EXECUTIVE SUMMARY

A significant opportunity exists for Aberdeen to become a leading European region in the early deployment of hydrogen fuel cell vehicles, as well as becoming the hub for hydrogen technologies in Scotland. Today, Aberdeen City Council (ACC) has already made significant efforts to engage with hydrogen technology: today the city boasts Europe’s largest fuel cell bus fleet and Scotland’s first facility for hydrogen production via water electrolysis. The launch of the Strategy Framework “A Hydrogen Economy for Aberdeen City Region” in 2013 reflects Aberdeen’s ambitions in the sector.

The hydrogen refuelling infrastructure in the City has the capability to cope with a considerable expansion of the existing fleet of hydrogen vehicles. Given the significant investment in vehicles and infrastructure, as well as the need to allow the investments to prove themselves, the time is now right to focus initially on nurturing other non-Council end-users to adopt the technology whilst ensuring that renewed investment is available in the medium-term (2018) to fund additional bus and hydrogen refuelling station (HRS) deployments.

Hydrogen vehicle technology is commercialising rapidly, however there remain considerable uncertainties in the rate at which the technology will mature. A hydrogen vehicle strategy for ACC has been developed which secures and increases demand on existing infrastructure in a measured fashion, whilst managing the financial exposure for the Council (by relying primarily on external sources of funding) and allowing the pace of the intervention to be dictated by the rate of increase in confidence in the technology.

An infrastructure strategy has also been developed, which envisages an expansion of the existing network in line with and contingent on a growing regional hydrogen demand. Once sufficient confidence has been established from both bringing vehicles to market and end-users adopting vehicles, the timely deployment of refuelling stations with sufficient dispensing capacity can be economical. This is only justified with demand towards 100’s of kg per day per station (equivalent to >500 cars or 15 buses serviced by a single refuelling station). This suggests that any early investment in stations can see returns when viewed over a long enough time horizon.

Consultation with regional fleet operators supported an assessment of the regional appetite for adopting hydrogen vehicles and willingness to pay. Based on this and associated ownership costs, a technology uptake scenario was developed, estimating 94 hydrogen vehicles deployed by 2020.

The aim of this strategy is therefore to maintain and build on Aberdeen’s existing lead in order to achieve the long-term goals associated with hydrogen rollout and being the leading hub in Scotland. This strategy and action plan outlines how these aims can be achieved in the short, medium and long term, in order to cement Aberdeen’s position and achieve the overall aims of the Strategy Framework - grounded by rational analysis of the opportunities available. Overall this strategy looks to secure investment for further vehicle deployments initially, followed by new infrastructure investment from 2018 when capacity will be maximised.

The action plan identifies a series of measures required to achieve this, across seven key objectives:

1. Vehicle Deployments A range of local stakeholders deploy hydrogen vehicles.
2. Renewable Hydrogen Hydrogen produced from renewable energy sources is widespread throughout the region.
3. Refuelling Infrastructure An accessible, convenient and safe refuelling infrastructure network is deployed across the City and beyond.
4. Non-Transport Applications Non-transport applications are trialled and tested including stationary power.
5. Supply Chain / Market Development A robust, local hydrogen supply chain is developed which utilises the areas existing energy expertise.
6. Communication & Education A greater understanding and acceptance of hydrogen technologies encourages widespread adoption.
7. Policy & Regulation Hydrogen technologies are embedded in all relevant areas of policy and supported at a national level.
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Promote vehicle deployments by a range of stakeholders in the region;

Objective 2: 
Expand Production and distribution of renewable hydrogen;

Objective 3: 
Develop hydrogen refuelling infrastructure;

Objective 4: 
Explore the roll-out of other tried and tested or innovative hydrogen uses;

Objective 5: 
Encourage the development of the hydrogen economy’s supply chain, seeking opportunities for the region’s existing energy expertise to diversify and benefit from this growing industry;

Objective 6: 
Promote a greater understanding and acceptance of hydrogen technologies through communication and education activities;

Objective 7: 
Ensure strategy and policy development at all levels of government are supportive of hydrogen technologies.

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FOREWORD

Aberdeen has a long history of innovation and expertise in energy technology - from the early industries like paper and textiles, powered by hydro, through to being at the centre of a global energy industry in oil and gas over the past four decades, and now also developing a low carbon economy in line with ambitious national targets.

The City Council recognises that hydrogen can support these targets, and has a vision for Aberdeen City Region in 2020 being a world-class energy hub leading a low carbon economy and at the forefront of hydrogen technology in Europe.

The Council sees opportunities for hydrogen to support economic growth in the region through inward investment, business development and job creation. We see that hydrogen presents a chance to diversify the existing energy industry in the longer term, create a local supply chain and add a long term demand for the transferable skills the city has in oil and gas as many of the components in hydrogen technologies are the same or similar to those used in the oil and gas sector.

We want to reinforce our place as the energy city, and be a leader in a low-carbon economy - the Council has created a variety of transnational partnerships, just as the city’s global energy sector also does and we recognise the importance of collaboration and co-operation in succeeding in innovation and in emerging sectors.

The region has tremendous capacity for renewable energy generation, but is constrained by energy storage issues and grid capacity - a key reason for our interest in hydrogen.

The opportunity to lead Europe’s biggest fuel cell bus demonstration project was really where we started, but at the same time we recognised a strategic approach was needed. Therefore we have been working with Element Energy on developing this detailed strategy to steer our priorities over the next ten years, along with a modelling tool to help us strike the right balance between infrastructure and vehicles.

We’re proud of the strong global and local partnerships that have developed as part of our hydrogen projects and see this collaboration as a key to our continuing success.

Aberdeen City Council sees a crucial role for itself as a facilitator and early adopter of hydrogen technologies, but in leading the way we now need others to follow on and get involved in the sector.

Councillor Jenny Laing, Council Leader

Angela Scott, Chief Executive

ENDORSEMENTS

Gordon McIntosh, Director, Aberdeen City Council

“Aberdeen is an Energy City which has built itself around oil and gas over the last 40 years. Today the City exports its goods and services throughout the world and it is important to stay at the forefront of this from an economic development perspective. Hydrogen and fuel cells gives us another string to our bow and allows us to diversify our economy further. We have the key skills in the City that can take this industry forward.

Energy is important to Aberdeen; renewable energy will be a key part of our future.”

Ben Madden, Director, Element Energy

“Aberdeen City Council’s targeted investments in hydrogen transport have led to significant new private sector investment and European funding for the region. ACC’s support so far and the projects that have been initiated have been very successful in putting Aberdeen on the map as one of the leading early European deployment hubs for hydrogen transport-related activities. The refuelling and support infrastructure, as well as the fleets deployed to date, have created the conditions required for expansion of the non-Council vehicle fleet as well as new private investment in hydrogen production and fuelling capacities.”

Nigel Holmes, CEO Scottish Hydrogen & Fuel Cell Association

“Hydrogen and Fuel Cell technologies can make a unique contribution towards delivering Scotland’s low carbon and renewables ambitions. Low carbon technologies will improve resource efficiency, support new low carbon business models, and deliver productivity and growth.

This Action Plan will help to develop the market sectors where Hydrogen and / or Fuel cells are likely to make significant contributions include efficient decentralised stationary power, sustainable transport applications, and energy storage and energy balancing applications linked to increased renewable energy deployment.

Scotland offers compelling and distinctive advantages, and this Action Plan will be a key factor in helping the ‘Energy City’ of Aberdeen to be a successful player not just in the oil and gas sector, but also in emerging global large scale Hydrogen and Fuel Cell markets.”
PART 1 - ABERDEEN’S ROLE IN A HYDROGEN ECONOMY

Introduction

In 2013 Aberdeen City Council launched the 2020 Strategy Framework “A Hydrogen Economy for Aberdeen City Region” which outlined a vision and high level actions for the City to achieve a hydrogen economy.

This strategy builds on the framework, providing a detailed action plan to help realise the vision to be “a world-class energy hub leading a low carbon economy and at the forefront of hydrogen technology in Europe”.

In July 2014, the Council commissioned Element Energy to undertake detailed analysis and stakeholder engagement to underpin the next phases of development. During the strategy development phase, a range of local fleet operators and key stakeholders were contacted in order to understand potential hydrogen vehicle demand in the region.

Why Hydrogen?

Hydrogen is the world’s simplest, lightest and most abundant element. Very little of it is in a freely available form on Earth however, where most hydrogen is in the form of compounds like water and hydrocarbons such as fossil fuels.

Scotland and the north east has a long history of producing and using hydrogen in the energy industry. It is mainly produced industrially through steam reforming of natural gas and used for processing crude oil into refined fuels such as petrol and diesel, as well as in producing fertilizer, treating metals, welding and processing foods.

Hydrogen is also produced from electrolysis of water. This involves running an electric current through water in an electrolyser to split the water (H2O) into hydrogen (H2) and oxygen (O2). By using electricity from renewable sources in this process, the hydrogen can be produced with very low carbon emissions.

The hydrogen acts as an energy storage medium, being compressed and stored until it is needed for use. This can be used in a fuel cell in vehicles, generators or in principle, anything that uses, including being converted back to electricity through a fuel cell in vehicles, generators or in principle, anything that uses, including being converted back to electricity through a fuel cell.

When the electricity that is generated from intermittent renewables such as wind is used to produce hydrogen, then it can have the effect of taking the energy that cannot be fed into the electricity grid and storing it for use as required. This helps to balance supply and demand for renewable electricity and ensuring renewable energy plays a bigger part in a low carbon future.

Policy Drivers

Advancing the adoption of hydrogen technologies is supported throughout Government policy. Whilst there is no specific hydrogen strategy for the UK or Scotland as yet, there are ambitious policies to reduce green house gas emissions, increase the proportion of energy coming from low carbon sources and increase security of energy supply. In addition, the desire to decarbonise transport is also based on a variety of legally binding environmental drivers including:

- EU legislation which seeks to limit emissions from new vehicles, for example fleet average emissions of 95gCO2/km by 2021 for new cars;
- Both UK and Scottish Governments have stated an ambition for mass market transition to ultra low emission vehicles, an approach consistent with the commitment to reduce cross-sector greenhouse gas emissions by 42% by 2020 and 80% by 2050 (relative to 1990 levels);

Switched On Scotland: A Roadmap to Widespread Adoption of Plug-in Vehicles, Transport Scotland, 2013

In addition to the clear environmental benefits, the decarbonisation of the transport sector offers a range of benefits, which are in themselves strong drivers for deploying low carbon transport technologies, including:

- Energy security: through reduced demand for fossil fuels, reliance on foreign oil imports is reduced; thereby reducing the geo-political risks associated with often unpredictable parts of the world; European Energy Security Strategy, Energy Act 2013 (UK)
- Long-term affordability: by reducing oil imports to fuel the transport sector, significant improvements to the balance of payments can be achieved – this is particularly relevant for alternative fuels produced locally, e.g. renewable electricity, hydrogen and certain biofuels; Energy Act 2013
- Expansion of renewables capacity: widespread deployment of alternative fuelled vehicles that use electricity as their main feedstock (e.g. electric vehicles, hydrogen vehicles) creates significant additional demand on the electricity grid, thereby enabling the deployment of additional renewables capacity - a key policy goal for Scotland; European 2020 targets, Climate Change Act (2008)
- Energy storage: Scotland’s renewable energy targets include 100% electricity demand equivalent from renewables by 2020 of intermittent renewable electricity generators to the grid (e.g. wind), unpredictable production patterns can lead to severe grid balancing issues in supplying electricity at times of low demand, or an inability to supply sufficient electricity at times of high demand. Low carbon transport technologies such as batteries and hydrogen are able to contribute towards grid balancing through offering options for energy storage at times of low demand, and re-generation at times of high demand.

Air Quality: significant local and national air quality benefits can be derived from the deployment of low carbon vehicles offering zero emissions, reducing harmful pollutants such as nitrogen oxides (NOx) and particulate matter (PM10).

There are three air quality management areas (AQMAs) in Aberdeen: the City Centre, Wellington Road between Queen Elizabeth II roundabout and Balnagask Road and the Anderson Drive/Haudagain/Auchill Road corridor. The AQMAs were declared due to exceedances of national air quality objectives for nitrogen dioxide (NO2) and particles (PM10). The EU NO2 objective is also exceeded and the UK government is at risk of substantial EU infringement fines should air quality not improve. High levels of both PM10 and NO2 are associated with impacts on the respiratory and cardiovascular systems of vulnerable people and increased hospital admissions. Every year an estimated 29,000 people die early in the UK as a result of poor air quality.

An Air Quality Strategy for Scotland will be introduced by the Scottish Government in 2015 detailing the Scottish Government’s approach to improving air quality. Additional duties will be placed on local authorities to implement measures to reduce emissions. The national Air Quality Strategy will not be limited to emissions directly impacting on health, but will also include transport, climate change, energy and planning development measures to reduce congestion, improve traffic flow and create urban areas that are more pleasant spaces to move around and spend time in.

The requirements of the Air Quality Strategy will therefore support the deployment of hydrogen technologies; EU Clean Air Policy Package, National Air Quality Strategy (UK), Local Air Quality Management Areas.
Hydrogen transport has the ability to touch on all of these policy issues, as well as others and as a result this strategy mainly focuses on the transport applications for hydrogen as an energy vector however hydrogen is a versatile energy carrier which can interlink a range of energy sources and uses as shown in Figure 1.

In 2010, the McKinsey report “The Power-trains for Europe” highlighted hydrogen fuel cell vehicles as a unique low carbon transport option offering long range, quick refuelling and zero exhaust emissions. The study, which was backed by leading vehicle manufacturers, energy companies and industrial gas suppliers, provided a fact base for decision making on investment in hydrogen fuel cell, battery electric and hybrid electric vehicles.

The report identified hydrogen fuel cell electric vehicles (FCEVs) as the only viable pathway to achieving low carbon transport for longer range, larger vehicles. Thus vehicle manufacturers have invested heavily in developing FCEVs and today a number of manufacturers are looking to commercialise their technologies, which is seen as one of the first sectors to reach commercial maturity. As part of this, many manufacturers are seeking early launch markets. An opportunity is therefore presented for early adopter regions to attract early deployments through supportive local policies and building out the infrastructure assets required - thereby helping to unlock the long-term regional benefits.

The report identified hydrogen fuel cell electric vehicles (FCEVs) as the only viable pathway to achieving low carbon transport for longer range, larger vehicles. Thus vehicle manufacturers have invested heavily in developing FCEVs and today a number of manufacturers are looking to commercialise their technologies, which is seen as one of the first sectors to reach commercial maturity. As part of this, many manufacturers are seeking early launch markets. An opportunity is therefore presented for early adopter regions to attract early deployments through supportive local policies and building out the infrastructure assets required - thereby helping to unlock the long-term regional benefits.

### Key Characteristics of Battery and Fuel Cell Electric Vehicles

<table>
<thead>
<tr>
<th>Battery electric vehicles (BEVs)</th>
<th>Fuel cell vehicles (FCEVs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Existing recharging infrastructure largely in place (electricity grid)</td>
<td>• Limited range based on existing battery technology</td>
</tr>
<tr>
<td>• Well suited to smaller vehicles and shorter trips</td>
<td>• Long recharge times (6-8 hours standard (c.3kW), c. 30 minutes fast charge (c.50kW))</td>
</tr>
<tr>
<td>• High grid-to-wheel efficiency, low p/km fuel costs</td>
<td>• Generally require off-street parking for home recharging</td>
</tr>
<tr>
<td></td>
<td>• Need national network of refuelling stations</td>
</tr>
</tbody>
</table>

Other technical solutions for example plug in hybrid electric vehicles and biofuels are expected to feature in the transition to zero emission transport. However, their role in the long term is likely to be limited due to the requirement for a fully decarbonised transport sector.

In the long term zero emission transport will require a combination of both BEVs and FCEVs, two technologies with distinct characteristics. The key advantages and disadvantages are summarised in Table 1.
Numerous global initiatives are underway to support hydrogen technology with the main developments occurring in the USA (in particular California), Germany, Japan, the UK and China.

Through a number of public-private partnerships, Governments are working together with industry to establish the rollout scenarios and funding pathways required for widespread deployment of these technologies. These programmes include Hi: Mobility in Germany, UK Hi: Mobility in the UK, H2USA and Hi: Mobility France. Figure 3 shows an overview of some of the Hi: Mobility programmes currently underway.

Figure 3: Overview of Hi: Mobility Programmes underway in Europe

### Likely implementation of the network by 2020 (>80 kg/day stations)

<table>
<thead>
<tr>
<th>Country</th>
<th>Programmes</th>
<th>Number of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scandinavia</td>
<td>The Scandinavian network will have deployed 35 - 40 hydrogen refuelling station (HRS) by 2020</td>
<td>up to 50</td>
</tr>
<tr>
<td>UK</td>
<td>The UK will have deployed 60 - 70 hydrogen refuelling station (HRS) by 2020</td>
<td>60 - 70</td>
</tr>
<tr>
<td>Germany</td>
<td>The German network will have deployed over 100 hydrogen refuelling stations (HRS) by 2020</td>
<td>over 100</td>
</tr>
<tr>
<td>France</td>
<td>The French network will have deployed up to 50 hydrogen refuelling station (HRS) by 2020</td>
<td>up to 50</td>
</tr>
</tbody>
</table>

**Key:**
- Major Roads covered by HRS
- TEN-T Corridors
- TEN-T Corridors linked by early HRS
- TEN-T is a European transport infrastructure initiative to connect the continent between East and West, North and South by building a network of transport corridors.

National Hydrogen Developments

The UK H2 Mobility project is a partnership of UK industry leaders and Government, working to develop a rollout strategy for FCEVs and supporting infrastructure in the UK from 2015. The analysis and network modelling undertaken within the project indicated that 65 stations across the UK could provide sufficient initial coverage to start the market, covering major population centres (with more than one HRS) and connecting roads.

**A UK infrastructure rollout plan has been defined from 2015**

A nationwide infrastructure network has been mapped out, based on population, income and traffic densities.

Early rollout phase of 65 stations to cover the major UK urban centres and intercity driving by 2020.

- **2015-2020:** Seedling of Tier 1 regions* – major cities and connecting roads
- Initial seeding in major population centres

- **2020-2025:** Coverage extended to Tier 2 and all major roads
- Extend coverage to enable close-to-Home refuelling to 50% of the population and long distance travel.

Figure 4: UK H2 Mobility planned roll out
H2 ABERDEEN - A STRATEGIC HYDROGEN PROGRAMME

Under H2 Aberdeen, the Council’s strategic hydrogen programme, a series of targeted investments are being made to secure a position as a leading deployment centre for hydrogen technologies.

Aberdeen City Council’s (ACC) 2020 Strategy Framework “A hydrogen Economy for Aberdeen City Region” frames the city’s ambitions to become a high-profile, world-class energy hub across multiple energy vectors, leading to a low carbon economy and to be at the forefront of hydrogen technology in Europe.

Aberdeen has to date initiated three major hydrogen-related deployment projects, including:

1. Europe’s largest hydrogen fuel cell electric bus (FCEB) deployment project, with 10 buses deployed, supported by a large hydrogen refuelling station (HRS) and a dedicated maintenance facility within the city centre;
2. Deployments of two H2 - ICE dual-fuel hydrogen/diesel Transit vans and two fuel cell range extended electric light commercial vans;
3. The planned deployment of a second publically accessible hydrogen refuelling station to support further hydrogen vehicle deployments to the city.

In addition, Aberdeen City Council is taking a leading role in:

The Scottish Cities Alliance (SCA) Hydrogen Action Group which has to date delivered the SCA Hydrogen Economy Strategy. This strategy recommends four strands of work that the seven Scottish Cities should focus on. These include:

1. Large scale fuel cell electric bus deployment;
2. Hydrogen refuelling infrastructure development;
3. Fuel cell electric vehicle deployment to Council fleet;
4. Renewables based “green” hydrogen production.

In mid-2014 a Scottish Cities Alliance Project Officer was recruited (hosted by ACC) to take forward the four strands of the strategy primarily concentrating on the coordination of a large scale fuel cell electric bus project which will see 500-1000 buses introduced across Europe. This will involve developing a Scotland wide business case in partnership with the Fuel Cell and Hydrogen Joint Undertaking (FCHJU) as part of the Europe-wide FCHJU Fuel Cell Bus Commercialisation Project.

The Council is also investigating the public perceptions of hydrogen through the Hyacinth (Hydrogen Acceptance in the Transition Phase) project funded by the FCHJU. This project aims to understand public attitudes and perceptions and levels of acceptance of hydrogen technologies in various EU countries.

CASE STUDIES - HYDROGEN VEHICLES IN ABERDEEN

Aberdeen Hydrogen Bus Project

The Aberdeen hydrogen bus project has seen key industry and public sector players join forces to fund and deliver Europe’s largest demonstration of hydrogen fuel cell buses in Aberdeen, realising an aspiration to become a leading city for low carbon technology.

The £19 million project deploys ten fuel cell buses on operational routes throughout the City. These buses emit only water vapour, reducing carbon emissions and air pollution, as well as being quieter to run. The project is part-funded by Europe under the FP7 innovation funding as well as contributions from UK Government, Scottish Government, Innovate UK, SSE, SDN, Scottish Enterprise, First, Stagecoach and Aberdeen City Council.

To fuel the vehicles a state of the art hydrogen production and re-fuelling station has been built producing high purity, low carbon hydrogen onsite via electrolysis. Using an electrolyser means hydrogen can be produced from electricity and water, onsite with no local emissions. No transport is required; the hydrogen is produced and dispersed at the same site. The next phase of the project will look to produce the electricity from renewable sources (making the entire process ultra-low emissions) but to start with grid electricity on a green tariff will be used. The re-fuelling station provided by BOC Linde Group is situated in the centre of the city at Aberdeen City Council’s Kittybrewster depot.

In addition a hydrogen safe maintenance area is being integrated into the working maintenance facility onsite at Kittybrewster which will allow the buses to be serviced, maintained and re-fuelled on the same site.

Hydrogen Fuel Cell Buses

- Ten low floor, 13m fuel cell hybrid (hydrogen fuel cell and battery) buses made by Van Hool
- Buses will be operated in the City Centre by both First and Stagecoach
- Ballard 150 kilowatt FCvelocity®-HD6 fuel cell module - warranted 15,000 hours
- Siemens electric motors
- Regenerative breaking system
- 10 hydrogen tanks containing a total of 40kg pure electrolytic hydrogen (gas) at 350bar
- Range of up to 260miles (420km) under typical urban transit cycle and loads.

Hydrogen Refuelling Station

- Hydrogen generated onsite by three electrolysers capable of producing 360kg of hydrogen per day;
- Will meet the demands of the ten buses;
- Ability to refuel a bus in ten minutes.

Ed Davey, Secretary of State for Energy and Climate Change launching Aberdeen’s Hydrogen Strategy Framework, May 2013

Hydrogen Hybrid Vans - a bridging technology

In June 2014, Aberdeen City Council added two new hydrogen vehicles to the fleet as part of the HyTrEc project (Hydrogen Transport Economy in the North Sea Region). Two Ford Transit vans, customised with ULEMCo’s H2ICED conversion technology, run on a hydrogen-diesel dual fuel blend. ULEMCo, a subsidiary of Revolve Technologies has developed an innovative process for modifying a regular diesel engine to use compressed hydrogen gas as the main fuel with small quantities of diesel as the ignition catalyst. Whilst internal combustion engines are less efficient than fuel cells (burning the hydrogen rather than using it in a chemical process) these hybrid conversions are a cheaper alternative to fuel cell vehicles at present and therefore act as a bridging technology.

A range of operational data is being collected for example fuel consumption, routes driven and location which will be used to analyse vehicle performance and will aid the development of the next generation of the technology. These vehicles are also being trialled in Swindon & London.

Benefits over conventional-fuelled vehicles:
- Improved environmental performance with a 70% reduction in carbon dioxide emissions and a 40% reduction in nitrogen oxide emissions;
- Promotes renewable energies (if H₂ from a renewable source);
- Improves corporate social responsibility for fleet operators;
- Attracts business benefits from lower road and fuel taxes;
- A lower emission vehicle solution with only water emitted from the exhaust.

Plug-in Hybrid Fuel Cell Electric Vans

Two plug-in hybrid fuel cell electric vans have been added to the Council’s operational fleet as part of the HyTrEc project (Hydrogen Transport Economy in the North Sea Region). Two electric Renault Kangoo Maxi Z.E. vans have been converted by SymbioFCell to include a hydrogen fuel cell range extender which doubles the original vehicle’s driving range with only water emitted from the exhaust.

Benefits:
- Improved environmental performance without a reduction in payload;
- A lower emission vehicle solution with only water emitted from the exhaust;
- Double the driving range compared to the Kangoo Z.E. (electric only);
- Promotes renewable energies (if electricity and H₂ from a renewable source);
- Improves corporate social responsibility for fleet operators;
- Attracts business benefits from lower road and fuel taxes;
- Familiar driving and operating characteristics;

Engine and Fuel System features:
- Dual-fuel selection switch (H₂/Diesel);
- There are 3 operating modes using different concentrations of hydrogen and diesel;
- The engine will always initially start on diesel fuel. It will then automatically switch to H₂ if pre-selected, once the engine reaches normal operating temperature (after approx. 2 miles);
- Compressed hydrogen with electronic fuel injection;
- 350 bar refuelling pressure;
- Familiar driving and operating characteristics;

Hydrogen Tanks:
- Manufactured by Dynetek Industries Ltd;
- 2 or 3 x 74 litre carbon-fibre reinforced H₂ storage tanks mounted underneath the vehicle;
- 3.6-5.4 kg of hydrogen fuel giving a total driving range of over 300km;
- H₂ tanks are subjected to the following tests: pendulum impact, drop test, bottle test, armour piercing bullet penetration, extreme temperature cycling and environmental fluids exposure;

Safety Features:
- Side impact-absorbing framework around hydrogen tanks;
- Leak Detection - the vehicle is fitted with a safety leak alarm which will monitor hydrogen pressure;
- Hydrogen tanks located underneath vehicle allowing gas to escape quickly and efficiently in the unlikely event of a leak;
- No design or structural changes have been made nor any safety features changed to seat-belt systems, airbags, braking system, or locking systems.

Engine and Fuel System features:
- Fuel cell produces heat as well as electricity; heat delivered through water at 80°C is used to heat the vehicle cabin in winter, without inducing extra power consumption (combined heat and power). The fuel cell produces heat as well as electricity;
- With the range extender kit, battery lifetime is increased. Increased driving range reduces the frequency of deep battery discharge which degrades the battery;
- The range extender kit can be dismantled and re-mounted in a new vehicle.

Safety Features:
- The fuel cell system is fixed to the vehicle chassis;
- Hydrogen tanks are positioned in the middle of the car.
- Tanks are EC 79 validated and resistant up to 2.5 times their working pressure;
- Hydrogen sensors detect any potential leak. The fuel cell can be disconnected from the rest of the system and can discharge in less than two seconds for optimal security.

Hydrogen Tanks:
- 74 litre hydrogen tank with 15 year service lifetime;
- 350 bar pressure;
- 1.8 kg H₂ per 360 km (NEDC) equivalent to 0.5 kg H₂ / 100 km;
- Refuelling time is less than 3 minutes;
PART 2 - THE STRATEGY

Vision, Aims and Objectives

The Aberdeen City Region Hydrogen Strategy will focus on promoting hydrogen technologies as a low carbon alternative to fossil fuels and as an energy vector to facilitate the deployment of renewable energy sources. Hydrogen has a number of different applications such as transport, stationary power and as an energy storage medium. The main focus will be on transport applications however other uses will be considered within this strategy.

The aim of this strategy is therefore:
To reinforce our place, now and in the future as the energy city by further enhancing the region’s economic competitiveness, maximising the capacity and value of renewable energy and giving greater energy security by being at the forefront of a hydrogen economy.

To achieve this, the objectives of the strategy are to:

Objective 1:
Promote vehicle deployments by a range of stakeholders in the region;

Objective 2:
Expand production and distribution of renewable hydrogen;

Objective 3:
Develop hydrogen refuelling infrastructure;

Objective 4:
Explore the roll-out of other tried and tested or innovative hydrogen uses;

Objective 5:
Encourage the development of the hydrogen economy’s supply chain, seeking opportunities for the region’s existing energy expertise to diversify and benefit from this growing industry;

Objective 6:
Promote a greater understanding and acceptance of hydrogen technologies through communication and education activities;

Objective 7:
Ensure strategy and policy development at all levels of government are supportive of hydrogen technologies.

To assist in meeting the aim and associated objectives, a number of actions have been developed for each objective. The action plan is outlined in Part 3.
Production pathways have been assessed as potential sources

Many processes in the chemical industry
Bacteria used to convert biodegradable waste into biogas (CH4 and CO2)

Bacteria can be combusted for electricity generation, or purified to give H2

Significant grid-constrained renewables

Currently no active projects in the region

New waste processing plant coming online c. 2020

Methane reformation
Water electrolysis (WE)
Municipal solid waste gasification
Water gas shift (WGS) reaction

CH4 + H2O → CO + 3H2
2H2O ↔ 2H2 + O2
Methane reformation to produce syngas and subsequently H2 following the WGS reaction is the most common H2 production pathway
We systems split water into H2 and O2. Cheap electricity can be sourced from local renewable generators
Plasma reactors used to convert non-recyclable landfill waste into syngas which is treated for impurities

Syngas can be combusted for electricity generation, or purified to give H2

No large centralised SMR production nearby

Peterhead CCS CO2 pipeline could facilitate a new ‘green’ SMR H2 production facility

Significant grid-constrained renewables

OM 2: Expand production and distribution of renewable hydrogen

Overview of locally available production pathways
Five hydrogen production pathways (see figure B) have been assessed as potential sources to supply any new hydrogen refuelling station in Aberdeen, with four out of the five options being considered as green hydrogen i.e. coming from a renewable energy source.

<table>
<thead>
<tr>
<th>Source</th>
<th>Chemistry</th>
<th>Description</th>
<th>Local availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam methane reforming</td>
<td>CH4 + H2O → CO + 3H2</td>
<td>Methane reformation to produce syngas and subsequently H2 following the WGS reaction is the most common H2 production pathway</td>
<td>No large centralised SMR production nearby</td>
</tr>
<tr>
<td>Renewable energy &amp; water electrolysis</td>
<td>2H2O ↔ 2H2 + O2</td>
<td>WE systems split water into H2 and O2. Cheap electricity can be sourced from local renewable generators</td>
<td>Significant grid-constrained renewables</td>
</tr>
<tr>
<td>Waste gasification</td>
<td>CH4 + H2O → CO + 3H2</td>
<td>Plasma reactors used to convert non-recyclable landfill waste into syngas which is treated for impurities</td>
<td>Currently no active projects in the region</td>
</tr>
<tr>
<td>Chemical plant by-product</td>
<td>Brine electrolysis</td>
<td>Many processes in the chemical industry produce H2 as a by-product</td>
<td></td>
</tr>
<tr>
<td>Anaerobic digestion (AD)</td>
<td>Overall Process CH4 + H2O ↔ CO + 3H2</td>
<td>Bacteria used to convert biodegradable waste into biogas (CH4 and CO2)</td>
<td>Small AD projects, inc. at AECC development due to come online in 2018</td>
</tr>
</tbody>
</table>

**FIGURE 5**: Technology uptake scenario for Aberdeen

**Actions:**

- **Extend operation of the 10 buses beyond 2018** as this provides the most cost-effective way of securing long-term demand for continued operation of Kittybrewster HRS;
- **Deploy a second HRS with 350 & 700 bar capability;** in order to attract early releases of passenger cars;
- **Secure additional hydrogen demand to ensure greater than 50% utilisation of the second hydrogen refuelling station;** extending operation of the existing 10 buses beyond 2018 does not create a large enough hydrogen demand to justify deployment of a second hydrogen refuelling station pre-2020;
- **Deploy more H2 buses in the near term** as this is the most cost-effective way to create demand, ideally supplemented by captive fleets of vehicles from non-OEM manufacturers, both of which have large, predictable fuel requirements and demonstrate the principle of the technology in new areas. In the long-term, the major source of demand is expected to come from private sales of passenger cars and vans. The pace of this rollout is dictated by OEM behaviour (and customer acceptance) and cannot be influenced by the Council;
- **Seek external funding/subsidy to support the rollout of significant numbers of additional hydrogen vehicles pre 2020.** All stakeholders conclude that achieving close to/better than total cost of ownership (TCO) parity is required for significant uptake;
- **Establish a hydrogen stakeholder group** to bring together interested end users and help facilitate further vehicle roll outs.

**FIGURE 6**: Overview of five possible hydrogen production methods for Aberdeen.
Short-term production options analysis (2015-2018)

From 2015-2018 water electrolysis is the only option considered for Aberdeen in the early years due to local availability, lower carbon emissions and its support of renewable energy deployment. Only a single source of Steam Methane Reformation based Hydrogen (with sufficient capacity and purity for transportation) exists in the UK (Cheshire) however, this is not considered green hydrogen unless it is coupled with carbon capture and storage plus costs of transportation via existing tube trailer technology is prohibitively expensive.

Water electrolyser utilisation is dependent on the availability of electricity from the grid or private wire connection and the economics are improved by maximising system utilisation. It is therefore important to consider the economics of sourcing a stable electricity supply from the grid compared to an intermittent, but potentially cheaper, electricity supply from constrained renewable generators in the region. Securing low cost electricity significantly impacts hydrogen production costs via water electrolysis therefore it is important for Aberdeen City Council to minimise exposure to high electricity prices.

Medium to long-term production options analysis (2018-2030 and beyond)

Three commercial technologies are available for the conversion of municipal solid waste into useful energy products - incineration, gasification-pyrolysis and anaerobic digestion (see Figure 7). These present a number of production opportunities for future investigation.

- In the long-term, waste gasification could produce up to 8 kilo tonnes per annum of hydrogen from municipal solid waste collected in Aberdeen and surrounding regions. Although the technology is commercially proven, the constant monitoring of heterogeneous waste input and complex gas stream production may act as a deterrent for adopting this over a simpler alternative for example incineration.

- Plans to deploy a 5 megawatt anaerobic digestion plant at the new Aberdeen Exhibition and Conference Centre could produce up to 0.3 kilo tonnes per annum of ‘green’ hydrogen. Methane from biogas could be supplied to a hydrogen refuelling station with on-site reformation equipment.

- Exxon Mobil own and operate a large ethylene cracking plant in Mossmorran, Fife which produces over 4,000 tonnes per annum of by-product Hydrogen that could be purified for Aberdeen once sufficient demand exists. The hydrogen is currently used to generate heat on-site but could be made available for other uses. Therefore even though it is produced from hydrocarbons using the by-product could render it as a ‘green’ source.

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incineration</td>
<td>Involves direct combustion of waste in presence of O₂ to produce heat or electricity</td>
<td>Heat or electricity</td>
</tr>
<tr>
<td></td>
<td>This is the most mature technology for extracting energy from waste but has no capability for H₂ production</td>
<td></td>
</tr>
<tr>
<td>Gasification/pyrolysis</td>
<td>Involves heating of pre-treated waste with limited O₂ (or no O₂ in the case of pyrolysis) to produce syngas for which requires purification or electricity generation via combustion on-site</td>
<td>Syngas (carbon monoxide and hydrogen)</td>
</tr>
<tr>
<td></td>
<td>H₂ can be extracted via the WGS reaction and subsequent PSA purification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;10 UK demonstration deployments of the technology on a medium-scale (30-140 ktpaMSW) and only Air Products’ two 350 ktpaMSW gasification plants in Teesside on a large-scale</td>
<td></td>
</tr>
<tr>
<td>Anaerobic digestion</td>
<td>Involves controlled biological breakdown of waste in the absence of O₂ to produce biogas (CH₄ + CO₂)</td>
<td>Biogas (carbon dioxide and methane)</td>
</tr>
<tr>
<td></td>
<td>Purification techniques can extract methane from the biogas for supply to an HRS with on-site reformation capabilities to produce H₂, or the H₂ can be extracted on-site</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7: Commercial technologies available for the conversion of municipal solid waste into useful energy products

Distribution mechanisms

Multiple hydrogen distribution mechanisms are available (see Figure 8) but only transportation by tube trailer is likely to be available in Aberdeen in the short-term. The economics of producing hydrogen onsite and delivering to hydrogen refuelling stations in Aberdeen e.g. through grid constrained renewable energy developments has been investigated. It is important to identify sufficient demand to load up the envisaged distribution system in order to make off-site production cost effective.

The optimum scenario would be if onsite, high load factor, “green” hydrogen sources are co-located with a hydrogen refuelling station near the city centre. However, if long-term contracts for very low-cost electricity can be secured at wind farms (at a much lower cost than is available in the city), this would suggest the principle of distributing Hydrogen across the city may be worth considering.

Hydrogen distribution via a pipeline has also been investigated. Installing a new hydrogen distribution pipeline in Aberdeen requires considerably larger demand than is forecasted to 2030 therefore this option would be considered as a long term option. However a point-to-point pipeline over a relatively short distance could be an attractive proposition for sufficient volumes of Hydrogen in the shorter term.
**Method** | **Description**
---|---
Gaseous H₂ via trucks | Compressed H₂ can be transported on road via tube trailers. Linde/BOC operate the largest tube trailer technology available with a capacity of 1.1 tonnes at 400 bar. Air Products recently deployed two state-of-the-art high pressure tube trailers with 0.8 tonne capacity at 500 bar under the HyTEC demonstration project. Two options are available upon arrival at destination: either the H₂ can be decanted from the trailer into storage or H₂ can remain in the trailer on-site from which the customer may extract as and when needed.

Gaseous H₂ via pipeline | The majority of UK’s domestically produced H₂ is consumed near its point of production and delivered via short pipeline networks, in industrial applications. While capital costs are high, operating costs and carbon emissions are significantly lower than for road transport.

Liquid H₂ via trucks | Liquefied H₂ can be transported on road via trucks supporting up to four times more H₂ than the largest tube trailer equivalents (up to 4 tonnes/delivery can be transported via a liquefied H₂ truck). Liquefaction plants require significant scale (40-200 tonnes/day) to be cost effective - no current UK network.

Metal hydrides | Demonstration technology, H₂ adsorbed onto magnesium hydride nanostructured composites. Provides 140% and 40% higher volume density than compressed or liquid storage respectively.

Liquid organic H₂ carriers | Demonstration technology, H₂ reversibly bonded to organic molecules easily transportable at ambient pressure and temperature. Very early stage technology, requires significant heat input to remove H₂ from carrier.

**Production economics**

Combining low cost electricity with high equipment load factors could provide attractively priced hydrogen production in the short to medium-term.

A trade-off needs to be made between the costs of production for on-site refuelling stations in convenient locations compared to the cost of production and distribution from remote electrolysers to more conveniently located refuelling stations.

**Actions:**

- Minimise exposure to high electricity prices; investigate opportunities for accessing lower electricity costs;
- Research best options for siting additional HRS whether at the point of production, or distributing to them from remote renewables-connected electrolysers; as each option will depend on the ability to establish a well-managed and cost-effective distribution system;
- Investigate options for point-to-point pipeline distribution over relatively small distances (e.g. < 5km) in the medium-long term but only as overall demand volumes ramp up (e.g. >1,000 kg/day);
- Explore alternative distribution mechanisms for example solid hydride and liquid; as these may provide an alternative opportunity for lower distribution costs in the medium term;

---

**OBJECTIVE 3:**

**Develop hydrogen refuelling infrastructure; Opportunities for economic optimisation of existing and planned infrastructure**

It is important to optimise the economics of any hydrogen refuelling station. Opportunities for optimising the economics include securing cheaper electricity and offering services to balance the grid which could provide up to 20% savings on production costs.

Current electricity price negotiated for Kittybrewster is a commercial rate, therefore there is reason to believe that a lower price could be achieved which could lower hydrogen production costs, making the economics more favourable. Other opportunities are outlined in Figure 9.

**Figure 8: Hydrogen Distribution Methods**

**Figure 9: Opportunities for lowering hydrogen production costs at Kittybrewster refuelling station**
Opportunities for Aberdeen City Hydrogen Energy Storage (Second refuelling station under development)

Opportunities for optimising the second refuelling station are less restricted due to the project being in its early stages therefore the following opportunities will be explored:

• Price optimisation strategies such as improving the Power Purchase Agreement and offering grid balancing services;
• Negotiate a lower electricity price prior to completing contractual agreements with the energy supplier;
• Low cost electricity sources within the City including excess combined heat and power (CHP) electricity, grid constrained rural wind generation and new solar generation projects.

Opportunities for economic optimisation of future infrastructure

For additional future hydrogen refuelling stations, larger refuelling stations offer better economics, if sufficient demand can be secured. Whilst smaller stations may reach higher loading in early years, larger stations will breakeven with lower relative utilisation rates due to economies of scale. In addition, hydrogen distribution costs will also be lower for delivery to fewer, larger stations.

Therefore, when planning the expansion of Aberdeen’s hydrogen refuelling network it is essential to consider the expected loading (demand throughput) in order to understand utilisation rates in relation to size.

In addition, when planning the future expansion of the network, we must look wider than the City boundary because for fuel cell vehicles to be deployed successfully, a Scotland wide refuelling network must be built. Therefore opportunities will be pursued to work with areas out with the City to expand the infrastructure network and encourage the take up of hydrogen technologies across Scotland.

### Actions:

**Existing Kittybrewster Hydrogen Refuelling Station**
- Develop an electricity price minimisation strategy, within the constraints of the grid supply agreement at Kittybrewster.
- Investigate opportunities to reduce hydrogen production costs through providing grid balancing services; accessing Short Term Operating Reserve (STOR).
- Upgrade station to dispense hydrogen at 350 and 700 bar by 2018.

**Planned second Hydrogen Refuelling Station**
- Secure long-term guaranteed low cost electricity; this is important to achieving attractive production costs;
- Investigate all opportunities for low cost electricity; for example from the planned solar PV array at the decommissioned Ness landfill site;
- Develop a price minimisation strategy;
- Investigate opportunities to reduce hydrogen production costs through providing grid balancing services; accessing STOR or other reserve-related revenues;

**Additional future Hydrogen Refuelling Stations**
- Pursue opportunities for securing low cost electricity;
- Investigate optimal hydrogen production/distribution model; the decision whether to produce hydrogen on-site or to have hydrogen delivered will be made based on the location and economics of new production sources identified and the costs of delivering hydrogen from more remote sources to the evolving hydrogen refuelling network;
- Investigate opportunities to reduce hydrogen production costs through providing grid balancing services; accessing STOR or other reserve-related revenues;
- Pursue opportunities to work with areas out with the City to expand the infrastructure network and encourage the take up of hydrogen technologies across Scotland.

### OBJECTIVE 4:

Explore the roll-out of other tried and tested or innovative hydrogen uses

Whilst this strategy primarily focuses on transport applications, other applications for hydrogen have been investigated including stationary power for buildings.

The use of fuel cells for combined heat and power (CHP) is an area of active interest worldwide and in particular for Aberdeen due to the City’s well established district heating system.

Fuel cells have a higher electrical efficiency than conventional thermal generators and hence have the potential to improve the economics of CHP systems. They also offer longer life, lower maintenance and less noise, as the electrochemical reactions have many fewer moving parts. Very few of these units use hydrogen directly. Instead they are fuelled by natural gas or biogas and so less relevant to the creation of a hydrogen demand in Aberdeen.

As with automotive technology, fuel cells for CHP are maturing and technology costs remain high for most applications. There are two main applications outlined in Figure 10.

<table>
<thead>
<tr>
<th>MicroCHP (0.5-10's of kW)</th>
<th>Large CHP (&gt;100kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A fuel cell for micro CHP would replace or supplement a boiler in a home or small commercial property</td>
<td>Larger fuel cells also have a potential application in conventional CHP. 100’s of units have been installed worldwide</td>
</tr>
<tr>
<td>Over 80,000 fuel cells have been installed for micro-CHP in Japan, where significant incentives boost uptake</td>
<td>Early market traction has been seen for a limited number of suppliers including Fuel Cell Energy, ClearEdge and Bloom Energy. Of these only Fuel Cell Energy offers units in the UK</td>
</tr>
<tr>
<td>Ene.field is the largest European demonstration project of residential micro-CHP. It will deploy 1,000 FC heating systems across 12 key member states over a period of 5 years</td>
<td>As of Summer 2014, 30 micro-CHP have been deployed in Europe and a rapid ramp-up in deployment is expected over the next 6 months</td>
</tr>
<tr>
<td>Technology developers include: Baxi, Vaillant, Panasonic, Toshiba, IE CHP, Elcore, Dantherm</td>
<td>Technology developers include: Mitsubishi, Toshiba, IE CHP, Elcore, Dantherm</td>
</tr>
</tbody>
</table>

**Figure 10:** Overview of the two main fuel cell CHP applications
OBJECTIVE 5:
Encourage the development of the hydrogen economy’s supply chain, seeking opportunities for the region’s existing energy expertise to diversify and benefit from this growing industry

Hydrogen presents an economic opportunity for the City Region both in the short and medium term (2015-2020) through local supply chain development as a result of the operation of hydrogen production, distribution and refuelling infrastructure in the area as well as vehicle support infrastructure and in the longer term (2020 and beyond) through diversifying the oil and gas sector.

Within the next 30-35 years it is predicted that oil reserves in the North Sea will be fully exploited therefore there will be a need to diversify the employment opportunities in the Aberdeen City region. It is important to act proactively now to ensure the economic readjustment required by the City over this period is positive and hydrogen presents an opportunity for this.

The City Council will use its current hydrogen deployment activity to promote nearer term growth opportunities in the region such as working with private sector organisations to maximise local benefits (for example establishing local support centres or new assembly or training facilities) whilst also having an eye on the longer term goal of industry diversification.

From discussions with members of the oil and gas sector it is evident that the existing skills base is well placed to capitalise on the opportunities presented by an emerging hydrogen sector. Areas of overlap between oil and gas skills and the hydrogen sector include:

- Gas storage and distribution;
- Safety planning, regulation and enforcement for hazardous gases;
- Handling of high pressure gases;
- Design and production engineering;
- Manufacture of storage vessels, compressors, balance of plant;
- Plant maintenance.

Actions:
Encourage the development of a local hydrogen supply chain by:
- Ensuring vehicle and infrastructure deployments are supported by local staff trained in hydrogen maintenance;
- Support OEMs in establishing hydrogen vehicle support centres at local dealerships;
- Engage with Aberdeen’s Universities, North East College and oil and gas training organisations to support the provision of training and education in the hydrogen field, as well as vocational skills relevant to the sector;
- Work with the wider region to identify areas where investments may be more attractive or the development of the supply chain may be feasible earlier, when skills shortages or high supply chain costs are seen as barriers against inward investment.

Maximise the involvement of the oil and gas industry
- Engage early with the oil and gas supply chain to encourage involvement;
- Encourage the transfer of relevant skills, for example handling of compressed gases, storage etc.
OBJECTIVE 6:
Promote a greater understanding and acceptance of hydrogen technologies through communication and education activities

Educating and raising awareness to stakeholder groups will be a significant factor contributing to successful commercialisation and acceptance of hydrogen technologies. Aberdeen City Council is committed to educating key target audiences that will play a role in achieving a hydrogen economy including the general public, teachers and students, national and local government representatives, safety and code officials, and potential commercial end-users. An educated and skilled workforce is essential to building a regional hydrogen economy and will need to be trained to manage, build and maintain hydrogen infrastructure and equipment.

Through the projects already underway, up-skilling of the workforce is taking place, with staff being trained to drive and maintain hydrogen vehicles. In addition the inaugural Aberdeen Schools Hydrogen Challenge took place in 2014. This was a partnership project between Aberdeen City Council, First Group and Arcola Energy to support the roll out of hydrogen buses in Aberdeen. Pupils from nine secondary schools across Aberdeen had the opportunity to engage with fuel cells, challenging them to design the most fuel efficient miniature hydrogen powered vehicle. In ten 90 minute workshops, teams of students worked with custom-designed Lego kits and 1.5W hydrogen fuel cells to engineer efficient vehicles. Through the creative application of science and technology, students develop scientific enquiry skills and knowledge about the role hydrogen will play within a future low-carbon society.

Actions:

- Identify the skills and training needs of the current and future hydrogen sector and develop educational materials where appropriate, particularly for early adopters;
- Support the take-up of hydrogen technologies by the public, businesses and government agencies through communication of high profile demonstration projects such as the Aberdeen Hydrogen Bus Project;
- Work with the EU and other partners to become a centre of excellence for hydrogen and fuel cell technologies;
- Work with education providers to integrate hydrogen into the curriculum for excellence; through activities such as the Aberdeen Hydrogen Schools Challenge;
- Undertake a public engagement / outreach programme to raise the profile of H2 Aberdeen activities, improve levels of awareness of hydrogen technologies and encourage widespread acceptance;
- Be an active partner in the HYACINTH (hydrogen acceptance in the transition phase) project; to gain a deeper understanding of the social acceptance of hydrogen technologies across Europe as well as to develop a communication and management toolbox;
- Increase awareness of the opportunities for local companies presented by hydrogen by delivering a programme of stakeholder events; In particular, engage oil and gas industry;
- Work with research and development organisations to address key market barriers to the use of hydrogen as an energy vector; including composite materials testing, making more robust fuel cells and remote power opportunities for the oil & gas sector.
OBJECTIVE 7:
Ensure strategy and policy development at all levels of government are supportive of hydrogen technologies

Policy and regulation are key instruments to encourage early adoption of hydrogen technologies. It is essential for policy and regulation at all levels (European, National and Local) to support low emission vehicles including hydrogen technologies in order to help to decarbonise road transport and the grid, reduce greenhouse gas emissions and improve air quality.

Actions:
Ensure hydrogen technologies are considered and where appropriate supported in all appropriate local policy and guidance including the:
- Aberdeen Air Quality Action Plan;
- Aberdeen City & Shire Strategic Development Plan;
- Aberdeen City Council Carbon Management Programme;
- Aberdeen City Local Housing Strategy;
- Aberdeen Local Development Plan;
- Aberdeen Regional and Local Transport Strategies;
- Energetica Corridor Development Guidance;
- Sustainable Urban Mobility Plan.

PART 3 - DELIVERING THE STRATEGY

The existing investment in Aberdeen’s hydrogen projects (particularly in infrastructure) places Aberdeen in a strong position where there is no need to worry about the “chicken and egg” situation common to most areas; that is what comes first the vehicles or the refuelling stations.

The development of the second refuelling station means that sufficient infrastructure will be in place to allow the build-up of demand from vehicle deployments, before demand justifies any future infrastructure investment. Therefore, near term actions will focus on securing a hydrogen demand for example by ensuring bus operation beyond 2018 as well as adding new Council and private fleets, followed by new infrastructure investment from 2018 when capacity will be maximised.

The Council has already committed over £3.4 million towards hydrogen and fuel cell projects and this has resulted in over £21 million investment to the City. To meet the objectives of the strategy further significant investment will be required however it is envisaged that the majority of funding will come from external sources with Aberdeen City Council working in partnership with both the public and private sector to deliver the aims of the strategy. Aberdeen City Council will continue to secure additional funding sources for example from Government, the private sector and other alternative outlets some of which are outlined in Table 2 Potential Funding Sources.

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
<th>Likely Size of Funding</th>
<th>Timescales</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCH JU (FCH 2 JU)</td>
<td>Public-private partnership between EC and industry, to advance the commercialisation of hydrogen and fuel cells</td>
<td>Up to 70% under Horizon 2020 with an overall budget of more than 1.3 billion, to be invested between 2014–2020</td>
<td>Annual calls for proposals 2014-20</td>
</tr>
<tr>
<td>TSB / Innovate</td>
<td>UK Government-run body to help fund innovation in a range of technology areas</td>
<td>Up to 60% for SMEs (50% otherwise)</td>
<td>Regular calls for proposals</td>
</tr>
<tr>
<td>Structural funds</td>
<td>EU funds for encouraging development across a range of thematic objectives</td>
<td>Up to 40% of project value</td>
<td>Annual calls for proposals 2014-20</td>
</tr>
<tr>
<td>Scottish Government</td>
<td>Has provided ad-hoc funding in the past, e.g. for the Aberdeen hydrogen bus project</td>
<td>Funding would be on an ad-hoc basis</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source Description Likely Size of Funding Timescales

FCH JU (FCH 2 JU) Public-private partnership between EC and industry, to advance the commercialisation of hydrogen and fuel cells Up to 70% under Horizon 2020 with an overall budget of more than 1.3 billion, to be invested between 2014–2020 Annual calls for proposals 2014-20

TSB / Innovate UK Government-run body to help fund innovation in a range of technology areas Up to 60% for SMEs (50% otherwise) Regular calls for proposals

Structural funds EU funds for encouraging development across a range of thematic objectives Up to 40% of project value Annual calls for proposals 2014-20


Scottish Government Has provided ad-hoc funding in the past, e.g. for the Aberdeen hydrogen bus project Funding would be on an ad-hoc basis N/A
KEY PRIORITIES (2015-2018)
The key priorities for the period 2015-2018 are detailed below.

**Total Budget: £1.9 million (excluding civil works costs)**

- Aberdeen City Council: £1.136 million
- European Regional Development Fund: £758,000

Civil works funded by:
- Interreg North Sea Region Programme and Transport Scotland.

**ACTION PLAN**
A range of well-timed deployment and engagement activities are required to secure the ambitious aims of this strategy.

**Figure 12: Phased implementation plan**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Continue support for 2 existing stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 HRS, demand secured to 2018</td>
<td></td>
</tr>
<tr>
<td>Continued operation of 10 bus project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Funded to end 2018</td>
<td></td>
</tr>
<tr>
<td>Deploy first fleet of commercial vans (up to 15)</td>
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<td></td>
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<td></td>
<td></td>
<td>Likely 4 years operation</td>
<td></td>
</tr>
<tr>
<td>Start maintenance activities</td>
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<td>Make available to other users</td>
<td></td>
</tr>
</tbody>
</table>

**Phase 1: Early investment activity**
- Decision to proceed subject successful 10 bus project
- Funding support, information sharing, joint procurement, etc.
- Provide long-term certainty: low-E zone exemption, use of bus lanes, free parking, tax incentives, etc.
- Long-term, regular engagement

**Phase 2: Supportive sector and political support**
- Secure Aberdeen as 2nd OEM deployment cluster
- Funding
- Extended bus operation 400 kg/day HRS
- OEM engagement
- Decision to proceed subject successful 10 bus project
- Deploy small Council Fleets

**Phase 3: Sustained investment activity**
- Secure low cost elec. Funding
- Freedom to ensure long-term supportive policy environment
- Long-term, regular engagement
- c. 3 meetings/year
- Decision to proceed subject successful 10 bus project

**Figure 12: Phased implementation plan**

- Start maintenance activities
- Secure continued operation of existing buses
- Work towards second major bus project
- Secure Aberdeen as 2nd OEM deployment cluster
- Continue to take early adopter role for new vehicle types
- H2 production and distribution optimisation and continued HRS deployments

**Ongoing supply-chain support**
- Support local supply chain development, O&G sector diversification

**Table 1: Project outline**

<table>
<thead>
<tr>
<th>Project</th>
<th>Outline</th>
<th>Delivery</th>
<th>Resource</th>
</tr>
</thead>
</table>
| Build a second Refuelling Station - Aberdeen City Hydrogen Energy Storage project | Build a second station with 350 & 700 bar capability in order to attract early releases of passenger cars | Aberdeen City Council, | Total Budget: £1.9 million (excluding civil works costs)

- Aberdeen City Council: £1.136 million
- European Regional Development Fund: £758,000

Civil works funded by:
- Interreg North Sea Region Programme and Transport Scotland. |
| Deploy a small number (<5) of OEM first generation vehicles | Engage with passenger car manufacturers to attract them to the region. Work with local partners to demonstrate the potential of these vehicles. | Aberdeen City Council, external funders to be confirmed | At the EPI Committee on 4th Sept 14 Aberdeen City Council approved the expenditure of £250,000 for up to 2 Tesla Model S5 fuel cell vehicles from external grants with no cost to the Council. Committee Report: EP/14/249 – 4th September 2014 |
| Council deployment of an expanded fleet of range extended fuel cell vans – ~10 | Act as an early adopter for new vehicle types by expanding the fleet of range extended vehicles from 2 to 12. | Aberdeen City Council, external funders to be confirmed | At the EPI Committee on 4th Sept 14 Aberdeen City Council approved the expenditure to purchase up to 10 hydrogen plug in fuel cell electric vehicles with an estimated expenditure of £366,000. It was noted that the cost of 5 of the 10 hydrogen plug in fuel cell electric vehicles will be purchased by the Council as part of normal fleet replacement (an estimated £71,000) with the balance coming from an external funding source (an estimated £295,00). Committee Report: EP/14/249 – 4th September 2014 |
| Work with bus operators to ensure a second major bus deployment from 2018 | Aberdeen City Council is a partner in the FCHJU’s ‘Bus Commercialisation Study’ which could expand the bus fleet in the city from 2017/18. A target deployment of 15 buses by 2018 supporting a third major HRS capability in a strategic location. This deployment is subject to: a) cost reduction for fuel cell buses (~£580k) and b) successful operation of the initial deployment of 10 buses. | Aberdeen City Council, Scottish Cities Alliance, Transport Scotland, Scottish Cities Alliance has funded a one year fixed term post to take this project forward. This post is hosted by Aberdeen City Council. Total Budget: £68k Scottish Cities Alliance |

Bus deployments will be supported by proposed match funding from the FCH JU of up to 200,000 per bus, 1m per refuelling station. | Aberdeen City Council, |

**Figure 12: Phase 2: Supportive sector and political support**

- Funding
- Extended bus operation 400 kg/day HRS
- OEM engagement
- Decision to proceed subject successful 10 bus project
- Deploy small Council Fleets

**Figure 12: Phase 3: Sustained investment activity**

- Secure low cost elec. Funding
- Freedom to ensure long-term supportive policy environment
- Long-term, regular engagement
- c. 3 meetings/year
- Decision to proceed subject successful 10 bus project

**Figure 12: Ongoing supply-chain support**

- Support local supply chain development, O&G sector diversification

**Figure 12: Phase 1: Early investment activity**

- Decision to proceed subject successful 10 bus project
- Funding support, information sharing, joint procurement, etc.
- Provide long-term certainty: low-E zone exemption, use of bus lanes, free parking, tax incentives, etc.
- Long-term, regular engagement
- c. 3 meetings/year
- Decision to proceed subject successful 10 bus project

**Figure 12: Table 1: Project outline**

<table>
<thead>
<tr>
<th>Project</th>
<th>Outline</th>
<th>Delivery</th>
<th>Resource</th>
</tr>
</thead>
</table>
| Build a second Refuelling Station - Aberdeen City Hydrogen Energy Storage project | Build a second station with 350 & 700 bar capability in order to attract early releases of passenger cars | Aberdeen City Council, | Total Budget: £1.9 million (excluding civil works costs)

- Aberdeen City Council: £1.136 million
- European Regional Development Fund: £758,000

Civil works funded by:
- Interreg North Sea Region Programme and Transport Scotland. |
| Deploy a small number (<5) of OEM first generation vehicles | Engage with passenger car manufacturers to attract them to the region. Work with local partners to demonstrate the potential of these vehicles. | Aberdeen City Council, external funders to be confirmed | At the EPI Committee on 4th Sept 14 Aberdeen City Council approved the expenditure of £250,000 for up to 2 Tesla Model S5 fuel cell vehicles from external grants with no cost to the Council. Committee Report: EP/14/249 – 4th September 2014 |
| Council deployment of an expanded fleet of range extended fuel cell vans – ~10 | Act as an early adopter for new vehicle types by expanding the fleet of range extended vehicles from 2 to 12. | Aberdeen City Council, external funders to be confirmed | At the EPI Committee on 4th Sept 14 Aberdeen City Council approved the expenditure to purchase up to 10 hydrogen plug in fuel cell electric vehicles with an estimated expenditure of £366,000. It was noted that the cost of 5 of the 10 hydrogen plug in fuel cell electric vehicles will be purchased by the Council as part of normal fleet replacement (an estimated £71,000) with the balance coming from an external funding source (an estimated £295,00). Committee Report: EP/14/249 – 4th September 2014 |
| Work with bus operators to ensure a second major bus deployment from 2018 | Aberdeen City Council is a partner in the FCHJU’s ‘Bus Commercialisation Study’ which could expand the bus fleet in the city from 2017/18. A target deployment of 15 buses by 2018 supporting a third major HRS capability in a strategic location. This deployment is subject to: a) cost reduction for fuel cell buses (~£580k) and b) successful operation of the initial deployment of 10 buses. | Aberdeen City Council, Scottish Cities Alliance, Transport Scotland, Scottish Cities Alliance has funded a one year fixed term post to take this project forward. This post is hosted by Aberdeen City Council. Total Budget: £68k Scottish Cities Alliance |

Bus deployments will be supported by proposed match funding from the FCH JU of up to 200,000 per bus, 1m per refuelling station. | Aberdeen City Council, |
To assist in the delivery of this Strategy and Action Plan progress will be monitored via the indicators and regular reports will be provided to the Council and its stakeholders. The Aberdeen City Region Hydrogen Strategy will be updated every 5 years.

### VEHICLE DEPLOYMENTS

**Objective 1: Promote Vehicle Deployments by a range of stakeholders in the region**

<table>
<thead>
<tr>
<th>Actions</th>
<th>Sub Actions/Tasks</th>
<th>Delivery Partners / Stakeholders</th>
<th>Resource Implication / Funding</th>
<th>Timescale / Target</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Establish a local Aberdeen stakeholder group</td>
<td>ACC, vehicle manufacturers, fleet operators, public sector organisations, car clubs</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Number of stakeholders involved per year</td>
</tr>
<tr>
<td>1.2</td>
<td>Provide a platform for project development, discussing common issues and funding bids</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Number of new projects initiated</td>
</tr>
<tr>
<td>1.3</td>
<td>Establish a programme of events to share knowledge, skills and experiences</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Number of events held</td>
</tr>
<tr>
<td>1.4</td>
<td>Define and assist in the development of industry and government policy and regulation to support a hydrogen economy</td>
<td>ACC, Scottish Government, UK Government, Transport Scotland, Office of Low Emission Vehicles (OLEV)</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Input to the national hydrogen strategy</td>
</tr>
<tr>
<td>1.5</td>
<td>Create public awareness with industry, academia, and government regarding the benefits and uses of fuel cell and hydrogen technologies use efficiency through</td>
<td>ACC, Scottish Hydrogen &amp; Fuel Cell Association</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>2015-2025 Number of stakeholders involved per year</td>
</tr>
<tr>
<td>1.6</td>
<td>Provide bilateral support to interested parties</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Literature developed and distributed to interested end users</td>
</tr>
<tr>
<td>1.7</td>
<td>Offer potential end-users the support of the Council in any external initiatives to deploy hydrogen vehicles, e.g. through sharing lessons learned/best practice, supporting planning or funding applications, etc.</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>Support potential end-users in evaluating external funding options</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>Work with interested parties to guide them through the process of preparing any applications for external funding, or considering developing joint procurement initiatives</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Number of interested parties assisted by ACC</td>
</tr>
<tr>
<td>1.10</td>
<td>Provide best practice guidance on accessing different funding sources e.g. Fuel Cells &amp; Hydrogen Joint Undertaking, Transport Scotland, Structural Funds, etc.</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td>Amount of external funding secured by end-users</td>
</tr>
<tr>
<td>1.11</td>
<td>Provide political support and buy-in to funding applications</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td></td>
</tr>
<tr>
<td>1.12</td>
<td>Support joint procurements through hosting ‘brokerage’ events, or putting potential partners in contact with each other</td>
<td>ACC</td>
<td>Officer time</td>
<td>2015-2025</td>
<td></td>
</tr>
</tbody>
</table>

### 1.4 Support vehicle deployments through available policy mechanisms

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.4.1 Explore options for providing a supportive regional and national policy framework for adopters of H2 vehicles, e.g. through allowing H2 drivers to access free parking, use bus lanes, enter restricted zones, other tax incentives, etc. Where possible, measures adopted should provide long-term certainty to adopters of H2 vehicles.</th>
<th>Officer time</th>
<th>2015-2025</th>
<th>ABS, Transport Scotland, Scottish Government</th>
</tr>
</thead>
</table>

### 1.5 Engage with UK Government and UK H2 Mobility

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.5.1 Engage with UK partners to ensure that Aberdeen is on the map as a leading early adopter region, following deployments in the South East around London</th>
<th>Officer time</th>
<th>2015-2025</th>
<th>ACC, Transport Scotland, Department for Transport, Office of Low Emission Vehicles</th>
</tr>
</thead>
</table>

### 1.6 Coordinate with other regions deploying Hydrogen

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.6.1 Work closely with other regions (e.g. North East England) to create a ‘hydrogen highway’ linking South East England to Aberdeen through the major road network, thereby allowing early national corridors and supporting the attractiveness of H2 vehicles in Aberdeen</th>
<th>Officer time</th>
<th>2015-2025</th>
<th>ACC, Scottish Cities Alliance, Scottish Government, Transport Scotland, UK Government</th>
</tr>
</thead>
</table>

### 1.7 Extend operation of the 10 buses

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.7.1 Identify budgets to fund the refuelling of fuel cells and continued operation of the current fleet of hydrogen buses from 2018</th>
<th>Officer time</th>
<th>2015-2018</th>
<th>ACC, bus operators, Transport Scotland, Scottish Government</th>
</tr>
</thead>
</table>

### 1.8 Work with bus operators to ensure a second major bus deployment from 2018

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.8.1 Develop a project to expand the bus fleet in the city from 2017/8, for example through initiatives such as the FCHJU’s ‘Bus Commercialisation Study’. Target 2018 for deployment of &gt;15 buses to the region, supporting a third major HRS in a strategic location This deployment should be subject to a cost reduction for FC buses (&lt;£500k) and b) successful operation of the initial deployment of 10 buses</th>
<th>Officer time</th>
<th>2015-2020</th>
<th>Scottish Cities Alliance, bus operators, bus manufacturers, FCHJU</th>
</tr>
</thead>
</table>

### 1.9 Engage with passenger car OEMs to attract them to the region

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.9.1 Seek to deploy a small number (&lt;5) of OEM first generation vehicles, working with local partners to demonstrate the potential of the OEM vehicles</th>
<th>Officer time</th>
<th>2015-2020</th>
<th>ACC, ColWheels, electric vehicle manufacturers</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sub Actions</th>
<th>1.9.2 Begin direct engagement with early OEMs (Toyota, Hyundai, Honda, Daimler), with the aim of ensuring that they consider Aberdeen as the second obvious cluster for deploying vehicles to the UK after the South East</th>
<th>Officer time</th>
<th>2015-2025</th>
<th>ACC, Transport Scotland, local stakeholders</th>
</tr>
</thead>
</table>

Options appraisal of potential policy incentives
1.10 Act as early adopter for new vehicle types made available to the region

1.10.1 Council deployment of an extended fleet of range extended FC vans, ~10 (2015)
1.10.2 Deploy small numbers of new hydrogen vehicle types within council fleets as they become available and as justified by funding/fit with council requirements. Provide access for trials to potential private sector adopters

ACC, Transport Scotland
ACC, vehicle manufacturers, external funders

2.2 Optimise
2.3 Continue to expand infrastructure deployments

2.2.2 Assess the options and costs for co-location of production and refueling stations or offsite production and distribution to centrally-located HRS in Aberdeen – with the aim of optimising overall H2 production and distribution costs.

2.3.1 Continue to support the expansion of Aberdeen’s refueling infrastructure, through promoting engagement with refueling infrastructure providers and supporting demand from additional vehicle deployments. Any decisions to deploy further HRS should be subject to clear stage gates based on proven demand growth at existing sites and clear signals from bus and car OEMs that affordable vehicles are coming to market

ACC, Transport Scotland, ACC, Transport Interreg MB (already allocated), Transport Scotland
ACC, vehicle manufacturers, external funders, Explore funding options

2.2.1 Assess the possibility of accessing low-cost electricity prior to any connection to the grid

2.3.2 Evaluate business models for continued public sector involvement in new HRS and develop a timeline and conditions for a transition towards new deployments being driven by the private sector

2.2.2 For future HRS sites, conduct feasibility assessments to compare the option of generating H2 on-site versus generation off-site, linked to stranded renewable resources. In particular, identify and engage with local funded and approved wind generation projects which have not been deployed due to grid constraints or currently operate with constraints, to assess the feasibility of generating and then distributing low cost H2 from these sites

2.3.1 Evaluate options for optimising operations to secure lower cost electricity for the Kittybrewster site, with a focus on optimising the electrolyser operation with respect to grid prices

2.2.1 Assess the possibility of accessing low-cost electricity prior to any connection to the grid

2.3.2 Evaluate business models for continued public sector involvement in new HRS and develop a timeline and conditions for a transition towards new deployments being driven by the private sector

ACC, Transport Scotland, ACC, Transport Interreg MB (already allocated), Transport Scotland
ACC, vehicle manufacturers, external funders, Explore funding options

2.2.1 Assess the possibility of accessing low-cost electricity prior to any connection to the grid

2.3.2 Evaluate business models for continued public sector involvement in new HRS and develop a timeline and conditions for a transition towards new deployments being driven by the private sector

ACC, Transport Scotland, ACC, Transport Interreg MB (already allocated), Transport Scotland
ACC, vehicle manufacturers, external funders, Explore funding options

Objective 2: Expand production and distribution of renewable hydrogen

<table>
<thead>
<tr>
<th>PRODUCTION AND SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 2: Expand production and distribution of renewable hydrogen</td>
</tr>
<tr>
<td>Actions</td>
</tr>
<tr>
<td>2.1 De-risk medium term H2 supply costs and logistics</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2.2 Optimise production and distribution logistics for the region</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2.3 Continue to expand infrastructure deployments</td>
</tr>
</tbody>
</table>

Objective 3: Develop hydrogen refueling infrastructure

<table>
<thead>
<tr>
<th>INFRASTRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 3: Develop hydrogen refueling infrastructure</td>
</tr>
<tr>
<td>Actions</td>
</tr>
<tr>
<td>3.1 Leverage existing infrastructure</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3.2 Deploy a second hydrogen refueling station</td>
</tr>
<tr>
<td>3.3 Minimise exposure to high electricity prices at Kittybrewster</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3.4 Secure low-cost electricity for the second station</td>
</tr>
</tbody>
</table>
3.5 Pursue opportunities to work with areas out with the City to expand the infrastructure network

3.5.1 Expanding the infrastructure network will encourage the take-up of Hydrogen technologies across Scotland. In particular, continue to work with the Scottish Cities Alliance Hydrogen Action Team

ACC, Transport Scotland Aberdeen City Council, Scottish Cities Alliance Officer time, Scottish Cities Alliance, FCHJU Explore further external funding options 2015-2025 Number of hydrogen refueling stations across Scotland.

NON TRANSPORT APPLICATIONS

Objective 4: Expand the roll out of either tried and tested or innovative hydrogen uses

Actions | Sub Actions/Tasks | Delivery Partners / Stakeholders | Resource Implication / Funding | Timescale / Target | Indicators
---|---|---|---|---|---
4.1 | Explore the roll-out of other tried and tested or innovative hydrogen uses | 4.1.1 Engage developers in discussions for a stationary fuel cell demonstrator project within the City; in particular the new Aberdeen Exhibition and Conference Centre | ACC, Henry Boot, ACC, Officers, ABCC, Aberdeen Exhibition and Conference Centre, Aberdeen City Council | Officer time, Partners, External funding, 2015-2025 | Demonstration of a stationary fuel cell within the City

SUPPLY CHAIN

Objective 5: Encourage the development of the hydrogen economy’s supply chain

Actions | Sub Actions/Tasks | Delivery Partners / Stakeholders | Resource Implication / Funding | Timescale / Target | Indicators
---|---|---|---|---|---
5.1 | Encourage the development of a local hydrogen transport supply chain | 5.1.1 Ensure vehicle and infrastructure deployments are supported by local staff trained in hydrogen maintenance | ACC, hydrogen sector, training providers | Officer time | 2015-2020 Number of staff trained
5.1.2 Support OEMs in establishing hydrogen vehicle support centres at local dealerships | ACC, vehicle manufacturers, hydrogen sector | ACC, Officers, External funding | 2015-2020 Number of vehicle support centres
5.1.3 Engage with Aberdeen’s Universities and oil and gas training organisations to support the provision of training and education in the hydrogen field, as well as vocational skills relevant to the sector | ACC, Aberdeen University, Robert Gordon University, Scottish Enterprise, ACC, Officers | ACC, Aberdeen University, Robert Gordon University, Scottish Enterprise, ACC, Officers | Officer time Explore funding options 2015-2025 Levels of training provided
5.1.4 Identify areas within the wider region where investments may be more attractive or the development of the supply chain may be feasible earlier, when skills shortages or high supply chain costs are seen as barriers against inward investment. | ACC, Aberdeen City Council, Scottish Cities Alliance | ACC, Aberdeen City Council, Scottish Cities Alliance | Officer time Explore funding options 2015-2020 Local authority areas identified with potential for hydrogen technologies
5.2 | Maximise the involvement of the oil and gas industry | 5.2.1 Engage early with the oil and gas supply chain to encourage involvement | ACC, Scottish Enterprise, ACC, Officers | ACC, Scottish Enterprise, ACC, Officers | Officer time 2015-2020 Number of oil and gas companies involved in hydrogen
5.2.2 Encourage the transfer of relevant skills, for example handling of compressed gases, storage etc | ACC, Scottish Enterprise, ACC, Officers | ACC, Scottish Enterprise, ACC, Officers | Officer time 2015-2020

EDUCATION & AWARENESS

Objective 6: Promote a greater understanding and acceptance of hydrogen technologies through communication and education activities

Actions | Sub Actions/Tasks | Delivery Partners / Stakeholders | Resource Implication / Funding | Timescale / Target | Indicators
---|---|---|---|---|---
6.1 | Promote a greater understanding and acceptance of hydrogen technologies | 6.1.1 Identify the skills and training needs of the current and future hydrogen sector and develop educational materials where appropriate, particularly for early adopters | ACC, Hydrogen industry partners | Officer time, External funding e.g. internships, Hydrogen sector and education project | 2015-2018 Complete skills and training needs assessments
6.1.2 Support the take-up of hydrogen technologies by the public, businesses and government agencies through communication of high profile demonstration projects | ACC, Aberdeen Hydrogen Bus Project partners, Assistant project partners | ACC, Project funding | 2015-2018 Complete and Disseminate project case studies.
6.1.3 Work with the EU and other partners to become a centre of excellence for hydrogen and fuel cell technologies. | ACC, National partners, European Union, ACC, Officers | ACC, National partners, European Union, ACC, Officers | Officer time, External funding, Hydrogen sector | 2015-2020 Aberdeen City regarded as a Centre of Excellence
6.1.4 Work with education providers to integrate hydrogen into the curriculum for excellence | ACC, Schools, Colleges, Education providers | ACC, Schools, Colleges, Education providers | Officer time, External funding and sponsorship | 2015-2020 Number of pupils taught about hydrogen for example through the Aberdeen Hydrogen Schools Challenge
6.1.5 Undertake a public engagement / outreach programme to raise the profile of Aberdeen activities, improve levels of awareness of hydrogen technologies and encourage widespread acceptance. | ACC, project partners, hydrogen industry, ACC, Officers | ACC, project partners, hydrogen industry, ACC, Officers | Officer time, Explore sponsorship options | 2015-2020 Number of citizens reached and number of events attended.
6.1.6 Be an active partner in the HYACINTH (hydrogen acceptance in the transition phase) project; to gain a deeper understanding of the social acceptance of hydrogen technologies across Europe as well as to develop a communication and management toolbox | ACC, project partners, Hydrogen industry, ACC, Officers | ACC, project partners, Hydrogen industry, ACC, Officers | Officer time, External funding | 2014-2016 Project objectives met
6.1.7 Increase awareness of the opportunities for local companies presented by hydrogen by delivering a programme of stakeholder events; in particular, engage oil and gas industry | ACC, Project partners, industry partners, ACC, Officers | ACC, Project partners, industry partners, ACC, Officers | Officer time, External funding | 2015-2025 Number of stakeholder events held per year
### Objective 7: Ensure strategy and policy development at all levels of government are supportive of hydrogen technologies

<table>
<thead>
<tr>
<th>Actions</th>
<th>Sub Actions/Tasks</th>
<th>Delivery Partners / Stakeholders</th>
<th>Resource Implication / Funding</th>
<th>Timescale / Target</th>
<th>Indicators</th>
</tr>
</thead>
</table>

#### 7.1 Ensure strategy and policy development at all levels of government are supportive of hydrogen technologies & infrastructure

- **7.1.1** Ensure hydrogen technologies are considered/supported in all appropriate local policy and guidance including the:
  - Aberdeen Air Quality Action Plan;
  - Aberdeen City & Shire Strategic Development Plan;
  - Aberdeen City Council Carbon Management Programme;
  - Aberdeen City Local Housing Strategy;
  - Aberdeen Local Development Plan;
  - Aberdeen Local & Regional Transport Strategies;
  - Energetica Corridor Development Guidance;
  - Sustainable Urban Mobility Plan.

  **ACC, Aberdeen Council, NESTRANS, Energetica, Aberdeen City & Shire Strategic Development Planning Authority**

  **Officer time**

  **2015-2025**

  **Number of policies hydrogen is considered in**

#### 7.2 Campaign for FCEV to receive equal treatment with other low emission vehicles / electric vehicles in national incentive schemes

- **7.2.1** Input to the development of national hydrogen policy and incentives by Scottish Government and Transport Scotland by contributing our experience and lessons learned to date.

  **ACC**

  **Officer time**

  **2015-2025**

  **Number of consultations/ policy/ strategy input to**

#### 7.3 Support the case for universal regulations, codes and standards for hydrogen across Europe and beyond

- **7.3.1** Support extended across Europe and beyond in areas such as:
  - Hydrogen purity, so that providers and suppliers can coordinate their products;
  - Safety protocols, to ensure long term viability and public acceptance;
  - Fueling stations, to facilitate the spread of infrastructure and encourage consumer acceptance;
  - Retail applications, to promote widespread deployment.

  **ACC, industry partners**

  **Officer time**

  **2015-2025**

  **Number of consultations/ policy/ strategy input to**

---

**POLICY**

**ACC** – Aberdeen City Council  
**BOC** – BOC Linde Group Industrial Gases  
**FCHJU** – Fuel Cells and Hydrogen Joint Undertaking  
**H2** – hydrogen  
**HRS** – Hydrogen Refuelling Station  
**HyTrEc** – Hydrogen Transport Economy project  
** LTS** – Local Transport Strategy  
**NESTRANS** – North East of Scotland Transport Partnership  
**OEM** – Original Equipment Manufacturer  
**SSE** – Scottish and Southern Energy  
**ULEMCo** – Ultra Low Emission Mileage Company Ltd