites in Cobham, on the outskirts of London. Shell opened a second refuelling site in the UK in 2018. And, in the USA, Shell has four hydrogen filling stations in California and is also working in partnership with Toyota to further develop its US hydrogen refuelling network.

In other parts of the transport sector Shell is part of a consortium in California to develop three new large-capacity refuelling stations for heavy-duty hydrogen fuel-cell trucks. Shell is also exploring the use of hydrogen for power. In Germany, Shell is building a 10-megawatt PEM (polymer electrolyte membrane) electrolyser, the largest of its kind, to produce hydrogen for its Rhineland refinery.



# GREEN TOMATO CARS, TOYOTA AND HYDROGEN

Green Tomato Cars launched in 2006 as the world's first exclusively green passenger car service.

Operating the first fleet of Toyota Prius private hire vehicles (PHVs), GTC pioneered the introduction of the Prius to London in general, and the private hire industry in particular. Today, more than 50% of London's PHVs are Prius.

In 2015, GTC and Toyota GB continued their collaboration to once again bring the newest technology to London's roads – this time, in the shape of the Hydrogen FCEV Mirai. After driving over 80,000 zero-emission miles with two trial vehicles, GTC added 25 Mirai to its fleet in 2018 and has added 25 more in 2019.

With its rapid refuelling time and 300+ mile range, the Mirai is now the flagship vehicle of GTC's *Zero Emission Executive* service, which

can be requested by any of the company's 2,000 corporate account customers. GTC's Mirai cover an average of 120 miles a day and have achieved a maximum reported range of 335 miles on a single tank.

Jonny Goldstone, our founder and MD, looks forward to presenting attendees with some key learnings and statistics from our 4 years with the Mirai, as well as sharing a day in the life of one of our Zero Emission Superheroes! (For a sneak preview and to see some of the celebrities who have said Hello to Hydrogen with Green Tomato Cars, go to [www.twitter.com/theo\\_mirai](https://www.twitter.com/theo_mirai).)

## **MORE GOOD STUFF ABOUT GREEN TOMATO CARS**

With a fundamental commitment to environmental sustainability, GTC has adopted more than 20 polar bears through

its partnership with WWF, plants trees in local parks and distant rainforests, supports cookstove and water purification projects in the developing world, and is the only company to double offset its unavoidable emissions. GTC is the official travel partner of BAFTA's pioneering *Albert* initiative to minimise emissions in TV and Film production

GTC is the preferred taxi and executive car provider to royal households, major media and news corporations, and many other leading London-based organisations. GTC services over 500,000 bookings each year in London and the Home Counties, and 50,000 national and international bookings through its global partner network ([www.greentomatocars.com/business/](http://www.greentomatocars.com/business/)).







# ENERGY OBSERVER

ENERGY OBSERVER, THE FIRST HYDROGEN VESSEL AROUND THE WORLD, WILL STOP OVER IN LONDON FROM OCTOBER 5 TO 13. AFTER BECOMING THE FIRST VESSEL POWERED BY RENEWABLE ENERGIES AND HYDROGEN TO REACH THE ISLAND OF SPITSBERGEN (ARCTIC) LAST AUGUST, THE CREW WILL COMPLETE THE 47TH STOPOVER OF THEIR ODYSSEY FOR THE FUTURE UNDER TOWER BRIDGE IN THE CENTRE OF THE BRITISH CAPITAL.

Energy Observer is the first hydrogen vessel autonomous in energy and that emits no greenhouse gases or fine particles. This electrically propelled vessel of the future operates through a mix of renewable energies and a system that produces carbon-free hydrogen from seawater. This technological and scientific challenge aims to test cutting-edge technologies in extreme conditions, anticipating the energy networks of the future that could be used on land but also to raise awareness among the general public and decision-makers on the energy transition.

Energy Observer is currently conducting an Odyssey for the Future that will last six years (2017-2022). During this time, it will visit 50 countries and call at 101 ports to

raise public awareness about key aspects of the environmental transition, in particular: renewable energies, biodiversity, mobility, and the circular economy, through the stopovers made by its traveling village, through social media and in a documentary series. This world tour is led by Victorien Erussard, founder and captain, and France's first ambassador for the UN's 17 sustainable development goals and Jérôme Delafosse, expedition leader and documentary film series director.

Energy Observer has received the High Patronage of Mr. Emmanuel Macron, President of the French Republic, as well as the official support from the European Union, UNESCO and IRENA.



ENERGY OBSERVER



# CANO WATER

CANO WATER WAS CREATED IN RESPONSE TO THE DAMAGING IMPACT THAT PLASTIC BOTTLES HAVE ON THE ENVIRONMENT, AFTER A TRIP TO A REMOTE ISLAND OPENED THE EYES OF THREE CLOSE FRIENDS.

With approximately 8 million tonnes of plastic ending up in the ocean each year, CanO Water is an infinitely recyclable alternative to plastic bottles. Recycle your can and it will be back on the shelf in as little as 6 weeks.

[www.canowater.com](http://www.canowater.com)







# MIRAI



**TOYOTA**

ALWAYS A  
**BETTER** WAY

# TOYOTA: AT THE FOREFRONT OF ENVIRONMENTAL SUSTAINABILITY

- 
- Today's environmental challenge and Toyota's response
  - How can a Fuel Cell Vehicle contribute to a better environment?
  - Popularising Fuel Cell Vehicles to pioneer a Hydrogen Energy Society
-

## **TODAY'S ENVIRONMENTAL CHALLENGE AND TOYOTA'S RESPONSE**

The continuing growth of the world's population – estimated to reach 9.6 billion by 2050 – will certainly lead to a further increase in the global production of vehicles and a resulting massive consumption of fossil fuels. This will exacerbate problems such as climate change, global warming and air pollution.

Two strategies are being taken to address environmental problems caused by the mass consumption of fossil fuels.

One is to use less petroleum. Combining high thermal efficiency, low fuel consumption engines and a host of advanced technologies, hybrid vehicles are a textbook example of how to use less petroleum.

The second strategy is to diversify energy sources. Energy diversification is a broad field, and Toyota has been working for decades to diversify the use of automobile fuels and powertrains. Each alternative fuel has its characteristics, and Toyota is confident that

hydrogen is one of the technologies that brings the promise of a cleaner future. Hydrogen is an environmentally friendly energy vector that can be produced from a variety of raw materials including solar and wind power, biofuel, and natural gas. The company is therefore investing heavily in Fuel Cell Vehicles powered by hydrogen.

## **HOW CAN A FUEL CELL VEHICLE CONTRIBUTE TO A BETTER ENVIRONMENT?**

A Fuel Cell Vehicle runs on hydrogen instead of gasoline or diesel. To be more specific, it runs on a motor powered by electricity generated by a chemical reaction between hydrogen and oxygen in a fuel cell. The only by-product of a Fuel Cell Vehicle in operation is water vapour. It does not emit any harmful substances such as CO<sub>2</sub> (a major cause of global warming), or SO<sub>2</sub> and NO<sub>x</sub> (causes of atmospheric pollution). In addition to producing zero emissions when driven, Fuel Cell Vehicles are also highly practical. They have an ample cruising range and can be refuelled very quickly.

# **ENERGY DIVERSIFICATION IS A BROAD FIELD, AND TOYOTA HAS BEEN WORKING FOR DECADES TO DIVERSIFY THE USE OF AUTOMOBILE FUELS AND POWERTRAINS**

Because of their simultaneous achievement of zero emissions and high practicality, Toyota positions Fuel Cell Vehicles as the ideal eco-cars.

### **POPULARISING FUEL CELL VEHICLES TO PIONEER A HYDROGEN ENERGY SOCIETY**

Fuel Cell Vehicles (FCVs) are highly energy efficient, have ample driving ranges with short refuelling times and only discharge water when driven. They are an environmental technology with great potential, truly worthy of being called the “ideal eco-car.”

Toyota has been working on the development of the FCV for three decades. While global attention is just beginning to turn towards the creation of a hydrogen-energy based society, Toyota’s journey dates back to 1992 when it first started development of Fuel Cell (FC) technology. The core technologies (the FC stack and hydrogen tanks) were both independently developed, and over time these development and manufacturing technologies became strong points for Toyota. Now, after developing and fine-tuning the necessary technologies, Toyota is bringing its first FCV to market. It’s called the Mirai, which is a Japanese word meaning “future”.



# INTRODUCING TOYOTA'S FIRST FUEL CELL VEHICLE: THE MIRAI

- 
- Toyota is bringing innovation greater than that of the first-generation Prius to market
-



The Mirai is a core component of Toyota's dream for a sustainable mobility society. This is one that allows us all to move freely in comfort and safety in an environmentally friendly, sustainable manner.

With a focus on the next 100 years of automobiles, Toyota has proceeded with the development of a vehicle that offers a new, unique value. The Mirai is a pioneering vehicle that will contribute to a Hydrogen Energy Society. In addition to its superior fuel cell technology and environmental performance, the Mirai is fun to drive, has a futuristic design that clearly marks it as an FCV, and offers a quiet and comfortable ride.



In order for green technology to contribute to the environment, the technology needs to become widespread. Toyota has already taken the initiative in popularising Hybrid Vehicles (HVs). With the Mirai, Toyota is bringing innovation greater than that of the first-generation Prius to market, and will do all it can to popularise the Mirai and the associated FCV technology.

As to who will buy the Mirai, it will be particularly attractive to business leaders aiming to personally start an "energy revolution" to change the world. In other words, pioneers who will create a revolution affecting the world for the next century. These could be individuals who place great importance on environmental performance and the necessity of FCVs; high-income innovators who admire advanced technology and originality; and of course automobile-fans.

Organisations interested in the Mirai could be public companies wanting to do their part for the environment, and public agencies/local governments keen to promote low-carbon technology.

**THE MIRAI IS A CORE  
COMPONENT OF TOYOTA'S  
DREAM FOR A SUSTAINABLE  
MOBILITY SOCIETY**

## SPECIFICATIONS

### FUEL CELL STACK

Model code	FCA110
Type	Polymer electrolyte
Number of cells	370
Connection method	Series
Max output (kW/DIN hp)	114/155

### BATTERY

Type	Nickel-metal hydride
Number of battery cells	34
Nominal voltage (V)	244
Capacity (Ah)	6,5
Connection method	Series

### MOTOR GENERATOR

Motor model code	4JM
Type	Permanent magnet synchronous motor
Max. power (kW/DIN hp)	113/154
Max. torque (Nm)	335

### DRIVE TRAIN

Layout	Front wheel drive
Transmission gear ratio	1.000: 1
Reduction gear ratio (final drive)	3.478: 1

### CHASSIS

Front suspension	MacPherson strut
Stabiliser bar	yes
Rear suspension	Torsion bar
Stabiliser bar	no
Steering	
Type	Rack&pignon
Power steering type	Electric
Overall ratio	14.8: 1
Lock to lock	2.81
Min. turning circle (body) (m)	11.4
Brakes	
Front	Ventilated disc
Rear	Solid disc
Tyres and wheels	
Wheels	17x7 J
Tyres	215/55 R17 94W

### PERFORMANCE

Max speed (km/h)	178
Acc 0 - 100 km/h (sec)	9.6

### FUEL CONSUMPTION (NEDC)

Urban (kg/100 km)	0.69
Extra-urban (kg/100 km)	0.8
Combined (kg/100 km)	0.76
Fuel tank capacity (kg)	approx 5.0

### WEIGHT (kg)

Curb weight	1,850
Gross weight	2,180

### AERODYNAMIC

Cd (Drag coefficient)	0.29
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### EXTERIOR DIMENSIONS (mm)

Overall length	4,890
Overall width	1,815
Overall height	1,535
Wheelbase	2,780
Tread front	1,535
Tread rear	1,545
Front overhang	1,080
Rear overhang	1,030
Ground clearance	130

### CARGO

Capacity (dm <sup>3</sup> VDA)	361
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### INTERIOR DIMENSIONS (mm)

Length	2,040
Width	1,465
Height	1,185

# MEDIA ASSETS

## TOYOTA MIRAI

### USB Contents:

- Full Mirai Press Kit
  - Word-, and PDF-files
  - Images Hi-res and Lo-res .jpg
  - Quicktime movies
- 

### For editorial use only.

The usage of this USB is strictly limited to editorial use. It shall not be used for any other purpose, not shall it be made available to any third party, without the prior written consent of Toyota Motor Europe NV/SA, Avenue du Bourget, B-1140 Brussels, Belgium.

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### Additional on-site material

<https://bit.ly/2nQ1Zwu>



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