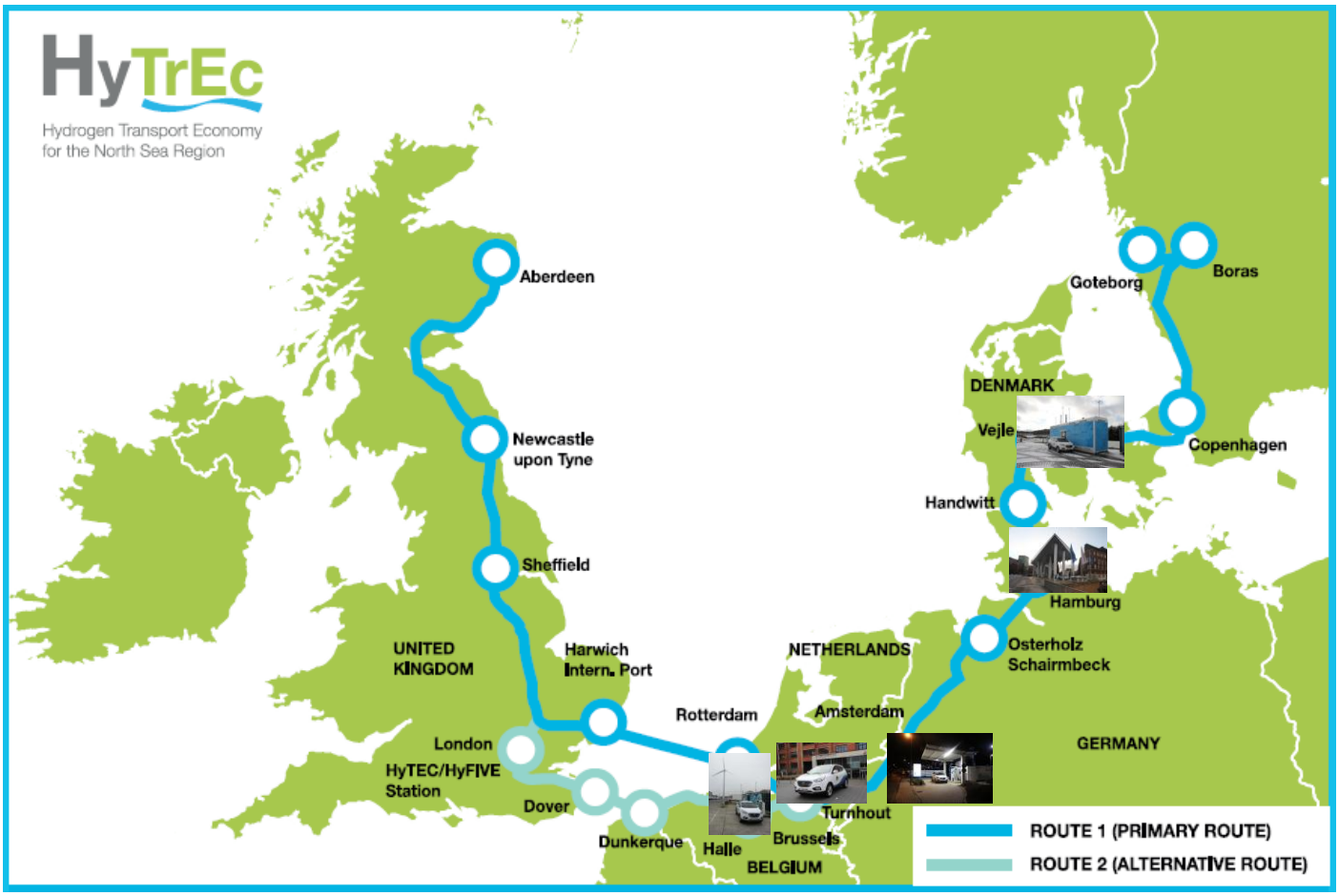
The Interreg IVB North Sea Region Programme

Investing in the future by working together for a sustainable and competitive region

EUROPEAN REGIONAL DEVELOPMENT FUND



Theoretical Hydrogen Journey Becomes Reality

ROADTRIP REPORT

Stefan Neis, WaterstofNet | HyTrEc Journey | 30 January 2015

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Brief Summary

This report summarizes the practical realisation of the Theoretical Journey, produced within the HyTrEc project, to drive a Fuel Cell Electric Vehicle (FCEV) through the North Sea Region from Aberdeen in Scotland to Gothenburg in Sweden. It contains a road trip diary, information on the car (including real life data logging) and refuelling infrastructure (including fuelling data) from throughout the journey. Only a part of the journey was performed by one of the partners (WaterstofNet) driving from Brussels, Belgium to a consortium meeting in Vejle, Denmark. The journey took place on the 27th January and return journey on the 29th January 2015.

Journey facts

Total distance covered: **1865 km**
Amount of refuellings: **9 times** [8 times 700 bar, 1 time 350 bar]
Kgs of hydrogen fuelled: **26,3 kg**

Average consumption in kg/100 km via data-logging: **1,19 kg/100 km (84 km/kg)**
Average consumption in kg/100 km via monitor WaterstofNet: **1,21 kg/100 km (83 km/kg)**

The main objectives of the journey were to:

- Put into practise the route, defined by the consortium in the "theoretical journey" document.
- test the car on the journey to Denmark
- test the current European hydrogen refuelling station network, it's compatibility and availability
- compare the HyTrEc desk-based study with reality
- provide information, facts and figures on driving a hydrogen car through Europe.

Key findings:
It is possible to drive from, in this case Brussels to Denmark and further to the North, in a hydrogen fuel cell car. The Hyundai FCEV used performed extremely well, in all weather conditions, comparable to a normal gasoline fuelled car but, without any exhaust emissions or noise.

It was a challenging trip, mainly due to the availability of the hydrogen refuelling stations in the different countries on the route. The trip went very well, particularly as a result of detailed preparation work, including obtaining entry passes or fuelling cards and communicating with the station operators in advance.

Thank you to everyone who assisted in making this journey a success!

In conclusion it can be said that this part of the theoretical journey became a reality and a success.

The HyTrEc project

As part of the Interreg IV B programme, partly funded by the European Regional Development Fund, the Hydrogen Transport Economy for the North Sea Region (HyTrEc) project aims to improve access to and advance the adoption of hydrogen as an alternative energy vector across the North Sea Region. The project will identify and address structural impediments constraining development of, access to and adoption of this alternative fuel in urban and rural settings.

The HyTrEc project supports the validation, promotion and adoption of innovative hydrogen technologies across the North Sea Region (NSR) and works to enhance the region's economic competitiveness within the transport and associated energy sectors. In addition, HyTrEc provides a platform to support the collaborative development of strategy as well as initiatives. Further, it helps inform and shape the development of infrastructure, technology, skills and financial instruments to support the application of hydrogen based technologies across the region. Therefore partners from the UK, Germany, Denmark, Belgium, Norway and Sweden are working together to improve cross border collaboration, share best practice and support joint activities. The project will establish a transnational network which will improve accessibility to hydrogen across the North Sea Region as an alternative energy vector by:

- Establishing a North Sea Hydrogen Transport Stakeholder Group, and developing strategies and initiatives to create a fully functioning hydrogen corridor;
- A transnational pilot study to improve the accessibility and connectivity of existing regional hydrogen corridors and supporting the development of hydrogen supply chain infrastructure;
- Developing a North Sea Region education forum to identify skills gaps and develop training solutions;
- Facilitating access to public and private sector financial instruments which support the development of hydrogen technology;
- Supporting the development of SME clusters to deliver hydrogen infrastructure solutions.

The objectives of the project are to promote:

- Regional accessibility strategies;
- Environmentally responsible energy production practices;
- Developing different modes of transport;
- Transnational transport corridors;
- Efficient and effective logistics solutions;
- Sustainable growth solutions.

This report on the practical journey fits within the transnational pilot study to improve the accessibility and connectivity of existing regional hydrogen corridors and support the development of hydrogen supply chain infrastructure.

The idea of a hydrogen journey through the North Sea region

During the transnational discussions amongst HyTrEc partners, it became clear that there were a number of practical challenges in attempting to travel in a hydrogen-fuelled vehicle within the North Sea Region due to disparities in infrastructure, policy, regulation and knowledge across the different member states. The partnership therefore undertook a transnational desk based pilot study to analyse the accessibility and connectivity of existing regional hydrogen corridors by identifying these factors, in order for key issues to be tackled where possible within the project, or recommendations promoted beyond the partnership.

REPORT: "A HYPOTHETICAL HYDROGEN JOURNEY THROUGH THE NORTH SEA REGION"

The task was to create a transnational document which shows the outcome of an imaginary route through all partner regions. The input for this model is based on feedback of each partner regarding issues which are related to existing restrictions, existing refuelling infrastructure, use of tunnels / ferries etc. This Theoretical Journey, desk-based study was co-ordinated and led by HyTrEc project partner, the European Institute for Innovation (EIfI) and was based on details collected through questionnaires for each project partner.

The Hypothetical Journey report describes a theoretical journey with a hydrogen car which is starting in Aberdeen and ending up in Gothenburg. The journey leads through the UK, to Belgium, the Netherlands and Germany, up to Denmark and Sweden. The idea is that all HyTrEc project partners should be "visited" during the trip. Each stage of the journey through the partner countries was analysed to highlight any restrictions and regulations that would affect the journey. The paper shows the barriers and restrictions that might occur when travelling through the North Sea Region in a hydrogen car. Parts of the journey lead through the Trans-European Road Network (TERN) and also the Hydrogen Infrastructure in Transport (HIT) Trans European Network for Transport (TEN-T). The aim of the TERN project is to improve the internal road infrastructure of the EU. Therefore it is interesting to investigate possible restrictions for hydrogen vehicles on this specific road network. Namely the Motorways M25 and M20 in the UK are included in the journey and are part of TERN. The HIT TenT project is enabling transport on hydrogen via the TEN-T transport network throughout Europe. The first hydrogen corridor from Denmark to Rotterdam was opened in 2014.

The study was carried out on a theoretical basis initially, and then followed by a real life journey. The results from this real life journey are explained in this report.

The Route

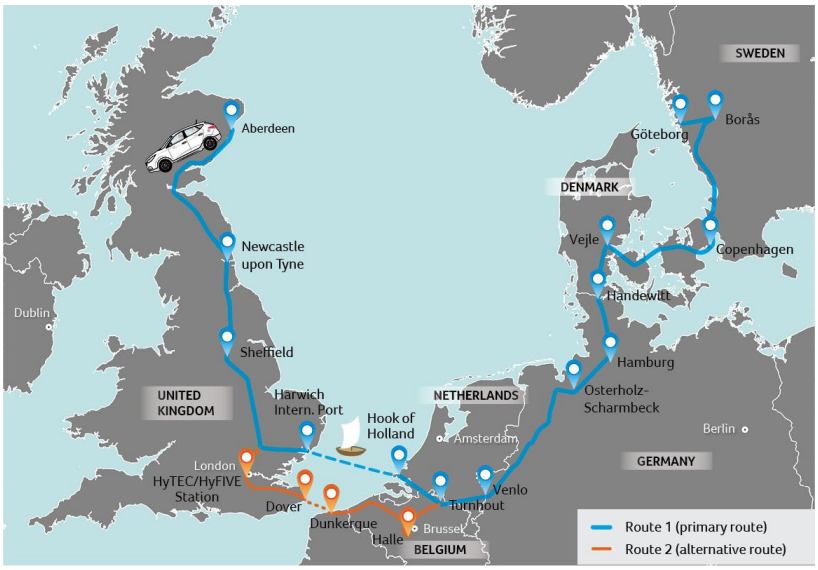
The complete Hypothetical Journey takes a car from Aberdeen, Scotland to Gothenburg, Sweden, passing through a large part of the Interreg North Sea area, as shown in the picture on the right.

Interreg North Sea Area Map

Due to the lack of hydrogen refuelling stations, it was necessary to drive through a part of Germany not included in the Interreg area.

With project partner WaterstofNet of Belgium taking delivery of a hydrogen fuel cell car in November 2014, it was decided that this car would be driven from Halle, near Brussels to the next project partner meeting, in Vejle Denmark in January 2015. This meant crossing four countries, three borders and eight provinces, therby completing a large part of the journey, but not the UK.

To undertake such a trip it is vital to have fuelling stations along the route. Fuellings took place at the Colruyt station in Halle, Belgium (operated by WaterstofNet); the Automotive Campus Helmond station in Helmond, Netherlands (operated by WaterstofNet); the public Air Liquide Höherweg station in Düsseldorf ,Germany; the public Vattenfall Hafencity station in Hamburg, Germany and the H2Logic public station in Vejle, Denmark.



Theoretical route Aberdeen-Göteborg

It is intended for Green Network, Denmark to drive the route to Copenhagen and the Swedish partners to complete the route to the north to Gothenburg with their own fuel cell cars, at a later stage.

Fuel Cell Electric Vehicle

To do a real life test and investigate the feasibility of the journey, a hydrogen powered fuel cell car was needed. At the time, the Belgian project partner WaterstofNet was the only one to have a car available. The project partner Green Network, from Denmark, received their two vehicles on the 27th of January 2015. Although other project partners have other demonstration vehicles, through the Hypothetical Journey process it became clear that it would not be possible to drive these vehicles around the North Sea Region because of the lower range these vehicles have and

Hyundai IX35 FCEV from WaterstofNet

the limited extent of the refuelling network. With hydrogen stored at 700 bar pressure, the FCEVs like the Hyundai have range in excess of 500km, and gave the best chance of travelling the long distances between refuelling stations.

Hyundai is the first OEM to commercially sell or lease FCEVs to the consumer market in Europe.

HYUNDAI IX35 SPECIFICATIONS

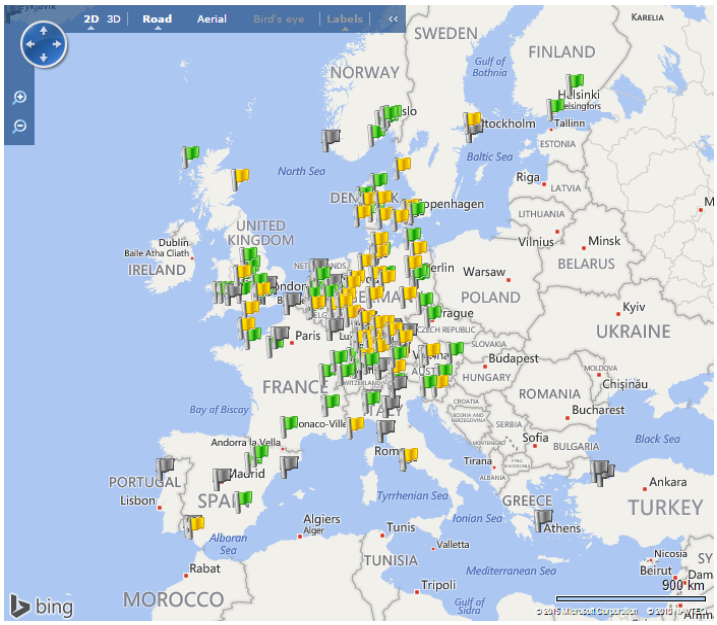
Weight: 1,830 Kg
Power: 100 kW Fuel Cell
Lithium ion battery: 21 kW
Torque: 300 Nm
Stored H_2: 5,6 kg @ 700 Bar
Size Storage tank: 144 L
Max. speed: 160 Km/h
Sprint 0-100Km/h: 12,5 s
Range: 588 Km
Fuel consumption: 0,95 Kg/100Km

The infrastructure

DESCRIPTION FOR EACH COUNTRY

Belgium

In Belgium there are currently no public hydrogen refuelling stations and also no 700 bar stations for hydrogen cars. The only 2 stations for hydrogen in the country are 350 bar stations, one for buses (HighVLOCity station in Antwerp) and one for forklifts (WaterstofNet station at Colruyt distribution centre in Halle); at the latter station it is possible to refill a car with half a tank of hydrogen (i.e. filling at 350 bar pressure instead of the ideal 700 bar). It is then able to drive about 250 km. In 2015 an H2Mobility plan for Belgium is being written, which will develop a strategy for roll-out of hydrogen refuelling infrastructure jointly between industry and government.



source: www.h2stations.org

The Netherlands

In the Netherlands there are two hydrogen refuelling stations. Only one of them is public, located near the A15 in Rotterdam, the other has semi-public access located at the Automotive Campus in Helmond. Both stations are equipped with both 350 and 700 bar to fuel cars and buses. Within the Netherlands there are four appointed regions where most of the hydrogen activities take place: Amsterdam, Rotterdam, Arnhem and Eindhoven/Helmond.
The Netherlands is currently working on an H2Mobility plan which aims to have 20 hydrogen fuelling stations in 2020. For the road tour the Helmond station was used as it is closer to the next station, on the route, Düsseldorf, Germany.

Germany

Germany is the European leader in hydrogen public fuelling stations and infrastructure with plans to roll out further hydrogen stations and cars. At the moment some 16 fuelling stations are already operating, covering the major cities. In 2015 it will extend to a network of 50 fuelling stations and the goal is to have 400 fuelling stations by 2023 as defined in the German H2Mobility plan. The Clean Energy Partnership is an initiative from the government and industry to investigate the everyday suitability of hydrogen as a fuel.

Denmark

Denmark is a small country with great ambitions and could become the country with the highest density of hydrogen refuelling stations. In the first phase there will be about 15 stations in 2015 with an average distance of about 75 kms between each station. The biggest fleet (15 cars) of FCEVs in Europe is being deployed in Copenhagen.

	2013-2015 Country-wide network	2015-2025 Build-up of critical volume	2025-2050 Commercial deployment
	~10-15 stations / €14 million *€4 million public support* *€3 million public support*	~185 stations / €227 million *30% public CAPEX (same as biogas)* *Public fuel support (same as biogas)*	~450-1.000 stations *Subsidies phased out by 2025* *Normal taxation beyond 2025*
	Vehicle test fleets *Vehicle tax exemption*	~110.000 vehicles by 2025 (4,5%) *Vehicle tax gradually introduced*	~50% of car fleet by 2050 *Normal taxation beyond 2025*

Source: Hydrogen Link Denmark

SPECIFICATIONS FUELLING LOCATIONS

Halle, Belgium

The station in Halle, near Brussels, which opened in February 2012, is owned by HyTrEc project partner WaterstofNet, and is being used by a fleet of 12 hydrogen forklifts at a supermarket distribution centre. The public station was built by Hydrogenics and produces the hydrogen via onsite electrolysis with power supplied from wind and solar energy.
It is regularly used by Hyundai and Toyota to fuel their FCEVs and is the starting point of the Journey through the North Sea Region to Denmark.

Specifications:

Production: 30 Nm³/h alkaline electrolyser, easy to extend to 60 Nm³/h
Green power from wind and solar
CSD: Membrane compressor up to 465 bar
55 kg storage @ 450 bar
-10°C gas-cooling

At the moment it has a track record of about 1750 refuellings by 10 different applications.

Helmond, the Netherlands

The station in Helmond, near Eindhoven, which opened in November 2013, is owned by WaterstofNet. This station can refuel at 350 and 700 bar. It is a semi-public station located at the Automotive Campus Helmond in the south of the Netherlands, near the German border. The manufacturer of the station was Ballast Nedam and it has an onsite production via electrolyses and two dispensers. It is used frequently by a refuse truck, a bus and a number of cars from Hyundai and Toyota.

This station enables users to cross the Netherlands-German border and make a journey north, for example to Denmark or south to Italy via Germany.

Specifications:

Production:	30 Nm³/h alkaline electrolyser, easy to extend to 60 Nm³/h, on Green power.
350 bar:	Piston compressor up to 465 bar
	70 kg storage @ 450 bar
	-10°C gas-cooling
700 bar:	Piston compressor up to 950 bar
	15 kg storage @ 900 bar
	-40°C gas-cooling

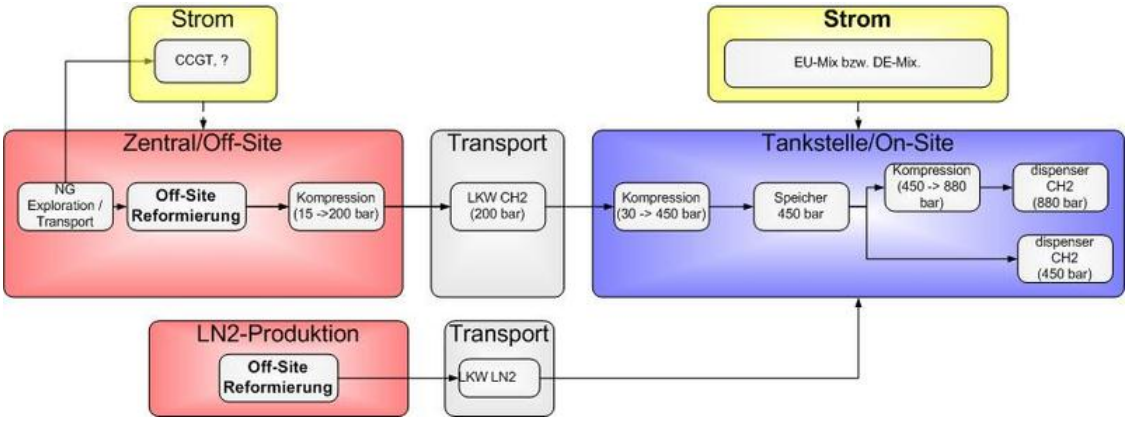
At the moment it has a track record of about 250 refuellings.

CEP Höherweg Air Liquide station in Düsseldorf, Germany

The station is owned and operated by Air Liquide under the umbrella of the Clean Energy Partnership (CEP). Within the state of North Rhine Westphalia, in Germany, it is the only public hydrogen refuelling station delivering 350 and 700 bar hydrogen for cars only. Together with the Helmond station it links the current transnational hydrogen refuelling network from Germany to the Netherlands (/Belgium). Within Germany it is the critical link for the North-South connection, connecting Hamburg to Stuttgart.

For example, the distance between Hamburg and Düsseldorf is 400kms without any refuelling station in-between. It was built to fuel 10 Opel/GM HyGen4 fuel cell vehicles and also some B-Class Daimler fuel cell vehicles.

Specifications:



Hydrogen supply via tube-trailer
Storage 200 kg @450 bar
Dual nozzle dispenser for 350 & 700 bar
Maximum output 50 cars/day

Hafencity Hamburg station, Germany

Vattenfall's Hamburg station is Europe's biggest public hydrogen refuelling station with a total capacity of about 750 kgs/day. It has been delivering hydrogen, which has partly been produced onsite and also trucked in, to cars and public transport buses since February 2012.

It has the capacity to fuel a fleet of about 20 fuel cell buses. The station is also equipped with a fast fill dispenser for cars which can both refuel at both 350 and 700 bar. Vattenfall together with other partners participate in the "Clean Energy Partnership" to build a national hydrogen refuelling network. The "Hafen City" station is part of this project.

Specifications:

Hydrogen supply via onsite electrolysis and trucked-in green hydrogen from windfarm
Maximum capacity: 700-750 kg/day, 2 Electrolysers 60 Nm³for 240 kg/day.
Storage: 250 kg in 120 bottles up to 800 bar, 2 medium-pressure tanks 50m³ @ max 45 bar (ca 2x220 kg.)
2 Dispensers: 1x Bus-dispenser with TK 16 high flow + IR and 1x Twin-Dispenser for 700 bar SAE fuelling with IR and 350 bar without IR.

Opened in February 2012

H2Logic station Vejle, Denmark

The last part of the journey took place from the Hamburg station to the refuelling station in Vejle, crossing the German-Denmark border near Flensburg.

This station is one of the 5 hydrogen stations that are operational in Denmark and has been in operation since January 2015.

Its position near the main TEN-T corridor, to the North, through Denmark is a strategic one. From here you can travel to the north, the west and also to Copenhagen in the east. This station connects the routes from Sweden to the rest of Europe.

Specifications:

Hydrogen supply via onsite electrolysis and truck in bottled hydrogen
Storage: n.a.
Integrated dispenser for 700 bar cars
Fast filling via SAE J2601, cooling -40°C
Maximum output 200 kg/day
Footprint 40 ft container

Analysis of the journey

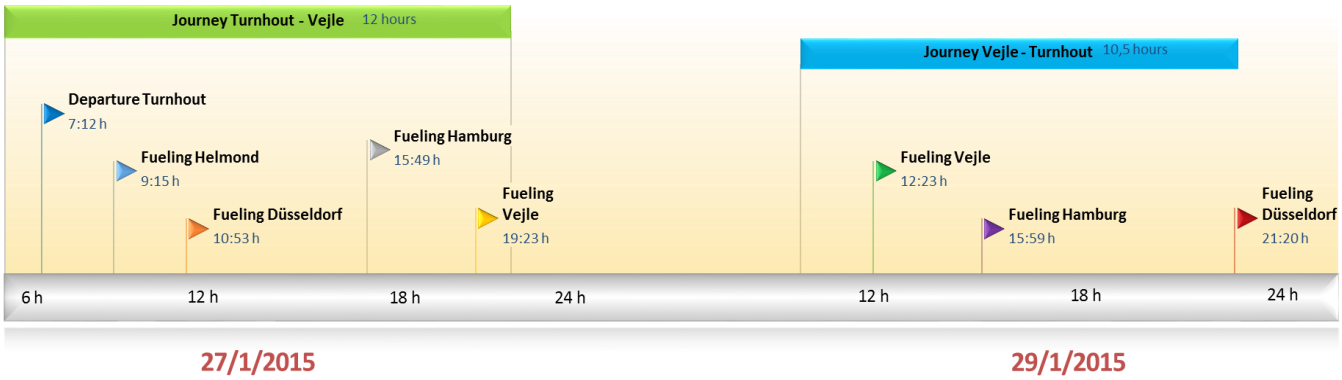
During the journey the most critical part of the route was between Düsseldorf and Hamburg. The gap between the fuelling stations is about 400kms and after fuelling in Düsseldorf the range indicator in the car gave a reading of 420 km. This distance would always give some 'range anxiety' but more so, due to the geographical terrain in North Rhine Westphalia. At one point during the cross over the indicator calculated we would be 8 kms short of the next station in Hamburg. After clearing the hills and driving on reasonably flat terrain to Hamburg the cross-over was successfully made with some 40kms left on the indicator at the fuelling station.

The same issue was noticed on the return trip, during which, the weather changed notably and on some parts of the route there was heavy snowfall and ice on the road. However this had no influence on the performance of the car or its fuel consumption.

Distances between the hydrogen refuelling stations:

Halle (Belgium) – Helmond (Netherlands): 174 km
Helmond (Netherlands) – Düsseldorf Germany: 106 km
Düsseldorf (Germany) – Hamburg (Germany): 404 km
Hamburg (Germany) – Vejle (Denmark): 274 km

TIMELINE



DATA MONITORING AND MANUAL LOGGING

WaterstofNet has an agreement with Hyundai Motor Europe to record real time data. A data logger already installed in the car provided accurate data and monitored some parameters during the journey. This was then compared with manual kilometre, fuelling and fuel-consumption data registered/calculated by WaterstofNet. The results are presented in the table below.

Vehicle ID	Trip ID	Trip start	Trip end	Odometer (km)	Trip distance (km)	Fuel used hydrogen	Average non zero speed (km)	Max speed (km)	Std of non zero speed	Idle time	Calculated Consumption kg/100km	Calculated average due to stopping
LMS10143	20150127_151203	7:12:11	8:15:19	9903,7	59,2	0,73	69,34	119	33,61	673	1,24	
LMS10143	20150127_173148	9:31:56	12:15:59	10079,0	175,3	0,90	73,65	132	33,84	813	0,51	
LMS10143	20150127_215643	13:56:51	15:58:38	10407,5	197,5	2,48	100,85	161	19,50	165	1,26	1,15
LMS10143	20150128_001220	16:12:27	19:09:14	10662,8	255,3	2,93	91,57	143	25,54	456	1,15	1,15
LMS10143	20150128_031011	19:10:19	19:23:44	10673,5	10,7	0,11	64,95	115	42,09	141	1,05	1,15
LMS10143	20150128_033318	19:33:26	19:46:03	10678,0	4,5	0,00	28,52	69	19,82	122	0,00	
LMS10143	20150128_035025	19:50:32	19:53:11	10678,2	0,2	0,00	12,23	26	7,83	15	0,00	
LMS10143	20150128_035332	19:53:39	19:55:16	10678,2	0,0	0,00	0,00	0	0,00	38	0,00	
LMS10143	20150128_051012	21:10:20	21:37:06	10706,7	28,5	0,34	72,84	103	27,25	150	1,19	
LMS10143	20150128_053706	21:37:14	22:07:19	10736,0	29,3	0,34	64,84	103	33,14	105	1,15	
LMS10143	20150128_180435	10:04:43	10:18:23	10742,0	6,0	0,17	34,60	76	20,41	129	2,82	
LMS10143	20150129_012832	17:28:40	17:44:26	10748,8	6,8	0,00	34,57	73	18,32	144	0,00	
LMS10143	20150129_171405	9:14:13	9:30:53	10754,6	5,8	0,17	33,02	68	18,46	295	2,92	
LMS10143	20150129_202406	12:24:14	12:33:08	10758,0	3,4	0,11	30,67	66	20,73	81	3,32	
LMS10143	20150129_204100	12:41:08	15:56:52	11024,0	266,0	3,72	91,43	148	32,61	1155	1,40	
LMS10143	20150130_000059	16:01:06	18:12:53	11209,0	185,0	1,75	88,28	119	20,93	262	0,95	1,05
LMS10143	20150130_021637	18:16:44	21:19:08	11419,7	210,7	2,43	70,74	134	36,10	119	1,15	1,05
LMS10143	20150130_052524	21:25:32	22:42:20	11518,8	99,1	1,30	86,47	155	36,87	386	1,31	

Data from data logger Hyundai Motor Europe

Legend:
- Trip to Denmark
- Stay in Denmark
- Trip back Home
- Calculated values

Date:	Odometer (km) before	Odometer (km) after	From	To	Fueling; Odo	Amount Fueled	Autonomy before fueling	Autonomy after fueling	Driver	Destination	kg/100km
23/01/2015	9337	9461	Turnhout	Colruyt	Ja; 9461 km	2,12	70	222	Stefan	WaterstofNet Colruyt station	1,14
	9461	9630	Colruyt	Helmond	Ja; 9630 km	2,02	75	226	Stefan	WaterstofNet station Helmond	1,20
27/01/2015	9844	9903	Turnhout	Helmond	Ja; 9903 km	3,51	110	428	Stefan	WaterstofNet station Helmond	1,18
	9903	10008	Helmond	Düsseldorf	Ja; 10008km	1,0	320	426	Stefan	AIRLIQUIDE	0,95
	10008	10407	Düsseldorf	Hamburg	Ja; 10407km	4,24	58	367	Stefan	VATTENFALL	1,06
	10407	10673	Hamburg	Vejle	Ja; 10673km	4,0	135	428	Stefan	H2LOGIC	1,50
	10673	10750	Vejle	Vejle					Stefan	Vliegveld Billund Adwin	1,14
29/01/2015	10750	10758	Vejle	Vejle	Ja; 10758km	0,97		424	Stefan	H2LOGIC	
	10758	11024	Vejle	Hamburg	Ja; 11024km	3,9	128	422	Stefan	VATTENFALL	1,47
	11024	11419	Hamburg	Düsseldorf	Ja; 11419km	4,14	78	362	Stefan	AIRLIQUIDE	1,05
	11419	11518	Düsseldorf	Beek					Stefan		
30/01/2015	11518	11593	Beek	Helmond	Ja; 11593km	2,39	214	376	Stefan	WaterstofNet station Helmond	1,37

Data from manual collection WaterstofNet

FUELLING DATA

Fuelling data provided by the different owners of the stations.

WaterstofNet stations	Halle	Helmond 27/1	Helmond 30/1
Time	*23/01/15 11:18h*	*27/01/2015 9:17h*	*30/01/2015 10:27h*
User ID	*WaterstofNet*	*WaterstofNet*	*WaterstofNet*
Amount fuelled (kg)	*2,12 kg*	*3,51 kg*	*2,39 kg*
Begin pressure (bar)	*99 bar*	*174 bar*	*311 bar*
End pressure (bar)	*344 bar*	*739 bar*	*649 bar*
Fuelling time (s)	*209 s*	*159 s*	*173 s*
Fuelling protocol*	*C35*	*A70*	*A70*
Ambient temperature (°C)	*n.a.*	*2°C*	*1°C*
Dispenser	*350 bar*	*700 bar*	*700 bar*

**SAE J2601 fuelling protocol*

Source: WaterstofNet

Air Liquide station	Düsseldorf 27/1	Düsseldorf 29/1
Time:	*27/01/2015 10:48h*	*29/01/2015 21:05h*
User ID:	*WaterstofNet*	*WaterstofNet*
Amount fuelled (kg)	*1 kg*	*4,14 kg*
Fuelling time (m)	*2:29 min*	*5:07 min*
Product	*GH2 700b Pkw*	*GH2 700b Pkw*

Source: Air Liquide Düsseldorf

Vattenfall station	Hamburg 27/1	Hamburg 29/1
Time	*27/01/2015 15:54h*	*29/01/2015 15:48h*
User ID	*WaterstofNet*	*WaterstofNet*
Amount fuelled (kg)	*4,24 kg*	*3,90 kg*
Begin pressure IR (bar)	*80 bar*	*159 bar*
Begin pressure (bar)	*79,6 bar*	*158,6 bar*
End pressure IR (bar)	*635 bar*	*719 bar*
End pressure (bar)	*656,5 bar*	*734,7 bar*
Fuelling time (s)	*145 s*	*139 s*
Other	*Stop nr. 9* *Error nr. 550*	*none*

Source: Vattenfall Hamburg

H2Logic station	Vejle 27/1	Vejle 29/1
Time	*27/01/2015 19:33h*	*29/01/2015 21:05h*
Amount fuelled (kg)	*4,0 kg*	*1,0 kg*
Fuelling time (s)	*156 s*	*81 s*
Begin pressure (bar)	*180 bar*	*534 bar*
End pressure (bar)	*746 bar*	*679 bar*
Fuelling State of Charge	*99,6%*	*100%*

Source: H2Logic Denmark

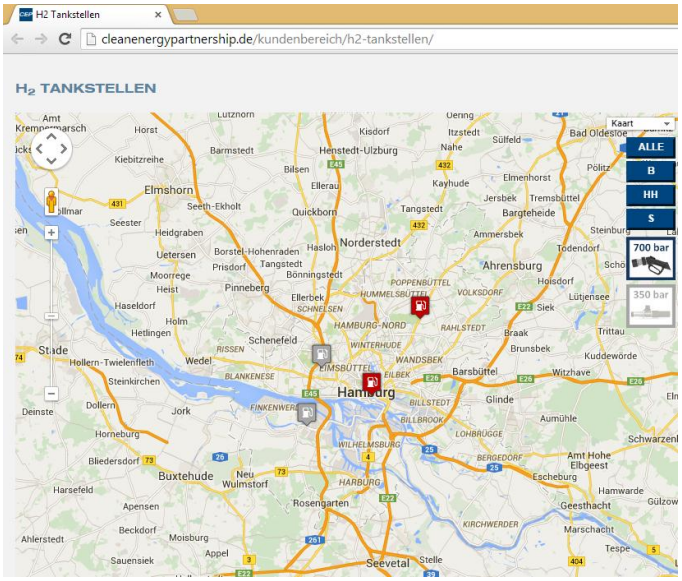
Current challenges

Throughout Europe there is a limited refuelling infrastructure network in place to fuel FCEV cars in place. On top of this, not all stations are publicly accessible. The distances between fuelling stations at the moment are quite big and it is only just possible to drive to other countries via the main road corridors, depending on small private stations.

Another issue is the identification or fuelling cards to be able to fuel at the station. At the German stations affiliated with the Clean Energy Partnership a CEP card is required. This card has to be ordered beforehand and is available for free to the public. At the stations from the partner WaterstofNet an access badge is needed, also to be ordered beforehand. At the Rotterdam AirLiquide station in the Netherlands you also need an AirLiquide fuelling card. For the H2Logic stations in Denmark a separate card is needed to fuel a fuel cell car. In summary it can be said, that every country or station operator region has its own means of identification at the station.

Therefore if passing through several countries, a range of different identification cards are required, which must be organised in advance. This is prohibitive to free movement throughout the North Sea Region.

Public accessibility of the stations is a key barrier at present. Some of the stations are owned by private organisations or are located on private ground, which provides a barrier to the public. Access can be granted but is limited or prohibited for external users.



Availability stations Hamburg 28/1/20151

The last issue, concerning availability of the refuelling stations is an important one. If planning a trip with a fuel cell car, in Germany it's possible to check the status of the different CEP stations online. Before returning to Belgium, the availability of the stations to travel home were checked and it became obvious that, both stations in Hamburg were out of service, due to maintenance. After checking with the station operators themselves, it turned out to be a small maintenance issue and the stations would be available at the time of arrival.

With this tool it is easy to check the availability of stations; however this system is not in place for other countries or stations.

RECOMMENDATIONS

One of the biggest tasks within different initiatives and projects is the extention of the hydrogen infrastructure, not only nationwide but also across the borders and regions in Europe. Examples of initiatives are the H2Mobility studies (UK, Germany, France, Belgium) and TenT projects to extend hydrogen in the European road transport corridor network. Within the Interreg North Sea Region, various strategic HyTrEc initatives contribute to the wider spread of hydrogen refuelling infrastructure, such as the Nort East England Hydrogen Economic Study, the Aberdeen Hydrogen Strategy, and also demonstration activities like those in Vejle, Denmark and the communication and education activities carried out by partners like Gateshead College, Hydrogen Sweden, SP Technical Research Institute and EIfI.

It is recommended that any future stations should be easily accesible and open to the public.

It is also important to have a refuelling/payment system which is compatible across countries. It should be made possible to fuel with a bank or creditcard instead of the different and individual set-ups at each station or in each country.

Conclusion

The trip was a success because of the detailed preparation work. A lot of work went into organising and receiving entry badges, Radio-frequency Identification (RFID) tags and operator contact details for every station along the way.

The car performed well, in all weather conditions, both moderate and harsh conditions with heavy snowfall, ice and cold temperatures.

The current hydrogen refuelling stations infrastructure should all be accessible to the public. The station in Brussels is private and the station in Helmond is semi-public.
The operators hope to see a bigger demand for hydrogen refuellings in the near future. Their main task, because of the very limited amount of fuelling stations, is to provide a high availability. An "out of service" station is a key risk to customers coming from far away!

Facts:

Total distance covered: 1865 km
Amount of refuellings: 9
[8 times 700 bar, 1 time 350 bar]
Kgs of hydrogen fuelled: 26,3 kg

Average consumption in kg/100 km: data-logging:
1,19 kg/100 km (84 km/kg)

Average consumption in kg/100 km: monitor WaterstofNet:
1,21 kg/100 km (83 km/kg)